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Impact of COVID-19 on healthcare professions education

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Impact of COVID-19 on healthcare professions education

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Editorial: Impact of COVID-19 on healthcare professions education

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KEYWORDS

COVID-19, healthcare profession, digital learning, face-to-face teaching, life-long learning

Editorial on the Research Topic
Impact of COVID-19 on healthcare professions education

The COVID-19 pandemic caused a major disruptive change in the educational system, including healthcare professions education. The highly contagious nature of the virus forced healthcare professions education to suspend or cancel face-to-face lectures, labs, and clinical teachings (1). While the pandemic will be remembered as a source of disruption, many will likely see it as a game-changer for the transformation of healthcare professions education. Due to the pandemic restriction and closure of educational institutions, educators and healthcare professionals shifted from real-time physical teaching to virtual learning with substantial changes in curriculum including the delivery and assessment modes (2).

In the post-pandemic era, face-to-face education has already been restored, but the integration of technology is highly likely to be an essential component of the future of health professions education. The present topic aimed to explore alternative teaching modes adopted in healthcare professions education due to the impact of the COVID-19 pandemic. We invited articles on various topics on scientific research and advances in innovations in teaching, learning, and evaluation in healthcare professions education. The published articles have highlighted the challenges as well as meaningful ideas and solutions to integrate technology in healthcare teaching and training.

Students and teachers had no choice but to adopt remote learning for the smooth transition of the curriculum. They came across numerous challenges such as poor technological infrastructure, lack of non-verbal communication, lack of clinical skills development, improper handling of virtual learning platforms, and lack of collaborative learning. Engaging students in the virtual learning process was also a herculean task for the instructors (Sarkar et al.; Hertling et al.). Gradually, students and teachers became acquainted with these new ways of knowledge transfer and remote learning. At the beginning of the virtual learning, students were enthusiastic and showed a positive attitude toward the new format of learning, whereas many teachers viewed it negatively because of the challenges to operate the digital platform. Subsequently, teachers were able to acquire technology skills and be comfortable with online teaching (Hertling et al.).

To continue with digital learning for the long term beyond COVID-19, it must be learner-friendly and diversified in terms of teaching and assessment. Teachers need to utilize both synchronous and asynchronous learning more efficiently. Yang et al. constructed a student-centered diversified online method to teach neurology by combining the advantages of modern information technology and scientific research. The teaching method consisted of diverse teaching resources (Online courses, MOOCs, virtual reality simulation systems),

diverse teaching services (question-answer sessions, discussion forums, teachers' feedback), and diverse teaching processes (multifarious teaching and assessment methods). It promoted students' interest in the subject, and they mastered the teaching content. It allowed teachers to reform their current teaching practices and improve the quality of teaching during the pandemic and for future education.

Practice-based clinical learning is a critical component of medical and healthcare training. It was challenging for the faculty and clinical preceptors to create an effective alternative to clinical learning when real-time classes were suspended during the pandemic (Bawadi, Shami et al.). Considering the safety of the students, family members, and patients, switching to virtual clinical teaching was considered necessary. However, it did not satisfy many preceptors and students due to the limited exposure to a real-time clinical teaching. Some students favored a real-time clinical learning environment with necessary protective measures (Bawadi, Rahim et al.). On the other hand, there is also evidence of students' positive outcomes in learning clinical skills by integrating appropriate technology. For example, Wang L. et al. found in their study that a virtual simulation operation (VSO) contributes to high-quality engagement in clinical skill courses. Students who used a VSO performed better in the clinical examinations compared to those who did not. It indicates that the proper use of technology, more specifically the VSO, can improve students' clinical skills operation. The outcomes of these studies set the base for future research to design effective and competency-based curriculum for online clinical learning using proper technology.

The COVID-19 pandemic opened the way to innovations in teaching adopting advanced digital technology such as e-learning, virtual simulation, podcasts, Siilos, Blackboard Collaborate, and many more (Wang M.-C. et al.). Podcasts are become increasingly popular in healthcare professions education. Healthcare professions education in Western countries has already integrated podcasts into curriculum design and delivery. The instant message application "Siilo" is another digital technology which has grown in popularity among physicians and health professionals during the pandemic. Siilo can create multiple folders in the smartphones or laptops which can store text messages, pictures, videos, and documents of patients separately. It appears to be a promising tool for facilitating case-based learning in health professions education. However, there is limited evidence showing the effectiveness of these digital technologies as teaching tools. More rigorous studies evaluating the students' learning outcomes and behavioral changes need to be performed to prove the significance of podcasts and Siilo compared to traditional educational modalities (Shahar et al.).

Health professionals require continuous and life-long learning to improve their competency level in their respective areas. Integration of technology in continuing medical education (CME) has undergone perpetual and progressive changes during COVID-19. Healthcare professionals used cloud classrooms which provided them with greater learning and exchange opportunities by attending virtual meetings and academic discussions from their homes without traveling anywhere. A cloud classroom plays a vital role in promoting learning experiences and developing the competency level of health professionals through a series of seminars, meetings, case discussions, special lectures, and interactive sessions (Chen et al.).

Good communication skills are a key attribute of a healthcare service. Therefore, every health profession student should demonstrate effective communication and interpersonal skills to become a competent healthcare professional. Assessment of these skills has always been a difficult job for the teachers. During the pandemic, assessing students' communication skills via *telehealth* provided a useful opportunity with the growing use of online environments. Wright et al. found that non-verbal communication is more difficult to assess using *telehealth* compared to verbal communication. To use *telehealth* effectively, proper training is required for teachers responsible for assessing students' communication and interpersonal skills.

The pandemic not only caused disruption in healthcare professions education but also created the issue of poor access to healthcare facilities. Due to lockdowns and restriction policies, self-medication practices had become widely popular among people across countries. Considering its harmful and dangerous effects, the engagement of healthcare administrators and policymakers and the implementation of health education programs are essential to regulate and monitor self-medication practices (Zheng et al.).

In summary, the articles included in the topic are related to the transformative changes in the approach to health professions education due to the COVID-19 pandemic. Despite enormous challenges, students and educators continued engaging through the virtual learning environment. The use of digital technology is inevitable in future health professions education. Educational institutions need a high level of preparedness and establish digital infrastructure; design online or blended curricula; explore multi-modal approaches in online delivery and assessment; and conduct advanced-level research to integrate digital technology in health professions education.

Author contributions

PS: Validation, Writing—original draft. HD: Validation, Writing—review and editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Student and Educator Perspectives of Adapting to Remote Health Professions Education: A Mixed-Methods Study

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During the COVID-19 pandemic, universities across the world transitioned rapidly to remote education. Engaging with a curriculum that has been transitioned from in-person to remote education mode is likely to impact how students and educators adapt to the changes and uncertainties caused by the pandemic. There is limited knowledge about individual differences in students' and educators' adaptability to remote education in response to the pandemic. This paper explored healthcare students' and educators' adaptability experiences to remote education. Drawing on pragmatism, a convergent mixed-methods design was adopted. Data were collected between May and August in 2020 using an online survey, followed by interviews with students and educators of five large health courses at an Australian research-intensive University. Data included 476 surveys and seven focus group interviews with 26 students, and 95 surveys and 17 individual interviews with educators. Results were interpreted through an integration of quantitative and qualitative elements from student and educator experiences. Findings indicated that students were less adaptable than educators. Whilst remote learning was less appealing than in-person learning, some students adapted well to the new learning environment. Limited social learning, transmissive pedagogy, and lack of technical and non-technical skills were identified as factors that impacted upon the experience of students and educators. Navigating the challenges associated with remote education provided students and educators with a unique opportunity to improve adaptability—an attribute critical for future uncertainties in healthcare practice.

Keywords: adaptability, uncertainty, pandemic, remote education, health professions education

INTRODUCTION

Adaptability refers to the cognitive, behavioral and emotional adjustments that individuals make to manage new, changing and uncertain circumstances, conditions and situations (1, 2). As Martin et al. (2) describes, cognitive adjustment refers to amending individual's thoughts, behavioral adjustment refers to amending actions, and emotional adjustment refers to amending affective responses, all to manage changing, new or uncertain events. A higher level of adaptability is associated with achievement, enjoyment, sense of purpose and life satisfaction (2). Adaptability is a key employability skill for success for graduates (3–6). There are uncertainties in the labor market caused by many factors, for example, technological advances, financial reforms and globalization (7, 8). Adaptability is thus required for graduates to cope with a rapidly changing, uncertain and highly competitive labor market (6).

Adaptability can be considered as a key requirement in all domains of work, life and education when natural disasters or global crises cause significant and lasting disruptions. March 2020, when the World Health Organization designated COVID-19 a global pandemic, marked a significant time in history when many things in our day-to-day lives were changed (9). The pandemic and the subsequent restrictions to physical gatherings interrupted conventional teaching and learning and disrupted the way tertiary education was delivered across the world. For health professions education, which has traditionally been supported through classroom-based teaching and work-integrated learning, the pandemic forced health professional courses to rapidly shift to a new mode of delivery. Pandemic-related restrictions considerably interrupted standard practices, requiring re-imaging of curricula, its delivery, and assessments (10, 11). Barriers included the loss of collaborative clinical experiences with peers, educators and patients, and the cancellation of face-to-face clinical workshops (12, 13). For preclinical medical education, whilst remote learning offered increased flexibility to students, these changes negatively affected the quality of instruction and student participation in learning (14).

The pandemic-related changes caused educators to adapt to different teaching philosophies and different modes of delivery (15). As Bao outlined, educators needed to adopt specific pedagogical strategies to maintain social learning for students in the online environment while achieving a smooth transition for them (16). Educators converted face-to-face teaching sessions to synchronous video conferenced lectures (e.g., using various video conference platforms) and asynchronous learning episodes. To promote student engagement in online learning, a range of online tools and remote teaching strategies were enacted (e.g., chat box, breakout rooms, polling, virtual whiteboards, annotate functions, quizzes and games) (17, 18). While many of these online tools were used pre-pandemic, their uptake was inconsistent, particularly with educators and students who had limited exposure to their implementation in the teaching and learning and learning context (15). A rapid response to the changes and preparation for remote learning left little time to adjust (19). Consideration was needed regarding logistics (e.g., technological devices, reliable network and a quiet study place), focus on learning remotely with limited academic advice, career guidance and mental health support (19). Additionally, both students and educators had to cope with the sense of isolation, stress and anxiety given the pandemic-related restrictions (20, 21). Understanding how online remote education influenced the preparation of health care professionals for practice is at the forefront of the global education agenda.

While there is a plethora of research exploring the impact of the COVID-19 pandemic on learning and teaching (17, 18, 22, 23), less is known about individual differences in adaptability to remote education by both students and educators in response to the pandemic. The COVID-19 pandemic is still unresolved, and there is uncertainty about when and how this can be resolved and what the future will be like post-pandemic. Given that adaptability is central to coping with, and problem solving in, new and uncertain circumstances (1, 2), understanding students' and educators' adaptability to the remote education during the COVID-19 pandemic may provide important insights into current and future complex challenges of health professions education. This study aims to explore healthcare students' and educators' adaptability experiences to remote education during the pandemic.

METHODS

Design

There is complexity of teaching-learning programs and multiple interactions involved in health professions education. This often requires various forms of data to make sense of health education research problems (24). Aligning with this, a mixed-methods design was adopted to facilitate our understanding of the various elements and factors that influence students' and educators' experience of adapting to remote education.

The study reported is part of a larger project which evaluates longitudinally the impact of the change to teaching and learning approaches in selective health disciplines, including remote education and changes to work-integrated learning, during the COVID-19 pandemic (25). This study was underpinned by pragmatism, which suggests pluralistic approaches to address research questions (26, 27). Pragmatism acknowledges both singular and multiple realities, and views knowledge being both constructed as well as based on the reality we are in and interact with (27). We come to know reality using both objective and subjective evidence. Aligning with these views, a convergent mixed-method design was adopted to utilize the power of quantitative and qualitative methods for answering the research questions (26, 28). Quantitative data were collected *via* online surveys of students and educators to capture their perceived adaptation to remote education and the challenges encountered in the process. In addition, group and individual interviews were conducted with selected students and educators to gain a deeper understanding of their experiences. The discussion then integrated these two types of data.

This research was approved by the Monash University Human Research Ethics Committee (Approval number: 24300) and informed consent was provided by all participants. Data reported in this paper were collected between May and August in 2020.

Study Setting and Participants

Participation was sought from the health faculty at Monash University—an Australian research-intensive university, which has 12 health professions and four health science courses. Disciplines were chosen purposively based on being the largest undergraduate courses in the faculty and included health profession and health science courses (pathways to post-graduate health professions degrees). Courses included medicine, nursing/midwifery, physiotherapy, health science/public health, and biomedical science. The study sample included students and educators of these selected disciplines.

Students from all year levels of these disciplines were invited using an announcement on the learning management system (Moodle) whereas educators were invited *via* email to complete the online survey, *via* Qualtrics. A subsection of the survey respondents voluntarily participated in the second phase of the study—group interviews for students and individual interviews for educators. Seven group interviews with students and 17 individual interviews with educators were conducted.

Data Collection

Phase 1

Separate surveys were administered for student and educator participants at the end of the first semester in 2020 (May–June). The surveys were developed by the researchers and refined through discussion in several rounds of team meeting. Prior to administering, the surveys were piloted with ten students and four educators. Both surveys asked some similar demographic questions (e.g., gender, and discipline). The student survey further asked about year of study, student status (local/domestic) and first language, while the educator survey asked about their academic level. The surveys also asked participants whether they have any experience of remote education prior to the COVID-19 pandemic. We asked participants to rate, on 5-point scales, how prepared and interested they viewed themselves for remote education. For preparedness, the scale ranged from 1 = not all prepared to 5 = extremely prepared, whereas for interest, the scale ranged from 1 = not all interested to 5 = extremely interested.

Both the student and educator surveys included a validated nine-item Adaptability Scale (2) to measure participants' adaptability. When responding to the items, participants were asked to consider their experience of remote education during the pandemic. The items of the Adaptability Scale asked them how constructively they could respond to new, changing, and/or uncertain circumstances, conditions and situations (e.g., I am able to think through a number of possible options to assist me in a new situation). Participants responded to items on a 5-point scale of 1 = strongly disagree to 5 = strongly agree. Additionally, participants were asked about their perceived effectiveness in adapting to changes related to remote education on a 5-point scale, ranging from 1 = not effectively at all to 5 = extremely effectively. It was anticipated that participants with higher level of adaptability, as measured by the Adaptability Scale, would report higher effectiveness in adapting to changes related to remote education.

Drawing on previous studies [e.g., (29, 30)] we compiled factors which might have challenged students and educators to adapt to remote education. The factors represented interpersonal types (e.g., lack of personal relationship), technology-related (e.g., inadequate technology support), and cost–benefit types (e.g., incremental change in workload burden). Both the student and educator surveys included 11 factors in common, wherein the educator survey had four additional factors (see **Figure 1**). These factors were: inadequate time for assessment and feedback, inadequate instructor training, inadequate pedagogical skills for remote teaching, and lack of body language cues from students. All respondents were asked to indicate the extent to which each factor challenged them in adapting to remote education on a 5-point scale of 1 = not at all a challenge to 5 = a serious challenge. The surveys also collected students' and educators' expressions of interest in participating in the follow-up qualitative phase. A copy of the surveys is available on request.

Phase 2

Phase 2 data collection (i.e., interviews) was conducted between June and August in 2020. Group interviews were used for students to stimulate discussion and enable debate in order to understand their views of remote learning experiences (31). For educators, we wanted to capture individual perspectives of their experiences, best facilitated through in-depth interviews, rather than focus group discussion. Also, based on our previous experiences working with busy educators, we perceived that scheduling group interviews might be challenging.

Semi-structured interview protocols were used with necessary probes and prompts allowing the interviewer to explore participants' answers to gain deeper insights and seek clarification (32). The protocols commenced with a general question "what was your experience of learning (or teaching) in this past semester", which generated intensive discussion about their adaptation to remote education and the associated challenges encountered. The protocols were developed by the research team after the initial analysis of the survey data to identify issues which warranted more exploration. For example, the surveys identified the lack of social learning as a major challenge of remote education for both students and educators. Reflecting on this, we included questions, e.g., "what role did your peers play in your learning in the past semester?" in the students' protocol, wherein the educators' protocol included, "why do you think the majority of educators are concerned about lack of social learning and what may be its impact?". In the group interview, we also facilitated as much discussion between participants as possible, using questions such as: "Did anyone else have a similar/different experience?"

All group and individual interviews were conducted virtually using Zoom (Zoom Video Communications, San Jose, CA, USA), which were recorded and transcribed for analysis. A total of seven group interviews were conducted with 26 students and 17 educators participated in individual interviews. Student interviews lasted between 44 and 74 min (mean 48 min, total 5 h 33 min) and the educator interviews lasted between 19 and 63 min (mean 43 min, total 12 h). Sufficient information power (33) to analyse and interpret findings was assisted by our focused

aim (i.e. stakeholders' experiences of the adapting to remote education), our tight sample specificity (i.e., student and educator stakeholders), the high-quality dialogue in the interviews, and our team-based thematic analysis strategy (34).

Data Analysis

SPSS (version 27, IBM Corp, Armonk, NY, USA) was used for statistical analysis of the Phase 1 survey data. After screening and cleaning of the data, descriptive statistics for demographic data were summarized using mean, standard deviation for continuous data (e.g., age), whereas, frequencies and percentages were calculated for categorical data (e.g., gender, year of study). Mean and standard deviation were computed for Likert scale data. The relationship between perceived effectiveness to adapting to remote education and adaptability score was analyzed using Pearson correlation coefficient. Significance of differences between groups was evaluated using independent-samples *t*-test for two groups (e.g., comparing adaptability scores between male and female) or one-way between group *ANOVA* for more than two groups (e.g., comparing adaptability scores among the disciplinary background). *P*-value of $< 0{\cdot}05$ was set as the threshold for statistical significance.

NVivo (version 12; QSR International, Melbourne, Australia) was used to analyze the interview data. Digitally recorded interviews were first transcribed, and then each was scrutinized by simultaneously reading them and listening to their recordings. Four authors (MS, KL, AK, and CP) were involved in the analysis using Ritchie and Spencer's (34) five-stage framework analysis. Using this approach, we first developed a coding framework with students' data and then adapted this for educators' data. The first stage involved a sample of student transcripts being analyzed and initial codes were generated individually across them. The second stage involved discussion in several rounds of team meetings based on which a coding framework was developed. We used the negotiated agreement process to resolve any disagreement and to establish the rigor of data analysis (35). This negotiated agreement process involved us coding the data independently and then regularly meeting to compare, contrast, and come to an agreement about our interpretations. This process was iterative until the final coding framework was agreed on. The coding framework detailed codes, definition/description together with illustrative quotes. The third stage involved each transcript being coded using the coding framework in NVivo. The coding framework was modified as required during this indexing process to complete all interview coding. The fourth stage involved identifying patterns in the data such as the similarities and differences between student and educator perspectives. The final stage involved ongoing discussion among the analysis team to compare, contrast and negotiate our interpretations of each theme and sub-theme and discuss the interpretations of the findings in light of the research literature. The entire process helped to maximize the credibility of the analysis and enhance the rigor of the study.

Team Reflexivity

Our team of eight was diverse in terms of our research experience and orientations with qualitative and quantitative methodologies, disciplinary backgrounds, and demographics (e.g., age, gender). We had representatives from each target discipline (i.e., medicine, nursing, physiotherapy, biomedical science and health sciences). We completed a team reflexivity exercise (36) at the beginning of the project. This provided us with a valuable opportunity to understand each other's perspectives and served to surface our backgrounds and experiences, and thus potential influences over data collection and analysis. Diversity within our team supported more rigorous data interpretation with team members contributing different perspectives and insights into the data analysis and reporting.

RESULTS

In this section, we report results on quantitative and qualitative data separately. The results are then examined together through integration in the discussion section.

Participant Demographics

A total of 476 students out of 717 who opened the Qualtrics link voluntarily completed the survey (completion rate 66%). Ninety-five educators out of 137 opening the Qualtrics link voluntarily completed the survey (completion rate 69%). Incomplete surveys were not included in the analysis. Students' mean age was 21.3 years ($SD = 4.3$) and educators' 47 years ($SD = 11.6$). First year students had the highest representation (29%) followed by third year (27%). The majority of the participants were female in both student (75%) and educator (76%) groups. Medicine students had the highest representation (36%) followed by biomedical science (27%), whereas the highest number of educators represented biomedical sciences (31%) followed by nursing/midwifery (26%). The majority of the student participants were local/domestic students (82%) with English as their first language (79%).

A total of 26 students participated across seven focus group interviews. Focus groups were heterogeneous, i.e. participants represented different disciplines and year levels. Female (72%), local students (68%) were the majority with half of the students representing medicine. First year students had the highest representation (36%) followed by fourth year (27%). Of the 17 individual educator interviews, the highest representation was from nursing ($n = 5$). Medicine, physiotherapy, biomedical science, and health science had equal participation ($n = 3$ each).

Phase 1 Results

Previous Experience of Remote Education

Two-thirds of the students (66%) reported that they did not have any experience of remote education prior to the COVID-19 pandemic. Of the educators, almost half of them (49%) had previous experience providing remote education.

Adaptability to, Preparedness for, and Interest in, Remote Education

For the Adaptability Scale, Cronbach's alpha for student and educator population calculated as 0.88 and 0.87, respectively, indicating the scale has high internal consistency (37) for our sample. So, scores as measured by the Adaptability Scale can be considered reliable.

As **Table 1** presents, the Adaptability Scale yielded a higher score for educators, indicating their higher adaptability to remote education than students. Neither students nor academics seemed prepared for remote education, leaving the mean score < 3 for both groups. Students' interest in remote education also seemed relatively low, whereas academics were significantly more interested in remote education.

A Pearson correlation test indicated a strongly positive correlation between participants' adaptability scores and their perceived effectiveness of adapting to remote education (students: $r = 0.41$, $p < 0.01$; educators: $r = 0.59$, $p < 0.01$). This result aligns with our anticipation that participants with higher level of adaptability would report higher effectiveness in adapting to changes related to remote education. Similarly, strongly positive correlations were found between adaptability scores and their preparedness (students: $r = 0.35$, $p < 0.01$; educators: $r = 0.22$, $p < 0.05$) and interest (students: $r = 0.14$, $p < 0.01$; educators: $r = 0.26$, $p < 0.05$) in remote education.

The sub-group analysis for the adaptability score was done using independent samples *t*-test (for two groups) or one-way between group ANOVA (for multiple groups). For the student cohort, their adaptability to remote education did not differ statistically for gender, discipline, year level, student status and any previous experience of remote education. Similarly, educators' adaptability to remote education did not differ statistically for gender, discipline, academic level and any previous experience of remote education.

Challenges to Adapting to Remote Education

Figure 1 illustrates the extent to which students and educators perceived the factors as challenges to adapt to remote education, based on the mean scores calculated. On average, all of the factors received a mean score of < 4, indicating that those were perceived as moderately to quite challenging by the participants. Factors of interpersonal types (e.g., lack of social interactions and lack of personal relationship) and cost–benefit types (e.g., increased workload) were the bigger challenges for

TABLE 1 | Students' and educators' adaptability and perceived effectiveness in adapting to, preparedness for, and interest in, remote education.

	Adaptability			Perceived effectiveness in adapting			Preparedness			Interest		
	Mean	SD	*t*	Mean	SD	*t*	Mean	SD	*t*	Mean	SD	*t*
Students ($n = 476$)	3.57	0.61	9.22**	3.18	1.01	8.89**	2.38	1.03	2.34*	2.22	0.67	16.71*
Educators ($n = 95$)	4.19	0.50		3.98	0.74		2.65	1.06		3.68	1.19	

*Significant at the 0.05 level; **Significant at the 0.01 level.

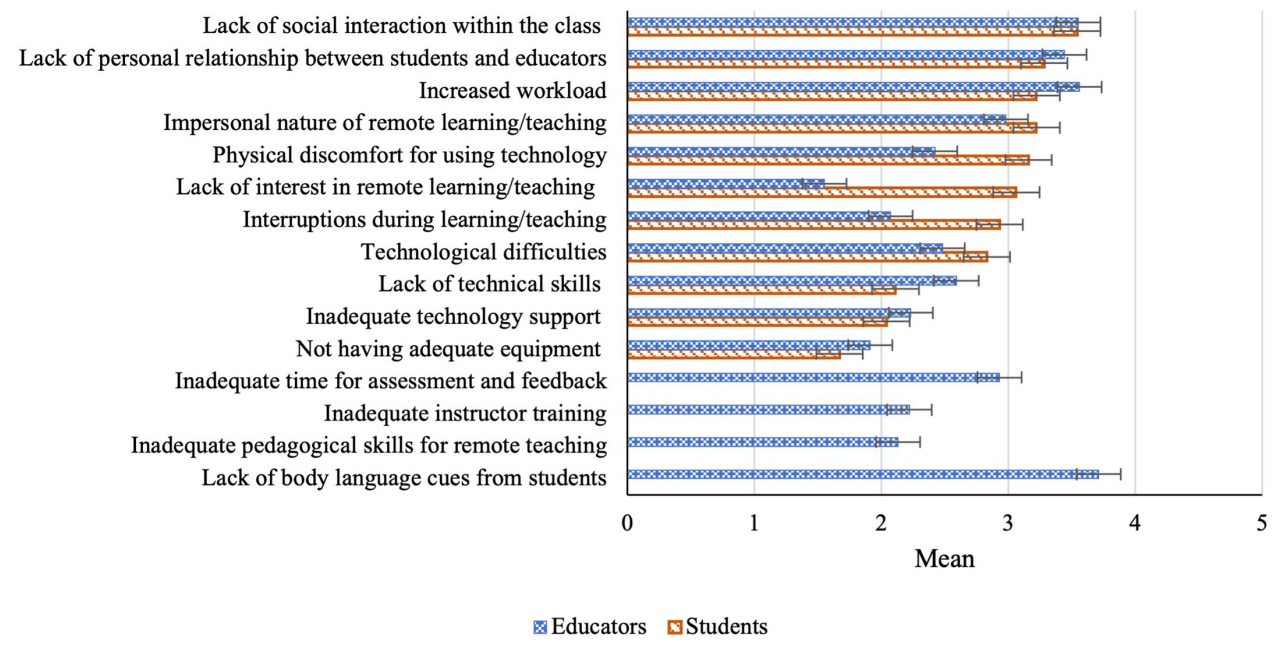

FIGURE 1 | Students' and educators' challenges to adapting to remote education. 1 = Not at all a challenge, 2 = A minor challenge, 3 = A moderate challenge, 4 = Quite a challenge, 5 = A serious challenge.

TABLE 2 | Illustrative quotations for social learning.

1.	I guess, face to face contact, even thinking back to lectures, being able to read body language, things like that being face to face, having bodies in a room. It is I guess, more difficult to keep up with students who maybe you are a little be concerned about, and that comes back to the body language, how they're interacting with their teammates and things like that. I felt like that was, I was a bit more removed from that. (EI2)
2.	I find there a little bit of awkwardness. You know, in zoom chat, someone wants to go say something, it's like, No, you go, No, you go, you go. I think that it's made the interaction a bit more sort of stilted. I don't think it's quite as natural as it would be if you're in person. Yeah, I think it's definitely been a I think it's been a factor. (SFG7)
3.	I think from a teacher's perspective, I find it very difficult because you can't, you're not getting any feedback from students. And if they're not turning their cameras on or they're not engaging, it's very hard. So you're chatting to this screen and you're not getting anything back. (EI1)
4.	Probably I just think we lack the connection and the ability to ask questions that we do in the pracs, where we can just stop and talk to you. (SFG1)
5.	I don't have the same rapport the students that would normally have and in saying that I feel like and I'm not trying to blow air and trumpet but I feel like our students feel like they've got struck a strong connection to us and they might have with other educators. But yeah, I don't feel like we've got that rapport that we would normally have. (EI4)
6.	Discussions with peers support deep learning, not much has really stuck because you know, having those discussions with your friends about things is not happening. (SFG4)
7.	Students are much more likely to critically evaluate what their peers say than what we say if we say something, they'll hear it the way they think they've heard it. And they will hold that misconception for years to come. Because they heard it from us, but really they didn't hear it from us, they heard us say one thing in their head that they thought they heard. But when their peers say it, they're more likely to critically evaluate it, they're more likely to really analyse and work out how that fits in with our own understanding. We've lost that ability this year. (EI9)
8.	I'm in a breakout room, I don't know what's happening in the other four breakout rooms, because I can't see them. Whereas, I could see it on a table before. And I could go well, I know that there's no other hands up, I know, I can see everybody else is working, I can keep an eye on the rest of the class. But I know that you're having trouble. So I'm going to sit here and try and get you to think it through rather than to tell you why. Now I'm like, okay, I've spent 5 min in this room already. I need to go make sure the other rooms are okay. You know, I don't know if they finished or not finished or whatever. (EI9)
9.	You know, normally you look in a classroom without being intrusive, but then when you go into a breakout room, everything stops or the whole dynamic changes. Either they notice you and the whole dynamic changes, or they don't notice you and then I feel like a stalker. (EI9)
10.	I think that motivation is the largest role that my peers play in my learning, being able to discuss content with them whether it's incidental in terms of on the wards or just *via* studying together or, more formally in a face to face setting and PBL. That's non-existent now and I find with the online modules, lacking the social element of learning impacted my engagement in learning. (SFG3)
11.	I think so often, I almost forget that I'm doing a course and there's other people also doing it, because it's essentially kind of just me in my house studying. Um, so I think it's really that social aspect that I'm missing, which kind of pulls everything and makes the whole process more enjoyable, and kind of exciting. (SFG5)
12.	Cannot make new friends, because it was very difficult to do that in the zoom environment. (SFG4)
13.	Before we go by just the incidental kind of social things like people you wouldn't necessarily, you know, send a message on Facebook, but you'd say hi to them in the corner, and you'd have a bit of a chat and stuff like that. That's something I've definitely missed. (SFG4)
14.	all the informal learning that happens between students in the corridors, meeting someone in the toilet cubicle, you know, like when you're washing your hands and having a chat at the library, walking down to get a coffee, you know, not just the formal classroom workshops, but all of that stuff is just pivotal to being socialized into University, and ask those trivial questions and all of that. (EI14)

EI, educator interview; SFG, student focus group.

TABLE 3 | Illustrative quotations for teaching philosophy.

1.	I'm very organic and bit more responsive in my teaching. And so I would take cues when I was teaching face to face to know which direction or I'd find those teachable moments where the gold is, you know, where you feel that buzz in the room that lights have gone on their heads. And, and I didn't have any of that. (EI4)
2.	I don't talk very much, they do all the talking with each other … that's sort of the basis of my teaching philosophy. I had to sort of revert back to didactic teaching because I didn't know how to really engage them in that peer to peer learning online in such a short period of time. (EI14)
3.	I'm becoming one of those old fashioned teachers who is more likely to go in there and say, Well, this is what the answer is, even if I do probe them for a bit of understanding, I'm still much more likely than I would have been in previous years to be able to, you know, to feel the pressure of time, perhaps and then maybe probe them a little bit, but kind of give in to them and give them an answer. Whereas, in the past I would say I would sit and problem solve with them. (EI9)
4.	Didactic teaching is already difficult to engage with at times, let alone on Zoom, and months of it was not an ideal way to learn. (SFG3)
5.	Teaching this way has been a challenge at times to stay engaged, to be honest. The inherent interest is still there. But I think this is just a consequence of being isolated and not having the change of scene and yeah, being alone. I think the engagement that it's, it has flagged at times, and you kind of do feel like I just want to hide a little bit from students. (EI7)
6.	I felt really insecure about my teaching online but I just not as I said, I'm not as good a teacher now, as when I was in the classroom. (EI2)

both students and educators. In comparison, lack of interest in remote education, physical discomfort and being interrupted were more challenging for students than educators. It appears from **Figure 1** that, of the 15 factors for educators, participants found the lack of body language cues from students as the most challenging factor.

Phase 2 Results

Analysis of qualitative data identified common themes representing the educational experiences students and educators had while adapting to remote education. The themes included: social learning, teaching philosophy, technical and non-technical skills, and supporting adaptability.

Social Learning

The major concern educators and students expressed in adapting to online learning was limited social learning that occurred during remote education. They observed the loss of body language cues (**Table 2**, quote 1), artificial and impersonal interactions (**Table 2**, quotes 2–3), limited conversation (**Table 2**, quote 4), weaker rapport (**Table 2**, quote 5), and little peer to peer debate and discussion that diminished the value of deep learning (**Table 2**, quotes 6). Educators were concerned about the impact of limited peer learning on student ability to discuss and critically evaluate learning content with their peers. They reported that students take educators' words as absolute truth but are more likely to critically evaluate what their peers say (**Table 2**, quote 7).

In response, educators attempted to replicate group discussion using breakout rooms that would usually happen around tables in a face-to-face environment. However, they struggled to keep track of the discussions being had in each group due to the inability to physically visualize the classroom (**Table 2**, quote 8). Also, they noticed that their presence in a breakout room affected the conversation dynamics and the level of engagement generally developed in a face-to-face classroom (**Table 2**, quote 9).

Students appreciated how important their peer's role was on their learning motivation and commented on how limited peer interactions impacted their engagement in learning (**Table 2**, quote 10). As a result of limited peer support, learning experiences for students became less enjoyable and boring (**Table 2**, quote 11).

Students struggled to make new friends online (**Table 2**, quote 12). They missed out on the incidental interaction opportunities to meet people that would happen in a face-to-face environment (**Table 2**, quote 13). This affected their ability to socialize with their peers, and extend the learning and conversation from the confines of the classroom to the wider space and University campus (**Table 2**, quote 14).

Teaching Philosophy

Adapting to remote education required educators to change their teaching philosophy. They reported the loss of being organic and responsive in teaching remotely that is naturally fostered in the in-person environment (**Table 3**, quote 1). This prompted them to shift to a more didactic pedagogy, given their limited knowledge of making online lessons engaging (**Table 3**, quote 2). Educators also recognized that students took on a more passive stance in learning, requiring more prompting from teachers (**Table 3**, quote 3). Students found the didactic approach less engaging and less efficient for learning (**Table 3**, quote 4).

Educators reported the shift to transmissive pedagogy affected their own levels of engagement, causing feelings of exhaustion and disconnect with students compounded by social isolation (**Table 3**, quote 5). This contrasted starkly with the energy naturally fostered in face-to-face learning environments, despite retaining the synchronous learning environment and interacting with students remotely. Additionally, this shift prompted educators to feel less competent in online teaching (**Table 3**, quote 6).

Technical and Non-technical Skills

Adapting teaching that previously was heavily centered on clinical placement and laboratory/practical classes into an online learning environment was reported as challenging. Educators and students noted the adverse impact that remote education had on students' technical skills development. This resulted in reduced student ability to effectively develop and practice these skills in real-time with their peers and teachers, and there was also a loss of the reasoning and critical analysis that is generally garnered from the physical involvement with a practical or a laboratory-based class (**Table 4**, quote 1). Educators noticed the shift to theoretical learning without applying this theory in a real-world, practical context (**Table 4**, quote 2). Similarly, students viewed that a lack of hands-on learning opportunities would result in limited clinical and practical skills (**Table 4**, quote 3).

Not only was the development of technical skills impacted, but educators also perceived the change in the physical learning environment to hinder students' abilities to develop non-technical skills (i.e., transferable skills, e.g., communication, teamwork and critical thinking) necessary for entering the workforce (**Table 4**, quote 4). Particularly, they perceived that students from culturally and linguistically diverse backgrounds would be disadvantaged in terms of limited key competencies as they missed the opportunity to interact with local students (**Table 4**, quote 5).

Supporting Adaptability

Many students viewed health professions as a rewarding career and felt that this view helped them keep focused on remote learning (**Table 5**, quote 1). They considered that they were part of a community going through the challenges caused by remote learning. Together with being resilient and continuing learning, this view supported their adaption (**Table 5**, quote 2). Students also recognized that how well they adapted to remote education did not necessarily indicate their liking for it but their acceptance of it for the time (**Table 5**, quote 3). For educators, having an intrinsic interest and passion in teaching and resource sharing and supporting other educators helped facilitate student learning in a remote environment (**Table 5**, quotes 4–5). They created a supportive structure for students through frequent check-ins and pastoral care (**Table 5**, quote 6). They were compassionate to student needs and ensured flexibility when required, for example, in assignment extensions (**Table 5**, quote 7). Both students and educators viewed the critical importance of a positive attitude to change, and viewed remote education as an opportunity to learn and grow to adapt to future changes (**Table 5**, quotes 8–9).

TABLE 4 | Illustrative quotations for technical and non-technical skills.

1.	I was teaching a very lab heavy, practical, focused unit, and that we basically had to set all of the technical side of the unit aside. So I think that's a big hole for the students that ordinarily were in a unit that really teaches them a lot of the fundamentals that they take on to other units, and throughout their degree. And the students obviously didn't gain any of those technical skills this semester. (EI6)
2.	The immediate impact is a complete disruption to the manner in which they learn and the skills that they learn. They are really forced into much more theory, and relying on to some degree of roleplay and new technologies, which they've not done before and a lot of them struggle a bit with that. (EI2)
3.	They did provide some videos that about how to, like provide a vital sign or measure blood pressure, actually, my brain was in but my hands are not on it. It's hard to transfer the knowledge from my brain to my hand. (SFG2)
4.	Online learning doesn't encourage questions and doesn't encourage critical thinking when students aren't surrounded by other people, and less team working and communication. So you miss the soft skills. (EI3)
5.	Perhaps a growing cohort of our students who come from culturally linguistically diverse backgrounds that don't have that same basis and don't have that same exposure to Australian culture and our sort of local cultural and communication practices. And I think that will impact quite profoundly on them. (EI15)

TABLE 5 | Illustrative quotations for supporting adaptability.

1.	For all of us, we're doing courses that especially now during like a pandemic, we realize, how important they are, we look at, like the doctors, the researchers, the nurses, like all those frontline kind of essential workers as heroes. So I think, seeing that you can also be part of it and essentially contribute to that is also something really special, rewarding (SFG5)
2.	All students are having, yeah, going to the same situation like you. … I think having that resilience to just keep pushing, keep learning, keep safe to make sure that you stay on top of those things really is important. (SFG4)
3.	I felt like I adapted quite quickly to online learning. That doesn't mean to say that I like it or I'm interested in it. It's just something that I've accepted now. (SFG3)
4.	If you're someone who I think is intrinsically, you want to see students learn, you want to challenge yourself in the way that you deliver content and get students involved and interactive. … I think the intrinsic interest is really important. (EI7)
5.	I think there's been a lot of resource sharing. … I think that's been a definite positive people being willing to say, yeah, sure, have a look at my Moodle site, take what you need. (EI6)
6.	I was a bit more plugged in, in terms of monitoring them and touching base, a lot of more unit announcements coming out every week just to check in and that pastoral care element. (EI3)
7.	There was a lot of extensions given for assessments. And marking it allowing for this particular, you know, pandemic and the anxiety that that would bring and all of those things. (EI14)
8.	Change happens all the time and how to adapt change in what the positives might be of the change. And so yeah, it's a willingness to adapt to change … is such an integral part of managing this whole situation in all aspects of our lives, not just in teaching. (EI16)
9.	When started [the semester], no one would have thought they've been doing the whole course online. We've all had to adapt to all the changes, so we are more prepared for any changes. (SFG5)

DISCUSSION

This study aimed to explore healthcare students' and educators' experiences while adapting to remote education. Integrating quantitative measurement of students' and educators' adaptability and qualitative exploration of their adapting experiences together showed that students were less adaptable than educators, and while remote learning was less appealing, some adapted well to it. Reduced opportunities for social learning, combined with a move to transmissive pedagogy and lack of clinical and transferable skills development, characterized participants' adapting experiences. Despite this, students and educators utilized adaptive strategies to address the shift to remote learning. Implications of these key findings will now be explored in light of the literature.

Adapting to the lack of social learning was found to be a challenge for both students and educators. Additionally, for educators, the most challenging factor was the lack of student body language cues—an aspect of social learning (16, 38). Educators described initiatives that attempted to maintain social learning using digital platforms. Other evidence has also suggested that educators worked harder to manage chatrooms and collect non-verbal cues from students that added to their workload and influenced their adaptability (38). The limited peer to peer interactions was reported to promote surface learning and student reliance on teachers. Others have highlighted the critical role of peer to peer interactions for promoting deep learning (39).

Adapting to remote learning hindered the development of technical (i.e., clinical) and non-technical (i.e., transferable) skills of students given their limited exposure to rich learning experiences encompassing authentic problem solving in clinical settings and collaborative learning with peers. Both clinical and transferable skills are essential for students' preparedness for practice or employability post-graduation (40). In addition, transferable skills (e.g., collaboration, communication and cultural competence) contribute to learning in a multicultural education environment comprising diverse student cohorts (41). Our finding, therefore, questions the fitness of remote education to prepare future healthcare graduates.

A striking finding suggested from our qualitative data was that educators adapted by shifting to transmissive pedagogical approaches. This contradicts the advocated pedagogical approaches for effective student learning, especially in remote education settings (16, 42). As Rapanta et al. suggested, in remote educational settings, the educators' role is more focused on facilitation (than direct teaching), while students take ownership of their learning. However, educators in our research focused on delivering content using didactic pedagogy, whereas students took a more passive role. Nonetheless, being a passive learner was not appreciated by our student participants, as aligned with recent studies (43–45). Data suggested educators' awareness of the notion of 'teacher presence' is significant for online learning (46), yet limited knowledge of how to engage students more effectively in remote settings, coupled with lacked time to make a more planned approach, attributed to the change in their teaching philosophy and disconcerting adaptability experience to remote education. This finding suggests the need for further professional learning opportunities for educators to design student-centered and engaging online learning episodes for students.

Strong career aspiration and positive attitudes supported students in adapting to remote education, whereas educators recognized the role of passion and intrinsic interest in teaching, collaborative and supportive network, and being flexible and compassionate to student need in their adaptation mechanism. Additionally, a willingness to adapt to changes facilitated the adaptation for both groups of participants to remote education. Aligned with previous research (47), this finding attests to the critical role of adaptability and the significant challenges experienced by students and educators in learning and teaching due to the need to rapidly adjust to the changes and uncertainties caused by the pandemic. Given that educators are better at adapting to remote education than students, their teaching may consider the promotion of adaptability mechanisms so that students are better equipped to adapt to future uncertainties. Since adaptability is a sought after skill for employability or preparedness for practice (6), its promotion may mean that students are graduated with higher adaptability to cope better with uncertainties within the future world of work.

Our study found that participants' adaptability did not differ for demographic factors (e.g., gender, student status, academic level) or whether they had previous experience of remote education. This finding does not align with previous research focusing on school-aged students that reported socio-demographic variables (gender, age, language background) as predictors for adaptability (2). Future research can therefore investigate if there are any specific socio-demographic variables affecting the adaptability of University students and educators. It would also be interesting to see if adaptability is associated with academic achievements or personality variables (e.g., extraversion and openness). Future research can also examine how individual participants interpret adaptability and relate this to their cognitive, affective, and behavioral reactions in novel and uncertain workplace situations.

Limitations and Strengths

The limitation of this study is the single Australian institution focus limiting the transferability of the findings to other institutions and countries. The lack of student participation in latter years of the courses who were likely to have been able to continue with clinical placements, including tele-health is a limitation. However, the study includes both students and educators—two key stakeholders in education—from various health professional courses, and uses a mixed-methods design with voluminous quantitative and qualitative data, meaning a complete picture of the research problem reported in this paper (28).

CONCLUSION

This paper reports healthcare students' and educators' adaptability experience to remote education during the pandemic. We found that whilst students and educators adapted to remote education with varying degree, their description of the remote education experiences can mostly be seen as unsatisfying (e.g., limited social learning, transmissive pedagogical focus, and lack of clinical and transferable skills development). These findings prompted us to question the effectiveness of remote education in preparing healthcare students for practice. The COVID-19 pandemic is not over yet. We further anticipate that remote education is likely to become more commonplace for many courses beyond the pandemic. We argue that online health professions education must be accompanied with adequate face-to-face skill development opportunities, and educators must be supported to design student-centered and engaging online learning. Navigating the challenges associated with different modes of education may support students and educators improve adaptability—an attribute critical to managing future uncertainties.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the qualitative dataset cannot be shared with anyone beyond the research team according to the approved ethics. Requests to access the datasets should be directed to MS, mahbub.sarkar@monash.edu.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Monash University Human Research Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MS, KL, AK, and CP were involved in analyzing and interpreting data. MS drafted the paper. All authors designed the study protocol, secured ethics approval, collected data for the study,

and critically reviewed and edited various iterations of the paper. All authors gave their final approval for this version to be published and agreed to be accountable for all aspects of the work.

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Assessment of communication skills using telehealth: considerations for educators

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Objective: The main aim of this study was to explore the views and perceptions of dietetic educators on their ability to assess communication skills of undergraduate student dietitians in a telehealth setting. A secondary aim was to provide recommendations to educators when assessing these skills using telehealth.

Methods: A descriptive qualitative study design was used. Australian and New-Zealand dietetic educators used a validated global communication rating scale to evaluate three pre-recorded telehealth encounters. Educators then answered a series of open-ended questions on their ability to assessed communication skills in the telehealth environment.

Analysis: Inductive analysis allowed the emergence of themes and sub-themes independent of a specific framework or theory. Peer debriefing and triangulation increased research rigor.

Results: Twenty-four educators were included in this study with the majority (87.5%) having > 10 years experience as a dietetic educator, and 41.6% (n = 10) with experience in assessing dietetics student using telehealth. Most (76%) educators reported the assessment of non-verbal communication skills were challenging in the telehealth environment. Five themes and 15 subthemes emerged relating to advice for students and educators when assessing communication skills and a checklist was developed from recommendations that students and educators can use when preparing, planning, implementing, and assessing telehealth consultations.

Conclusion: Assessing student communication skills *via* telehealth provides a useful opportunity with the growing use of the online environment, however, it also presents challenges that must be taken into consideration. While verbal communication skills are easier to assess than non-verbal, both need to be adapted for the telehealth setting.

KEYWORDS

communication, dietitian, education, simulation, student, telehealth, telemedicine, university

Introduction

In the wake of the COVID-19 pandemic the education sector had to rapidly shift to an online learning environment. This posed unique challenges and opportunities for healthcare education, assessment, and skill development. Telehealth is one such opportunity that was embraced by universities, clinicians, and students alike (1–4). Telehealth is defined as the use of information and communication technology for persons and communities who have difficulty in accessing their healthcare provider (5). Telehealth provides telemedicine, medical education, and health education without the constraints of distance. It is seen as the future of healthcare as it enables access to quality healthcare for those that are constraint by time and distance (5–7).

Telehealth has shown promise to help overcome patient-centered and health care barriers to health management (8), and within dietetic service delivery to be effective in the provision of nutrition interventions including malnutrition (9), and management of non-communicable disease (10–12). However, prior to the COVID-19 pandemic, telehealth was not necessarily incorporated into the curricula of dietetics and other healthcare programs or widely used in service delivery due to various concerns and challenges (i.e., quality of care, ethical, and legal issues) (13). Nevertheless, evidence emerged on the potential benefit of using telehealth as an alternative setting for student skill development (14, 15), with an e-Health skills component positively received by dietetic students (16). In 2020, despite limited time, resources and readiness to embed telehealth into dietetic curricula, educators had to quickly adapt in response to the unfolding pandemic and utilize telehealth as an alternative setting for student training prior to and during clinical placement (3). With the surge in the uptake of telehealth, professional bodies developed guidelines to support dietitians in the implementation of telehealth (17, 18). Recently a United States-based study surveyed registered dietitians about their perceptions of telehealth in practice prior to and during the pandemic. The study identified several opportunities afforded by telehealth including longer assessment times with patients and enabling an insight into the home environment, not otherwise seen in face-to-face consultations (19). Similarly, Mehta and colleagues (20) identified several positive aspects to telehealth and concluded that telehealth is likely to remain as a component to dietetic practice. This highlights the importance for dietetics educators to effectively implement and design experiential learning opportunities which incorporates telehealth into curricula in order to best equip future dietitians in the delivery of healthcare now and post-pandemic. Currently there is paucity in resources and guidance on the assessment of dietetic skills in a telehealth setting.

An area of concern in the implementation of telehealth is the risk of depersonalization in the clinician-patient relationship due to the lack of human contact and ability to pick up on non-verbal cues (13). The importance of appropriate interpersonal skills for the telehealth setting has also been highlighted by Henry et al., as well as the recognition that non-verbal communication is difficult to facilitate in the online environment (21). Good communication skills are a key attribute of health care professionals and is central to the delivery of optimal health care (22). In fact, effective communication skills positively impact overall health outcomes and compliance (23, 24), improve patient satisfaction (25), and self-management (26), and has been linked with reduced malpractice claims (27). In dietetics, increased patient satisfaction was found with dietetic consultations where dietitians display effective non-verbal skills, was able to build rapport, and showed empathy (25, 28, 29). It is therefore not surprising for the growing need in development and skill acquisition of verbal and non-verbal communication skills of student dietitians (29). The importance of communication skills is further acknowledged and reflected in the professional competency standards for dietitians in both Australia (30) and New Zealand (31). These state that dietitians should display effective communication and interpersonal skills that establish and maintain professional relationships using a client-centered approach.

Given the importance of communication skills in health care delivery, the challenges of communication in the telehealth setting, and the lack of best practice guidelines in the training and assessment of communication skills in the online environment, further research is needed to understand the unique challenges faced by educators when assessing communication skills in an online setting. The study aim was to explore the views and perceptions of dietetic educators on the assessment of communication skills of undergraduate student dietitians using telehealth and seeks to provide educators with recommendations for assessment of these skills *via* telehealth. The following research questions were therefore posed: What are the views and perceptions of dietetic educators on their ability to assess communication skills of students delivering nutrition care *via* online video conferencing? How can dietetic educators prepare themselves and their students for telehealth delivered *via* online video conferencing?

Materials and methods

Study design and sampling

A descriptive qualitative study design explored the views and perceptions of dietetic educators on their ability to assess communication skills using telehealth. A qualitative description design was selected as this methodology seeks information directly from those with the shared experience of the phenomenon (32).

Purposive sampling was conducted of Accredited Practicing Dietitians (APDs) in Australia and Registered Dietitians (RDs) in New Zealand with experience in the skills assessment of pre-placement dietetics students. Recruitment occurred through an established Australian-New Zealand community of practice of dietetics educators as well as through the research teams' various university and placement partner networks. Participants were asked to view telehealth dietetic interview recordings and assess the communication skills of pre-placement dietetics students using a previously validated global rating scale from medicine (33). The aim of this study was not to evaluate the communication skills of students thus scores are not reported here.

Three simulated telehealth video recordings of different dietetics students that successfully passed a communication and counseling practical exam were selected for this study. Passing students were chosen to allow the participants to focus on the telehealth platform rather than student quality, in line with the study focus. The practical exam was part of a third-year capstone course prior to clinical placement. The communication and counseling practical exam followed the Nutrition Care Process (34). Students were given 40 min to prepare for their consultation under exam conditions using a referral letter and food diary. They then undertook a 20-min online consultation with a simulated patient focusing on clarification of data assessment information, nutrition education and nutrition counseling (goal setting and negotiation of strategies), as per the Nutrition Care Process (34). Two researchers (blinded for peer review) identified the most suitable recording to represent each distinct part of the interview to be used for this study. Selection was based on the potential for students to display relevant communication skills, as assessed by the global rating scale (33), which would afford assessors to comment on their ability to assess communication skills through telehealth. Simulated consultations were conducting and recorded using the online videoconferencing system Microsoft Teams.

Ethical approval was gained from the Research and Ethics committee of [Griffith University] (No. 2020/881). Students and simulated patients provided written informed consent to be recorded and for the recordings to be used for future training and research purposes.

Data collection and analysis

Demographic information was gathered through an online survey and included primary workplace, years of practice, years of experience as an assessor of pre-placement skills, and previous assessment of dietetic skills *via* telehealth.

Participant views and perceptions

After participants watched the video recordings and scored students' communication skills, they were asked to reflect on their ability to assess communication skills *via* a telehealth recording through answering a series of open-ended questions using an online written survey: "*What communication factors do you believe were easily assessed? Where possible, please provide an explanation*," "*What communication factors do you believe were not able to be adequately captured? Where possible, please provide an explanation*," "B*ased on your experience, in what ways could this marking experience be improved?*," "*What advice do you have for university educators setting up telehealth consultations for assessing student readiness for placement?*," and "*What advice do you have for students to improve communication skills when consulting via telehealth?*"

Analysis

Participant characteristics are reported as frequencies and percentage of the total group. Open-ended questions were analyzed using qualitative description which allowed inductive thematic analysis which is not guided by a theory or framework and thus allows the opportunity for new or unexpected understandings (35). Thematic analyses were conducted according to the six-phase process of Braun and Clarke (36). Responses to open-ended questions were organized by descriptive coding into topics reading through each response and organizing into subthemes. Coding was done in duplicate by "HW" and "MCO" (dietetic educators with extensive dietetic education and simulation-based learning experience, including telehealth experience) and reviewed by "JK" (5 years' experience in simulation-based learning and extensive dietetic education experience). Subthemes were then grouped into overarching themes by "LM and HW (LM has extensive dietetic education experience) (37). To reduce risk of subjective bias peer debriefing was used during the finalizing of subthemes and themes with all members of the research team involved in the process. To gain insight into the agreement of educators on the ease of assessment of non-verbal and verbal communication factors inductive content analysis was also performed and is presented as frequency of agreement (38). A checklist was developed by the researchers for educators who assess communication skills using telehealth. Checklist items were identified from study results through a review of comments across all questions by the researchers.

Results

Twenty-four participants were recruited, representing New Zealand and five Australian states. Participant characteristics are outlined in **Table 1**, with individual participant details in **Supplementary Material**. The majority of participants were working in the university setting (88%) with 10 or more years in the workforce (88%) and most had past experience assessing dietetic students using telehealth (63%).

TABLE 1 Demographic information and characteristics of participants.

	Frequency (n = 24)	Percentage total group (%)
Primary workplace		
University	21	87.5
Hospital	2	8.3
Private practice	1	4.2
Dietetic registration		
Accredited practicing dietitian (APD)	13	54.2
Registered dietitian (RD)	9	37.5
Both APD and RD	2	8.3
Country, state		
Australia	13	54.2
New South Wales	4	16.7
Northern Territory	0	0.0
Queensland	4	16.7
South Australia	1	4.2
Victoria	3	12.5
Western Australia	1	4.2
New Zealand	11	45.8
Dietetic experience		
1 – < 3 years	1	4.2
3 – < 5 years	1	4.2
5 – < 7 years	0	0.0
7 – < 10 years	1	4.2
10 – < 15 years	9	37.5
15 – < 20 years	5	20.8
20 + years	7	29.2
Experience assessing dietetic students prior to clinical placement		
2 years or less	3	12.5
3 –5 years	4	16.7
>5 years	17	70.8
Experience assessing dietetics students using telehealth		
No experience	9	37.5
Yes, prior to practical placement	7	29.2
Yes, prior to and during practical placement	3	12.5
Yes, during practical placement	5	20.8

TABLE 2 Categorization of qualitative comments about ease of assessment of communication factors using telehealth, n = 24.

Communication factor reported	Easily assessed n (%)	Same as in person n (%)	Harder to assess n (%)
All skills, both verbal, and non-verbal communication	7 (29.2)	1 (4.2)	–
Logical flow and structure of interview	2 (8.3)	1 (4.2)	–
Non-verbal			
Reference to general non-verbal communication	–	–	6 (25.0)
Eye contact	–	–	5 (20.8)
Body language	–	–	7 (29.2)
Gestures	–	–	1 (4.2)
Empathy	3 (12.5)	1 (4.2)	–
Cues/Expressions	–	–	4 (16.7)
Rapport	1 (4.2)	–	3 (12.5)
Posture	–	–	2 (8.3)
Use of pause	–	–	1 (4.2)
Verbal			
Reference to general verbal communication	6 (25.0)	–	–
Cues/expressions	1 (4.2)	–	1 (4.2)
Tone and volume	1 (4.2)	–	–
Voice change	1 (4.2)	–	–
Counseling skills	1 (4.2)	–	–

Communication factors assessable using telehealth

A summary of participants' reported ease of assessment of different communication factors using telehealth is summarized in Table 2. Ten participants (40%) indicated that verbal communication skills were easy to assess. Specific reference was made to "tone and volume," "voice change," "paraphrasing," "verbal cues," "minimal encourages," "verbal followings," "summarizes" and clear audio. As one educator reported: "*it is easier to assess most verbal communication skills. . .*" (P9).

Seven (28%) participants indicated "*. . . it was easy to assess all communication factors*" (P5) and "*verbal expression and non-verbal expression are easily seen on video*" (P8). The fact that the encounter was recorded was viewed as beneficial to participants, for example: "*. . . [you] can replay sections to review and watch the student vs. the patient*" (P5). The structure of the interview process and empathy was viewed easy to assess and "*. . . similar to any session whether telehealth or face-to-face counseling*" (P20).

The majority of participants (n = 19, 76%) reported non-verbal communication "*. . . is somewhat challenging to assess*" (P16), particularly factors such as "*eye contact and body language. . .*" (P12). An unclear view of the student and patient's body made it hard to assess some elements, for example: "*. . . body language of the student and also ability of the student to pick up on client cues as [the assessor] can only see the patient's head and neck and upper body of the student. Eye contact is [also] difficult via telehealth as [students] tend to look at the client on the screen rather than the camera.*" (P22). Some participants found it challenging to pick up on the client's non-verbal cues which made it hard for assessors to judge "*. . . whether patients are engaged with the consult or not*" (P10). Rapport building was identified as "*. . . often more difficult using*

telehealth. . ." (P6) and needs to be considered when assessing a student. Difficulty assessing students' posture and some gestures were also mentioned. Despite the challenges identified to assess non-verbal communication factors using telehealth, assessors reported that it was "*not impossible*" (P3) but "*. . .more difficult than verbal skills*" (P11).

There were contrasting views on the mode of assessment with the feeling that "*. . . telehealth was not dissimilar to face-to-face methods*" (P21) compared to "*. . . assessment can only be in relation to telehealth, not another situation such as face-to-face, because the students may have used these skills differently in a face-to-face communication. . .*" (P20).

Advice to educators and students on communication skills when consulting *via* telehealth

Participants were asked to provide advice to dietetic educators when setting up telehealth consultations and assessing recorded telehealth consultations, as well as to student dietitians on how to improve their communication skills when using telehealth. As there was consistent overlap between advice for students and dietetic educators these questions were analyzed together. Overall, five key themes and 15 subthemes were identified, as summarized in **Table 3**.

Theme 1. Non-verbal communication is more difficult using telehealth

Participants highlighted that awareness of non-verbal communication is particularly important (Subtheme 1.1) in the telehealth environment. Students need to be made aware of their own non-verbal cues as well as those of the patient and the importance of adapting non-verbal communication for the telehealth setting. Dietetic educators can encourage students to focus on non-verbal communication by "*Reiterating the importance of . . .. non-verbal cues*" (P2) and provide suggestions how to optimized their non-verbal cues:

> "*The client can still see you so your non-verbal communication skills from the waist up [is] very important.*" (P1)

Participants reported the telehealth environment to pose a challenge for students to demonstrate their non-verbal communication skills, as well as educators to assess these skills. As illustrated by these participants:

> "*. . . non-verbal communication is more difficult to demonstrate via telehealth.*" (P17)

> "*Some 'leniency' is required around assessing body language and similarly non-verbal patient cues as these can be lost via telehealth.*" (P22)

Telehealth can often limit visibility of the whole body, therefore it is important to focus on upper body gestures (Subtheme 1.2) and maintain eye contact "*even if it feels artificial*" (P12). The camera set-up of the student and the location of the patient's image on their screen can reduce the ability of the student to monitor or assess non-verbal cues, therefore students need to be reminded to "*look at the*

TABLE 3 Themes and subthemes identified from advice to students and dietetic educators to improve communication skills when consulting *via* telehealth.

Theme	Subtheme
1. Non-verbal communication is more difficult using telehealth	1.1 Non-verbal communication is important
	1.2 Focus on upper body gestures, in particular eye contact
2. Adapt verbal communication for telehealth	2.1 Use strategies to facilitate engagement
	2.2 Rapport building is more difficult online
	2.3 Ensure speech is clear with pauses to not speak over clients
	2.4 Continue to focus on elements that are not unique to telehealth
3.Establish an optimal telehealth environment	3.1 Ensure technology is working
	3.2 Create an ideal environment with minimal distractions
	3.3 Use online tools to maximize communication
4. Telehealth specific preparation	4.1 Provide sufficient training for students in telehealth
	4.2 Practice using telehealth
	4.3 Consider ways to provide real-time feedback and opportunities for students to reflect on performance to improve practice
5. Assessing *via* telehealth	5.1 Beneficial setting to assess and complements in person assessment
	5.2 Logistics to ensure assessable telehealth environment
	5.3 Standardized and clear assessment tools are required

camera" (P22) so that the patient has a clear view of the student's face and the student appears engaged. Students need to be reminded to adapt their non-verbal communication for the telehealth environment, as too much movement can be distracting:

> "*Be careful with hand gestures as these can be really distracting on a small screen.*" (P24)

Theme 2. Adapt verbal communication for telehealth

Subtheme 2.1 highlights the requirement to use strategies to facilitate engagement, despite being in a different location so the patient does not feel distant and become disengaged:

> "*. . .*[the] i*mportance of making effort to engage with patient even though not in same room.*" (P17)

Use of active listening skills such as "*reflecting back*" (P19), "*screen sharing*" (P12) to help with education, and provide space (for example, pausing) to allow patients time to ask questions and engage was mentioned:

> "*Regularly check in with a quiet patient as it can be more difficult for a patient to interrupt via telehealth.*" (P22)

Verbal communication needs to be adapted, sometimes to make up for limitations in non-verbal cues and other times needs to be cut back:

> "*. . . strategies [is needed] to counteract non-verbal body language potentially being diminished during video consults.*" (P19)

> "*. . . to minimize patient interruptions with yip and respond in non-verbal ways so that the clients flow is not broken.*" (P1)

Due to the nature of telehealth, students may be tempted to follow a pre-determined script during their consult. This limits engagement with the patient, with responses less likely to be tailored to the patient's needs:

> "*Check students are not just reading from a (hidden) script but adapting the consultation to the patient.*" (P7)

It was also identified that rapport building is more difficult online (Subtheme 2.2), as highlighted here:

> "*To develop rapport online can be more difficult for some so make sure you cover what the client wants and what they value.*" (P1)

Subtheme 2.3 highlighted the need to ensure speech is clear with pauses to not speak over clients and the pace is not too fast. This is important so clients can navigate an unfamiliar setting, manage "*transmission delays*" (P19), as well as provide sufficient time for clients to speak:

> *"It is important to not speak over patients, it is harder with telehealth to sometimes identify the pauses, so always telling students it is okay to have some pauses in conversations to allow patients to speak." (P9)*

Participants also recommended continuing to focus on elements that are not unique to telehealth (Subtheme 2.4). The opportunity to observe experienced clinicians or have "*recorded examples*" (P16) will assist in learning:

> "*Like any situation, I think telehealth requires observation of a clinician who does it well (or preferably more than one to observe different styles).*" (P20)

Other similarities such as maintaining a clear consultation "*structure*" (P2) and flow, utilizing effective "*counseling skills*" (P14), assess patient receptiveness and "*readiness to change*" (P11). The importance of active listening and clarifying patient understanding were also highlighted:

> "*Incredibly important not to assume patient understands what is being said.*" (P2)

The importance of student "*reflection post consult*" (P14) and the opportunity for debriefing with the client after the interaction was recognized to extend and deepen the learning experience: "*client feedback perhaps re how they felt.*" (P3)

Theme 3. Establish an optimal telehealth environment

A key factor to optimizing the telehealth environment was to ensure the technology is working (Subtheme 3.1). This included internet connection, clear sound and visuals so the client can "*hear and see before commencing*" (P18). Dietetic educators were encouraged to provide technical support to students during consultations, oversee general tasks such as ensuring the client is comfortable and the session is being recorded if required:

> "*Ensure the technology is working and the record button is clicked!*" (P7).

Creating an ideal environment with minimal distractions (Subtheme 3.2) was emphasized. Students were encouraged to "*Be organized so not shuffling lots of papers*" (P7) as well as be aware of their surroundings. A quiet space with minimal background noise, appropriate lightning and minimizing distractions was recommended:

> "*Explaining to them how distracting small things can be (like fan behind student's head. . ., moving hands etc.)*" (P2).

Educators should make use of a "*waiting room*" (P12) functionality to ensure confidentiality and minimize distractions whilst in consultation. When using telehealth for assessment, participants highlighted the benefit of "*Getting good '[simulated] patients*"' (P23).

Finally, in order to establish an optimal telehealth environment, participants recommended the use online tools to maximize communication (Subtheme 3.3). Educators and students should familiarize themselves with the functions of the videoconferencing platform used in order to create an environment that supports communication and engage the client. Utilizing the online whiteboard, screen sharing and highlighting functions to facilitate education were recommended:

> "*It is important to use the functions to share the screen and show resources to aid patient understanding, don't just talk as people get distracted*" (P9).

In addition, the benefit of emailing education resources and a written plan to the patient following the consultation was identified: "*encourage them to have a written plan that they could email to the patient*" (P2).

Theme 4. Telehealth specific preparation

Sufficient training for students in telehealth (Subtheme 4.1) is required. Participants felt checklists and tip sheets on verbal and non-verbal communication skills will support student training. Specific elements to include in training are setting up the telehealth consultation, confidentiality, patient engagement, and differences in verbal and non-verbal communication:

> *"At our Uni, I feel like we have transitioned to telehealth quickly/everything was done on the fly because we had to and now need to go back and do some work with students around how to best set up telehealth consults, how communication might differ/similarities and differences, additional privacy"* (P16)

Subtheme 4.2 then highlights the need for students to practice using telehealth either in class with peers or formal simulations is required "*to develop and fine tune the specific skills required for [telehealth] context*" (P20). The importance of students practicing individually was also highlighted:

> "*Practice in front of a camera to review self-awareness including movements which could be distracting*" (P5).

Educators were encouraged to consider ways to provide real-time feedback and opportunities for students to reflect on performance to improve practice (Subtheme 4.3). Telehealth provides the ability for timely feedback as well as coaching by using the chat function. Recording consultations can afford students the opportunity to replay, reflect and improve their skill development but also provide educators the opportunity to provide further feedback:

> "*I've found that tele-health provides good opportunity for coaching during the consultation using the chat functions and this has been valuable*" (P12).

Theme 5. Assessing *via* telehealth (dietetic educators only)

Participants clearly identified that telehealth was a beneficial setting to assess that complements in person assessment (Subtheme 5.1). Teaching students to be adaptable and flexible in translating their skills to different settings within an "*ever-changing health system*" (P1) was voiced. Telehealth is a growing area for delivery of healthcare and participants identified the value of including telehealth training and assessment in the curriculum:

> "*I think the telehealth consultation is important to include, as it is very relevant to the current climate and very likely would continue to be relevant to practice moving forward.*" (P20).

Telehealth does present multiple benefits for assessment, including its flexible nature and ability for assessors to be present but unseen.

> *"The fact that the assessor's face cannot be seen during the interview can be quite empowering for the student—patients cannot look to supervisor for input and the student is allowed to 'own the space,' whilst still having the opportunity to call the supervisor into the 'room' if needed."* (P24)

Some participants identified the benefit of using telehealth in addition to face-to-face:

> *"A mix of both telehealth and face-to-face consultations would be important as these different mediums could have different effects on student's confidence and building communication skills using both mediums are important skills to have in today's environment."* (P18)

The additional complexity that telehealth brings to skill development and assessment compared to a face-to-face setting was acknowledged:

> *"There is just the added complexity of working with the students to develop their dietetic skills and then also work with them to develop the technology skills needed for telehealth assessments. . . how to show resources and explain DDR [diet-disease relationship], how to check patient understanding. . . and pick up on cues etc."* (P9)

There were a variety of logistics to ensure assessable telehealth environment (Subtheme 5.2) that need to be considered. When organizing cases and simulated patients it is

important to have all the required details set up at the beginning, including: "*Pre-arranged consent*" (P14): and "*adequate patient information re background, medical status etc.*" (P17): "*Make sure you have your cases well set up with a very simple referral for the student and much more detail available for the patient*" (P24). It is also important to "*Have a plan for when patients don't turn up*" (P9). Additionally, "*Ensure the student cannot see the assessor on the screen/in the room during the consultation*" (P6). For delayed assessment, "*Ensure there is a recording capability*" (P5), that it is possible "*to view entire consult and be able to stop and start video as needed*" (P17), and the recording is of good quality "*where there is no/poor video it makes assessment difficult*" (P12).

Assessment *via* telehealth requires standardized and clear assessment tools (Subtheme 5.3) that can be utilized by both students and educators to support preparation and transparency with assessment:

> "*Having clear assessment guidelines/tools so the student is aware of what is being assessed*" (P6)

There is a need for standardized and validated assessment tools developed for the telehealth setting that captures required adaptation of communication skills:

> "*Developing a standard model for the assessment of non-verbal behavior in tele-consultations*" (P10).

Lastly, having confidence in the administration of an assessment tool designed for telehealth were valued by participants:

> *"The limiting factor for me is this is the first time using the marking tool so adjusting to that and interpreting it was hardest more than the telehealth aspects"* (P4)

Ways to improve the online marking experience

A checklist was developed for educators during the planning, preparation and assessment of communication skills using telehealth (see **Table 4**). Broad categories include student preparation, educator preparation, assessment, and post-assessment.

Discussion

To the authors knowledge, this is the first study to report on the views and perceptions of educators assessing communication skills using telehealth. Five key themes emerged from analyses: non-verbal communication is more difficult to assess using telehealth compared to verbal communication, the need to adapt verbal communication for telehealth, establishment of an optimal telehealth environment, telehealth specific preparation, and assessment *via* telehealth.

Both verbal and non-verbal communication are important for the development of a trusting patient-clinician relationship which is linked to improved patient outcomes (39, 40). Educators in the current study had varied views on the ability to assess communication skills *via* telehealth with some saying it was easy and/or similar to an in-person face-to-face setting whilst others felt some adaptations are required to enable adequate assessment of all communication skills. Verbal communication skills were deemed easier to assess *via* telehealth compared to non-verbal communication skills. These findings support compensatory adaptation theory where those that convey a message through electronic communication adapt to enhance the "naturalness" of the medium (41). Telehealth provides the opportunity for synchronized face-to-face communication which increases its "naturalness," in other words having a comparable experience to the in-person face-to-face setting. Nevertheless, some adaptation is required when communicating *via* telehealth. Participants in the current study identified it was more challenging to assess rapport building, eye contact, body language, cues, gestures, posture, and use of pause during a consultation. It is recognized that non-verbal communication requires adaptation in a telehealth setting, with motions such as nods, verbal and facial expressions, and body language modified to create a video presence and improve relationship building (2, 21, 40, 42). Furthermore, effective use of pause and silence has been identified by clinicians experienced in the use of telehealth (21) to allow the client to process information and provides an opportunity to express their feelings and values.

Concern has been raised whether clinicians can effectively empathize using computer mediated communication such as teleconferencing (42) which is important for rapport building and ultimately support patient-clinician relationship building (39, 40). Liu and colleagues (43) found doctors had a lower frequency of praise and empathy utterances during a telehealth compared to face-to-face consultations which may influence the patient-clinician relationship. In the current study, educators found it easy to assess empathy and felt it to be similar to in-person assessment, which aligns with media richness theory (44). Thus, telehealth afforded the ability for some student dietitians to portray empathy *via* a videoconference telehealth session which participants could observe and felt confident to assess. It appears that some students in the current study were able to adequately adapt their communication to the telehealth setting while others needed further training in adapting their communication skills. Our results indicate that when communication skills are adapted for the telehealth setting, educators are able to identify both verbal and non-verbal communication skills and feel confident to assess these. On the other hand, if students lack the ability to adapt their

TABLE 4 Checklist items for educators to plan and implement telehealth consultations for undergraduate students.

Category	Item	Check
Student preparation	Ensure students have adequate communication skills and understand how to adapt these to the telehealth setting, e.g., active listening, client led, and counseling	
	Prepare students for telehealth setting using resources, videos, briefings, e.g., pre-recorded consults, practice with peers	
	Provide opportunities for students to practice skills using telehealth in a safe, supported environment using simulation or reviewing pre-recorded consults	
	Support student to build confidence in using technology	
	Facilitate the development of telehealth etiquette to improve engagement: appropriate responses in a telehealth consult, how to build and maintain rapport, the use of silence, the pace of the consult	
	Familiarize students with learning outcomes and assessment criteria	
Educator preparation	Identify learning outcomes of the consultation	
	Develop case scenarios that allow students to demonstrate relevant skills	
	Design simulation-based learning using evidence-based guidelines	
	Identify appropriate assessment tool to assess student skills	
	Familiarize self with student assessment tools	
	Develop technology skills for platform to be used e.g., waiting room function, recording function	
	Check audio and video quality of recordings	
	Gain consent for recording from students and simulated participants	
Assessment	Allow adequate time for consultation including bringing the client in from the waiting room and explaining the nature of the consultation, e.g., recording, assessor observing	
	Turn camera and microphone of supervisor off during consultation	
	Provide feedback *via* chat function to student if required to support learning*	
Post-assessment	Ensure that there is sufficient time allocated for student debrief	
	Make recordings available to students for self-reflection*	
	Ensure that there is sufficient time allocated for client debrief with students	
	Encourage student reflection	
	Arrange for moderation*	

*Relevance of item will depend on whether assessment is formative or summative.

communication skills it reduces the confidence of educators to assess these skills.

Despite the rapid uptake of telehealth to deliver healthcare services, literature on telehealth education and training of students and clinicians remains limited (45, 46). Formal training of clinicians using telehealth is recommended with particular focus on verbal and non-verbal communication as well as adapting interpersonal skills to the telehealth environment (45). Participants in the current study suggested students be provided with the opportunity to observe telehealth consultations and to practice utilizing telehealth which is supported by current guidelines (46). The increased complexity of teaching students technology skills and telehealth etiquette was acknowledged as a barrier in the current study. This may have been intensified by the rapid roll-out of telehealth education in the curriculum and on placement as a result of the COVID-19 pandemic (3). Student training on adapting counseling and communication style for the telehealth setting was identified as a need by participants in the current study. Similar to Ferro (2), findings of the current study highlights the need for further research on tailoring nutrition counseling to the telehealth environment to ensure effective computer mediated communication.

A number of recommendations were provided by participants in the current study to both students and educators in general to improve the delivery of nutrition care *via* telehealth. Recommendations align with current

telehealth guidelines to clinicians regarding screen etiquette, adapting non-verbal and verbal communication, appropriate preparation, and telehealth environment to optimize the experience (2, 19, 40, 45, 47). There is currently limited guidance for educators responsible for student training and assessment using telehealth and a need for standardized procedures and assessment tools were voiced by participants in the current study. A checklist was developed in the current study from the recommendations provided by participants for educators and students in planning, preparing for, and assessment of telehealth encounters, thereby addressing a gap in the current literature. Recently Henry et al. (48) published a validated checklist to assess interpersonal and communication skills of clinicians using telehealth (48). Our findings align with the items in their checklist and suggest further consideration when applying it for student training.

Three key recommendations from this study are highlighted. Firstly, to foster relationship building between students and patients, students should be discouraged from using verbal scripts. This may not be an issue for experience clinicians, however, can be viewed as a helpful aid for inexperienced students. Students may be tempted to use a script in the telehealth environment as it may be hidden compared to when they are in the same room as the client. In the current study scripts were viewed unfavorably as it did not allow students to tailor their communication to the client's needs. Telehealth encounters for student training should include nuances of real-life challenges faced by clinicians to better prepare students for the workforce. Engaging clients during a telehealth consultation is one such challenge (49) emphasizing the importance of effective communication skills to build and maintain trusting patient-clinician relationships. Secondly, including moderation was identified as an important consideration for summative assessment of communication skills due to the subjective nature of the assessment of this skill in the current study. Bias on the part of assessors during the assessment of practical skills have been reported in the literature (50). Bacon and colleagues (51) explored the variation in assessors' judgment of student dietitian's performance by a video recording of a nutrition consultation, as well as the influence of a group discussion amongst assessors on their judgments. They found no agreement in assessors' ratings before or after the discussion, although 78% of assessors changed their scores and/or reported a change in confidence levels in assessment. Assessment of procedural activities, albeit still challenging, may be less so than non-tangible aspects like communication skills (50). Nevertheless, assessment of competency in communication and interpersonal skills with video recording is an accepted evaluation method in medical education and other health professions (52). More recently, the use of Zoom teleconferencing software was found to be an appropriate platform to assess various skills including communication skills using Objective Structured Clinical Examination (OSCE) (51) with some recommendations provided for educators when conducting online OSCEs (53). Lastly, to support a deeper level of learning, participants in the current study recommended that educators provide timely feedback, allow time for debriefing and encourage student reflection after the telehealth encounter. These recommendations align with guidelines for the use of virtual simulation programs to assess student clinical competency (54–56).

Limitations to the current study include the use of sections from dietetic interviews rather than the full consultations in order to reduce participant burden. This may have impacted the ability of participants to observe all communication skills. Furthermore, a global communication rating scale was used to facilitate the assessment of communication skills that was not developed for teleconference use. However, similar issues were raised by participants that are included in a recently published checklist for assessment of communication skills using telehealth (48), thus the tool used in the current study did not seem to detract from the marking experience. Only telehealth encounters of pass level students were included, therefore perceptions of participants may be different with the inclusion of borderline or students that failed the encounter was included.

In conclusion, dietetic educators felt it was easier to assess verbal communication skills in telehealth using videoconferencing. Assessment of non-verbal communication skills were challenging and required adaptation and awareness from students to enable educators to observe these skills and allow easier assessment. Despite challenges identified in assessing communication skills, educators in the current study agreed on the importance of including telehealth training in the curriculum to better prepare dietetic students for the future workforce. This study endeavored to shed light on the perceptions of dietetic educators to assess communication skills within the telehealth environment. Our findings reveal a scarcity of recommendations for educators when conducting online assessment of communication skills using telehealth. Further research is warranted to develop best practice guidelines and validated tools for educators when assessing communication skills and competencies using telehealth.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Research and Ethics Committee of Griffith University (No: 2020/881). The patients/participants provided their written informed consent to participate in this study.

Author contributions

HW and MCO conceptualized the study. HW wrote first draft. All authors contributed to manuscript revision, read, contributed to data analysis, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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Health sciences students' and instructors' perceptions of the emergency switch to virtual internship amid the COVID-19 pandemic: A case from Qatar

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In efforts to contain the COVID-19 pandemic, health colleges at Qatar University shifted their clinical training to virtual internships (VI) and project-based learning (PBL). The shift was new to students and faculty alike, and a major change that posed many challenges. This study aimed to explore the experience of changing to VIs during the pandemic from both the clinical instructors' and health sciences students' perspectives. A qualitative study was conducted based on the framework of readiness to change. It involved focus group discussions with students from the departments of Public Health and Human Nutrition and in-depth interviews with clinical instructors using appropriate online platforms. A total of 4 focus groups with 20 students and 4 interviews with instructors were conducted. Transcripts were analyzed following the inductive-deductive approach. The major themes that emerged from the analysis described students' and clinical instructors' perceptions of the necessity and efficiency of the switch to VI; the design of the VI and the extent of the clinical/field experience and skills that it offered; confidence in the ability to succeed in this type of internship and confidence about reaching expected goals; academic and moral support from clinical faculty and coordinators and the communication process with faculty and preceptors; and finally, the benefits gained and how employers would view this type of internship. Health sciences students' readiness for VI was generally low. Several student and faculty needs have to be addressed, specifically regarding the design of the program and the level of preceptors' communication with students. The findings would direct health programs, clinical instructors, and preceptors to better understand students' needs and efficiently plan for virtual internships during not only emergencies but also whenever there is a need to deliver online experiential learning courses.

KEYWORDS

students, readiness to emergency change, virtual internship, health sciences, COVID-19 pandemic, Qatar

Introduction

Worldwide, many educational institutions have experienced an urgent shift of teaching and learning activities to full-scale online modes in response to the COVID-19 pandemic. Although there are benefits to online education, including learning flexibility and inclusiveness, there are several challenges: increased workload for instructors, difficulty motivating students, lack of opportunities for interaction, technical issues, and lack of appropriate teaching materials (1).

Practice-based learning is the backbone of effective learning across all health and medical professions (2). Early practical experience in medical education strengthens learning and is associated with an important set of learning outcomes. Such outcomes of early clinical learning include increased student satisfaction, adaptation to clinical environments, reducing stress and enhancing confidence upon interacting with patients, learning self-reflection and appraisal skills, developing professional identity (3), and building the set of essential competencies for medical students (collaboration, communication, problem-solving integrity, responsibility, and respect) (4–7). While the above-mentioned literature outlines the benefits and challenges of virtual health education, the studies were mostly conducted in well-planned programs where students participated by choice and with the availability of alternative or supplemental modes of learning. Some recent studies explored medical students' perceptions regarding the effectiveness of online learning and the learning challenges faced during the COVID-19 pandemic (8, 9). For example, in a study from The United States of America (USA) (10), and another from The Kingdom of Saudi Arabia (KSA) (8), the majority of medical students expressed that the clinical aspect was a main missing component of VI. In Brazil, there was diversity among medical students' responses regarding their willingness to maintain their regular clinical training during the pandemic, but more than 80% of their expressed views reflected widespread insecurity toward the current situation (11). However, in a study from Singapore, up to two-thirds of medical students expressed a need to go back to their regular on-site training during the COVID-19 pandemic (12).

Qatar University (QU) health programs, like many of their counterparts around the world, had been challenged by the COVID-19 pandemic. At the College of Health Sciences (CHS), the Department of Public Health (PH) and Department of Human Nutrition (HN) faculty and clinical preceptors struggled to create safe and appropriate alternatives to practice-based learning due to the suspension of routine services in the health care system. Similarly, students struggled to cope with the abrupt change in their mode of learning. These two programs are only offered for female students at QU.

When the university started the virtual clinical practice, the PH department shifted its health education practicum to a project-based internship (PBI) replacing their clinical training in Primary Healthcare Centers in which they would finalize their internship after having their community-level training at the Ministry of Public Health and other public health organizations in Qatar. In the PBI, students constructed different instruments after reviewing the literature to assess the needs of specific audiences in regard to different public health topics. They collected online data and conducted the analysis. Then, they tailored the findings toward specific activities to promote the health of the chosen audiences or to enhance the services provided for them in various settings. Students also built creative models to plan for implementing these activities and services and suggested a variety of methods to monitor the implementation process to enhance their outputs. In addition, they planned for effect evaluation by suggesting specific outcome indicators and different research designs.

The HN internship is a structured program including rotation in community sites such as Qatar Diabetes Association (QDA) and clinical sites such as cardiac, oncology, renal, food service, and other medical departments of Hamad Medical Corporation (HMC) hospitals. During the pandemic, most clinical rotations were immediately shifted to virtual rotations, and different student tasks were suspended such as patient education, counseling, and working in interdisciplinary teams. These were replaced by an extended number of hours of professional development classes where students attended some workshops by dietitians abroad and got more involved in case simulations using the telehealth concept, case studies, case presentations, preparation of awareness campaigns, and writing articles.

Theoretical framework

The decision to shift to full-scale online education was taken by the national authority overseeing the pandemic response. Under such emergency circumstances, students and instructors were not prepared for the transition, which may be critical for their readiness for change. In turn, readiness for change is important for the success of targeted outcomes (13, 14). Originating in organizational studies, readiness can be defined as "the cognitive precursor to the behaviors of either resistance to, or support for, a change effort" (15), or "recipients' beliefs regarding the appropriateness of, support for, and value of the change (16). As such, it is critical to understand the students' perceptions and experiences in this unique setting.

Abbreviations: CHS, College of Health Sciences; HN, Human Nutrition; HMC, Hamad Medical Corporation; KSA, Kingdom of Saudi Arabia; PH, Public Health; PBI, Project-based internship; QU, Qatar University; QU Health, Qatar University Health; VI, Virtual Internship; QDA, Qatar Diabetes Association; USA, United States of America.

Holt et al. (17) suggest that readiness for change is a comprehensive attitude influenced simultaneously by a number of factors, including the content (i.e., what is being changed), process (i.e., how the change is being implemented), context (i.e., circumstances under which the change is occurring), and individuals involved (i.e., characteristics of those being asked to change). It is also influenced by how the change recipients, as an individual or as a group, are cognitively and emotionally prone to accept, adapt and cooperate with a particular plan to change the situation.

In line with the framework of readiness for change to facilitate effective VIs, it is essential to support students with initial readiness for emergency change, addressing the following five aspects. First, discrepancy refers to understanding the need to use VIs in such an emergency in order to reach the aspired goals, and have the knowledge/skills about VIs. Second, appropriateness refers to students' belief that the current use of the online learning platform and the design of VIs is appropriate for the given purpose. When students understand how the change is implemented and what strategies are being used to support VIs, they have a better chance to develop a strong belief in the appropriateness of the change and get motivated in and engaged with the changed mode of learning (18–20). Third, efficacy, which refers to students' confidence in their own and the institution's ability to conduct online training for the aspired goals, is an essential aspect for change readiness. Understanding students' efficacy is important to develop educational strategies to prepare students with the necessary knowledge and skills regarding online learning tools and platforms when shifting from face-to-face to the online environment (21).

A fourth aspect of readiness for change is principal support. Leadership support is significant to improving motivation and self-efficacy to ensure the success of change efforts (22). Literature on online education also suggests that it is essential to establish a supportive learning environment to facilitate online active learning and student-centeredness (23–25). Finally, valence is a significant aspect of readiness to change, which refers to the perception of long-term personal benefit for the learner in the VI experience. Seeing long-term benefits can help change recipients to develop motivation, efficacy, and strategies in coping with challenges in the change process (7, 14).

While current literature highlights the critical role of readiness for change, little is known about how change recipients report their readiness in the context of an urgent shift, when the decision to make the change is enforced externally. Understanding CHS students' experiences while shifting to virtual internships, and the factors shaping this process would direct health programs, clinical instructors, and preceptors to better understand students' needs and efficiently plan for virtual internships during a not only emergency but also whenever there is a need to deliver on-line experiential learning courses. This study aimed to explore health sciences students' and instructors' experience of an emergent shift to virtual internship and their perceptions of VI replacing on-site experiential learning.

Methods

A qualitative design was employed in this study, which took place at the time when the COVID-19 pandemic was at its peak in Qatar (Spring semester 2020). Purposive sampling was followed to recruit participants who are considered rich cases and would help answer the overarching research question. Our study ran in two parallel streams, one involving focus group discussions with senior female students registered for clinical practice from the departments of Public Health (PH) and Human Nutrition (HN), and the second involved conducting in-depth interviews with clinical instructors (clinical coordinators, clinical faculty, and preceptors). Online platforms (WebEx and Microsoft teams) were used for data collection, given regulations surrounding social distancing and restrictions on in-person gatherings. An interview guide and a focus group guide were developed considering the main constructs of the readiness framework and based on the discussions of the research team and a review of the relevant literature. Interviews and focus groups were recorded with participants' permission, and a member of the research group took written notes simultaneously.

First stream: Students

To invite participants, emails and reminders were sent out through Blackboard to all students registered for clinical training in spring 2020, providing research information and a link to an electronic consent form. We conducted four focus groups until data saturation was reached, where no new themes emerged (26). A trained member of the research team who is not involved in coordinating or delivering clinical training for the students facilitated the groups. The focus groups, conducted in English, were conducted online, each lasting 60–70 min.

Second stream: Clinical coordinators and clinical faculty preceptors

Similarly, clinical instructors, including clinical coordinators and faculty responsible for bedside teaching in clinical sites were contacted by email with electronic consent. Four semi-structured interviews were conducted on online, each lasting 45 min.

Data analysis

All interviews and focus groups were audio-recorded and transcribed into texts for analysis. An inductive-deductive approach was employed in the analysis. Inductive qualitative analyses were used to discover emerging themes, and the transcripts were analyzed for predetermined themes mapped to the readiness framework as well (27). Coding was the first step in the analysis process and it started after the first interview. A codebook was constructed and themes were added to the codebook as they emerged from each transcript. Constant comparisons were conducted to differentiate one theme from another and to identify the dimensions of each theme (28). With each addition of new data, themes were added and modified as needed. Finally, the themes were combined into a coherent description of the phenomenon. Two members of the research team worked independently to analyze the data. A different research team member who was not involved in the focus group discussion nor in conducting the individual interviews reviewed the transcribed data. The three members read the transcripts and identified the common themes separately then discussed the results and reached a consensus regarding themes and categories.

Results

In total, we conducted four focus groups with students from CHS ($N = 20$), two with senior health education students from PH ($N = 11$), and two with senior students from HN ($N = 9$). We also conducted four individual interviews with 2 clinical instructors from PH and another 2 clinical instructors from HN. The major themes that emerged from the analysis described students' and clinical instructors' perceptions of the necessity and efficiency of the switch to VI; the design of the VI and the extent of the clinical/field experience and skills that it offered; confidence in the ability to succeed in this type of internship and confidence about reaching expected goals; academic and moral support from clinical faculty and coordinators and the communication process with faculty and preceptors; and finally, the benefits gained and how employers would view this type of internship.

Discrepancy

The necessity and efficiency of the switch to VI

Most of the students expressed an understanding of the decision to switch to VIs and worry about being in a clinical setting during the pandemic. They also mentioned that their clinical faculty were worried about them contracting the infection from the training site and possibly transmitting the infection to their families.

> "Well, like we still wanted to have the experience of clinical practice. However, we were afraid. I was afraid of, you know the situation. So, it was also a relief to me that I will stay at home. I will not, I will not be at risk of having the disease and then passing it to my family, so yeah." [PH student 3]

A preceptor for HN students also explained that the majority of students understood the need for the shift. The teaching assistant from PH explained that, although students were disappointed that they missed the training in a clinical setting, they understood the safety issues involved.

> "The students are mature, it is a safety issue, health issue it is not only what they want, it is a pandemic. They understood it is serious and they did not give us hard time. They understood the shift. They have to work, to create a program and work from home."

On the other hand, only a few students mentioned that this switch was not necessary since they were aware of the preventive measures they need to follow. These students showed accountability to the profession and felt responsible to support their colleagues in the healthcare system. They also explained that since other health care providers were on the site fighting COVID-19, they should have also joined them. A PH student commented: "It was our area, it was our responsibility. We know how to protect ourselves, and we could have helped more. It is our job to fight this pandemic with other professionals."

Most students agreed that the college's response and action to the pandemic as well as the switch to online learning and VIs were timely and prompt. A student from HN mentioned: "I think it was a very good response and they did their best to compensate the training while being at home which is hard to do especially when the preceptors are there in the hospital and busy with this situation, but our department response was suitable during COVID19." Another added, "It was a very quick and adequate response, the best that could have been done with the sudden changes to the entire system."

Appropriateness

The VI design was not well structured

Students' perceptions regarding the overall design of the VI were generally negative. Only a few PH students were satisfied with some gaining of important research skills as well as online communication and planning skills. The majority of the students mentioned that the PBI did not equip them with the skills they were seeking from the field experience and emphasized that they missed the real hands-on experience they were looking for and missed gaining the skills and competencies needed for a patient educator.

> "I think it's not enough just to have a project. Uh, because it's better to go to the site, learn more, explore the working environment. How you deal, interact with patients, yeah. How you will be a professional health educator? This is how we will gain the needed skills and from the training."

Perspectives of HN students about the appropriateness of the design of the VI reflected several concerns regarding some types of rotations, which they believed were not compatible at all with online delivery. One of the HN students explained how she missed gaining experience with tray line in the food service rotation:

> "Also in the food service rotation, I see that we couldn't have the opportunity to see what is happening in the tray line. I was waiting for this rotation, but couldn't have the ability to see what is happening there. So maybe if they could show us pictures, I know that this is against the policy, but this is a new situation. I think the design was good, but if we could shadow a dietitian it would be better."

Moreover, the majority of HN students mentioned that the VI needed to be more structured and had to allow for more communication with preceptors. They explained that there should be a clear timeline for the daily activities they will be practicing. "I think it needs to be more structured and doing more virtual meetings with the preceptors every day because we benefit a lot when communicating with the preceptors rather than doing the assignments alone," expressed one of the HN students.

In agreement with students' generally negative perceptions, all clinical instructors mentioned that the overall design of the internship was partially satisfying, partially meeting the students' needs, addressing the course objectives, and achieving the students' learning outcomes:

> "This type of internship is another project for them because they also were working on their capstones, they want a different experience. They want real, practical experience. PBI helped improve their research skills, writing skills, communication skills, planning skills, teamwork and collaboration, technology, and online skills. " [PH Clinical Coordinator]

Disappointment with the limited clinical/field experience

While students expressed their understanding of the university's decision, and tried to be supportive of such a policy, the majority expressed their disappointment from missing the opportunity of being in the field and having real practical experience. Most of the PH students were not satisfied with the PBI, because this type of internship did not address their learning needs, nor the objectives of their practicum course. Two HN students explained,

> "I don't like the virtual SPP because I feel that like I'm repeating this theoretical semester just doing the assignments as my friend said that there is no time to meet the preceptors and listen to them."

This was echoed by the clinical instructors who mentioned that students reacted differently when the shift happened, but the majority felt disappointed from missing the opportunity of being in the clinical sites and interacting with other professionals and patients. They explained that students were not satisfied since there was a big difference between being in the field and working from home. The PH clinical coordinator explained:

> "We were all challenged; faculty, supervisors, and students. There is a big difference from the real work experience to another public health project through a screen AND from home. Experiential learning is very important for our students, especially for PH students. The PH field is new and challenging in the country, students were looking for this training to apply what they have learned in the classroom and for real hand-on experience."

Efficacy

Student's confidence in their ability to succeed in this type of internship

Despite their doubt about the appropriateness of the internship design *via* online mode, the majority of the students were confident that they would be able to manage the VI and submit the required assignments, case studies, and working sheets on time. Students from the PH program explained that they were familiar with the steps they need to follow in conducting a PH project, as one student mentioned, "So I could say we were confident; we did the project anyways in a previous course. So, I thought like, yeah we have enough time to be done with the project and all will be fine." Similarly, HN students expressed that the knowledge they gained from previous practical training along with their good online skills gave them high confidence during their VI.

> "I don't doubt that any of our batches don't have the technical skills and knowledge required for this virtual training… The number of skills we used in the practical training was much more than what we needed in the virtual training. [HN student]

PH clinical coordinator confirmed students' confidence in managing the PBI. A clinical instructor from HN added

that students were confident in navigating online training and emphasized that students were technology-oriented.

> "I think they were confident for a reason is that they were familiar, they have practiced the major steps in planning for a health education program, and I think we can do it and we can work on reviewing the literature, collecting data, and planning. . . They have been practicing this for years." [PH Clinical Coordinator]

Students lack confidence in reaching expected goals

On the other hand, the majority of students from the CHS mentioned that the VI would not help them reach the internship objectives and gain the needed skills required in a clinical setting. A PH student expressed "I think we were not confident that we will reach our goals, I mean the practicum goals. This is a PH project, not the training we were looking for. Even the instructors themselves; they were not confident about the outcome." The same negative perceptions were expressed regarding the confidence in own practical skills when a HN student added:

> "I do feel confident in the knowledge I have received with regards to the different cases seen at the different rotations and the treatments that are given to them. But, with regards to patient consultation, the practical experience would have definitely helped in building communication skills plus experiencing how to consult different people and personalities."

Clinical instructors shared the same perceptions regarding the students' lack of gaining some skills during the VI:

> "There are many differences, but the main difference is that the lack of ability to assist the students in the development of needed skills such as team-building skills, time management and prioritization in patient care, role-modeling, and evidence-based professional dietitian practice." [HN Preceptor]

Principal support

Academic and moral support from QU clinical faculty and coordinators

Most of the students held positive perceptions of the support provided by the university faculty and clinical coordinators. Students agreed that the college's response was prompt and that faculty provided an efficient and clear plan. Students mentioned that clinical coordinators and faculty were available and showed a willingness to provide support and instructions at any time. They explained how faculty used different communication channels to assess their needs and listen to their concerns in regards to their internship and even other courses.

> "I think the faculty had their agenda constructed, they have limited time, and they were trying to do certain things in a limited time and to accommodate the situation. So, I think what was done in this course and even other courses in the department such as the weekly meetings with the clinical coordinator, were very helpful to direct, assist and support us." [PH student 5]

Clinical faculty had similar views to those of students regarding academic and emotional support from the college, department, and faculty. They also emphasized they were keen on "Assessing learning needs, providing constructive feedback, and applying effective communication" to students, as indicated by one HN faculty preceptor. The other HN faculty preceptor also indicated that discussions were the main way that preceptors used for clarifying students' concerns regarding any experiences in the rotation.

Negative perception of the communication process with preceptors from training sites

The majority of the students were not satisfied with the support and guidance provided by the preceptors from the training sites. They were also not satisfied with the quality and frequency of the communication with these preceptors.

> "To reach the goals I think we need to communicate more with the preceptors so we can gain more of their practical experience. Also, to do more tasks other than theoretical assignments, like the counseling." [Nutrition student 1]

Clinical faculty from PH agreed that students were expecting more support from preceptors and stakeholders:

> "We do need external support to give students a little bit of sense of the work in the field. I believe we need to have somebody who gives lectures about what's going in the site. We need guest speakers from the field in addition to the project." [PH Clinical Coordinator]

Valence

Benefits gained from the VI

Students were asked about their views regarding the long-term benefits of VI. Few PH students mentioned that the PBI improved their research and online communication skills. It also enhanced their online skills in the implementation of health education sessions, data collection, and needs assessment. One

PH student mentioned, "I feel the project. Yeah, to write in my CV that we have done research and need assessment. It's I think, it's really good and a positive thing because as a public health educator we should be confident and have these research skills."

Meanwhile, some students from the nutrition program positively perceived how they learned about navigating online counseling and telehealth and worked under emergency conditions:

> "Do online counseling or deal with patients online which could benefit me in my future career if I need to work online. The program prepared me for dealing online with patients and also working under different circumstances and under a global emergency situation in which we experienced this now and if in the future had to work under the same circumstances, we will be able to. [HN student 2]

Clinical instructors shared similar views regarding some of the skills that were provided to students through the VI. The PH clinical coordinator mentioned that students built on their previous skills from the PBI, such as research skills, data collection skills, communication skills (oral and written), collaboration and teamwork, online skills, planning skills, critical thinking, and creativity. A nutrition preceptor mentioned:

> "As Food service is an inevitable part of the Dietetics department, the rotation will help the students to apply their knowledge of food systems management and understand the functions of the dietitian in food service and administration. As throughout the rotation they are participating in the supervision of food production, sanitation inspections, menu planning, sensory evaluation and kitchen design."

Students were worried about how employers would perceive this type of internship

Most of the public health students agreed that the PBI would not enrich their resume, nor enhance employability when they apply for jobs in the near future. They were concerned that employers would prefer having an internship in a clinical setting during the pandemic instead of having an online public health project or a project-based internship.

> "Not sure how the employers will view this type of internship. Like. I know that it's a new thing, but I don't know how they would accept and view such an internship as they would ask about any previous experience in the field or things like that… I'm not sure how they would see it since it was like 4 credit hours…" [PH student 8]

Students from HN felt a need to compensate for the lost practical experience and suggested:

> "After the situation gets better, we could revisit the sites we weren't able to. For the sake of practicality, we could maybe have a choice of choosing 2 or 3 rotations out of all the rotations we have missed, or we could even shorten the time spent in each practical rotation when visiting on-site…."

The PH clinical instructors were also concerned about how employers will view this type of internship and suggested that the department needs to support students and issue certificates explaining this type of internship.

> "As I mentioned, the project was realistic they built on their experience from the previous site, this is something to highlight. In addition, they had research skills, writing, literature review, and online presenting skills. Yet, I have a concern, yeah, maybe it won't be taken as a field internship. Maybe we need to support these students with a certificate, saying that this online training was a real training when applying for a job." [PH teaching assistant]

Discussion

This study aimed to explore health sciences students' and instructors' experience of an emergent shift to virtual internship and their perceptions of VI replacing on-site experiential learning. Being sensitized to the main constructs of the readiness framework, major themes arose from the analysis reflected on the participants' understanding of the shift to VI, the appropriateness of the overall design of the VI, confidence in one's own abilities to succeed through the VI, efficient communication and instruction, leadership support and technical support, and personal benefits from the VI in the long term.

In general, students had a sufficient understanding of the need to shift to VI and described the decision by the university to move to VI to be prompt and efficient. When exploring student safety during the pandemic, many students perceived that the switch to VI was necessary to maintain their safety, the safety of their families, and that of patients. Such a finding is understandable because our study was done at a time when the pandemic was at its peak, a time when the psychological effects of the pandemic, such as fear and anxiety, were highly seen (29). On the other hand, some students were confident that taking the protective measures could have been enough to maintain their security and that of the patients while not depriving them of having the real clinical training. Moreover, these students expressed a need to be involved in the fight against the pandemic. Similar diversity in the views of students regarding returning to clinical settings was also reported in a study in Brazil (11). However, our results differed from those from a study in Singapore, which assessed the medical students' preferences and showed higher levels of preference for

returning to the clinical setting during the COVID-19 pandemic and linked this preference to return to clinical settings with a high level of internal motivation, professional responsibility and little fear that students would pose risk to patients and to the healthcare system (12). Another important theme that emerged from our study indicated that students were disappointed with the limited clinical experience they were offered. This coincides with results from several other studies (8, 10, 30).

The majority of students in our study had negative perceptions about the overall appropriateness of the VI program. A theme from our study indicated that students were not satisfied because the program did not enable them to gain the needed skills and competencies that are usually gained from on-site practice. The students' views about the importance of gaining such competencies are consistent with what was reported in the literature (4–8). Students also felt that the current design of the internship lacked organization and structure. This agrees with results from a study in Brazil (11), conversely, data from KSA show that students were more satisfied and held positive perceptions of the general educational impact of the move to online learning during the COVID-19 pandemic (8). Our findings regarding the perceived inappropriateness in the design of the VI also diverge from several other studies (31–33).

Our study results reflect that students' efficacy depended on certain factors, such as their previous exposures to clinical settings, how much they would be earning essential skills from VIs, and the extent of communication and feedback they were being provided with. Since most of them had the needed online skills and were familiar with clinical settings from their previous rotations, CHS students were confident that they would succeed in this type of internship. Nevertheless, students were not confident that they would reach the expected goals by taking this VI. Such a negative perception was driven by the lack of gaining some of the skills that are essential for clinical practice, such as effective communication with patients and doctors (7), because students were not exposed to real-life interactions with patients, or with the diverse profiles of the healthcare team.

As for their perceptions of support, the majority of students said they received academic and moral support from QU clinical faculty and coordinators. Faculty members provided good quality and frequency of communication with students as well as providing them with timely and constructive feedback. However, there were a few negative student perceptions about the communication process with clinical preceptors assigned from training sites. Only a small number of students were not satisfied with both the quality and the frequency of such communication. It is evident from the literature that such an issue with communication is a major obstacle that usually creates a negative impact on the students' confidence and capability to undertake new challenges and changes (34–36). Our findings regarding student efficacy and the importance of feedback go in accordance with results from other studies (37–39).

Nevertheless, students perceived gaining several benefits from this unique VI. They improved their online skills in data collection and implementation of health education sessions and enhanced their online communication skills. In addition, some of them got exposed to online counseling and telehealth, which according to literature, comprises a valuable asset for the future careers of medical students (40). Finally, students were worried about how employers would perceive this type of internship, which is consistent with findings from another study (41). Previous research reported how SPP enhances employability for nutrition students (42).

Findings from this study provide students' and clinical instructors' insights into the VIs that were being offered as an alternative to the standard onsite clinical training. If students are not ready, they will tend to reject change and face it with negative reactions such as sabotage and absenteeism (36). Just like the case of any organization, one of the main academic institutional tasks and challenges is to ensure the establishment of supportive, cooperative, and trusting relationships that empower both faculty and students and make them more committed (36, 43–45). Although the lack of interaction and lack of clinical experience tended to be the main perceived concerns students expressed toward shifting to VIs, the literature suggests that there is room to overcome such barriers by integration of new learning methods such as simulated patients, case based learning and telehealth (9). In that context, challenges to student readiness, which are due to the nature of some rotations, can be faced by tailoring the rotation in a way that ensures more benefit and confidence to students.

The findings of our study set a base for future research that can suggest what improvements should be implemented in the design of the VI program, and evaluate the impact of such improvements. In that sense, it would be important to consider the introduction of new interactive learning techniques that can enhance students' clinical skills and hence provide more benefits from the VI. Moreover, this study shed the light on several student and faculty needs that should be addressed to optimize the students' experience of VI. There will be an urgent need for training of preceptors, specifically in relation to improving their skills of communication and providing feedback during VIs.

Applying qualitative research methods helped us recruit rich cases and understand the experience in depth. In order to enhance the credibility of our findings, we applied triangulation is different ways: data collection through interviews and field notes, and independent data analysis by three members of the research team. On the other hand, one of the principal limitations of the study is the inability to have the themes validated by the study participants due to time constraints. The study assessed students' readiness from the perspective of members and students from only one health college of QU. However, to enrich the understanding and

provide broader views of the VI it would be important to assess the perspectives of students and members of other health colleges in QU and those in other universities in Qatar.

Conclusion

Results from this study highlighted health sciences students' experience in switching to VI during the COVID-19 pandemic in Qatar. Our study revealed that students held several negative perceptions about the different aspects of the change, and hence their readiness for shifting to VI was generally low. However, the study suggested other positive views including the prompt and efficient decision by the university to move to VI, good moral support from faculty and preceptors as well as several perceived benefits of this type of training. The finding would support planning for efficient VI for health sciences students.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Qatar University Institutional Review Board (QUERG-CHS-2020-1). The patients/participants provided their written informed consent to participate in this study.

Author contributions

HB, HA, XD, AE-A, and AA-M: conceptualization of the study, designing the interview guides, and critical review of the manuscript. JM: data collection and write-up of the manuscript. RS and MD: write-up of the manuscript. GA-J: conceptualization of the study, designing the interview guides, data collection, data analyses, write-up of the manuscript, critical review of the manuscript, journal submission, and response to reviewer comments. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Constructing a diversified online neurology teaching model under the COVID-19

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Purpose: To construct a diversified and comprehensive network teaching model to provide highly qualified medical teaching in neurology under COVID-19 pandemic.

Materials and methods: Published studies on medical education were systematically reviewed and summarized. Based on previous studies and our experience, we constructed a novel online neurology teaching model and applied it to real scene. Students taking traditional in class lessons and online lessons were asked to finish the test, respectively, to compare the efficiency of learning. Questionnaires were designed and assigned to get the feedback from students.

Results: The average test score of students who take online class (84.27 ± 4.64) was significantly higher than those who take in class lessons (82.08 ± 6.17) ($P < 0.01$). According to the feedbacks from students, online classes were more attractive to students than the conventional one.

Conclusion: Traditional single-mode teaching can no longer meet the needs of current medical education, especially under the rampant epidemic. This novel teaching mode, which orchestrates high-tech tools, diverse teaching methods and traditional teaching concepts, provides the solution to the challenge faced by traditional medical education. We believe that this novel online teaching mode will boost neurology education and inspire educators in other fields during this tough period.

KEYWORDS

COVID-19, education reform, medicine, neurology, online teaching

1. Introduction

A pneumonia epidemic, first reported in Wuhan, Hubei province in December 2019, has become a global issue because of its surprising infectivity through droplets, air, and physical contact (1). On 11 February 2019, the World Health Organization (WHO) officially named this disease as the coronavirus disease (COVID-19) (2) and the International Committee on Taxonomy of Viruses named the virus as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (3). In this special epidemic period, traditional in class teaching no longer meets the needs for disease control and prevention due to the close social distance. To curb the further spread of virus and consolidate the obtained achievements in epidemic prevention, local governments decided to delay the reopening of schools at all levels. Educational authorities have proposed using online platforms and cloud classrooms for online teaching in the extended holiday to achieve "continuous teaching even when classes are suspended." With richer teaching resources, more diversified course designs and free of time limits, online teaching has shown huge and magic power in this tough period. Despite all these advantages, there remain some hurdles and difficulties, such as the restrictions on course contents, the rigid demand for digital equipment, the requirement for students' self-learning ability and most importantly, the loosened ties between students and teachers separated by the cold screen. All these problems will get tougher and trickier when it comes to clinical medical education, as it takes time to record the changes of the patient's condition and put theory into practice. Therefore, it is of great importance to construct a novel teaching mode in the COVID-19 pandemic to improve the teaching quality for medical students.

Recently, medical education has generally adopted a teaching method of "mainly traditional teaching supplemented with online teaching," which has gradually replaced traditional "spoon feeding" and has obtained positive feedback. After systematically reviewing the literature, we found that previous models and methods in neurology teaching have their limitations. Considering the dual needs of neurology teaching theory and practice, as well as the difficulties and challenges in comprehensive online teaching during the COVID-19 epidemic, we have constructed a diversified online teaching method for neurology education. We intend to combine online courses, massive open online courses (MOOC) and virtual reality simulation systems to improve the quality of online education. In this article, we took neurology education as an example to summarize the practical experience of online teaching and evaluate diverse online teaching methods during the COVID-19 pandemic. Besides, we combine multiple teaching modes to construct a new diversified online teaching mode to make up for the shortcomings of traditional online teaching. Though developed in response to challenges under COVID-19 pandemic, this teaching mode is also helpful in remote education and tans-national education, which can be further applied in the future.

2. Study participants and methods

2.1. Design

We systematically reviewed the published papers involving in online education and summarized the characteristics of online teaching, neurology education and existing neurology teaching methods. Based on this, we established a new teaching model and applied it to the neurology teaching of undergraduates in Xiangya Medical College of Central South University. Students taking online and traditional offline classes were asked to finish tests to evaluate the neurology learning effectiveness. Questionnaire surveys were conducted to obtain their feedback on the new teaching model.

2.2. Participants

We chose 260 clinical medical undergraduates of Xiangya School of Medicine, 130 of them taking online courses and others taking offline courses. Forty hours were allocated to theoretical and practical teaching, twenty hours for each. After 6-month classes, from February to August 2020, they were asked to finish the test. The study was approved by the ethics committees of the Xiangya Hospital, Central South University. The purpose of the study was clearly explained to the participants before distributing the questionnaire. Informed consents were obtained, and all questionnaires were administered anonymously.

2.3. Teaching methodology

We constructed a diversified online teaching method in neurology education based on three aspects: resources, processes, and services, aiming to overcome the current challenges and improve neurology education quality during the COVID-19 pandemic and for future education (**Figure 1**). This teaching mode emphasizes on the subjective motivation and initiative of the students and interdisciplinary cooperation of teachers.

2.3.1. Construction of diverse teaching resources

2.3.1.1. Online courses

Images, videos, and animations were used in the theoretical online teaching. Continuous image photography, audio, and short videos of positive signs of classical neurological disorders were obtained from the Department of Neurology, Xiangya

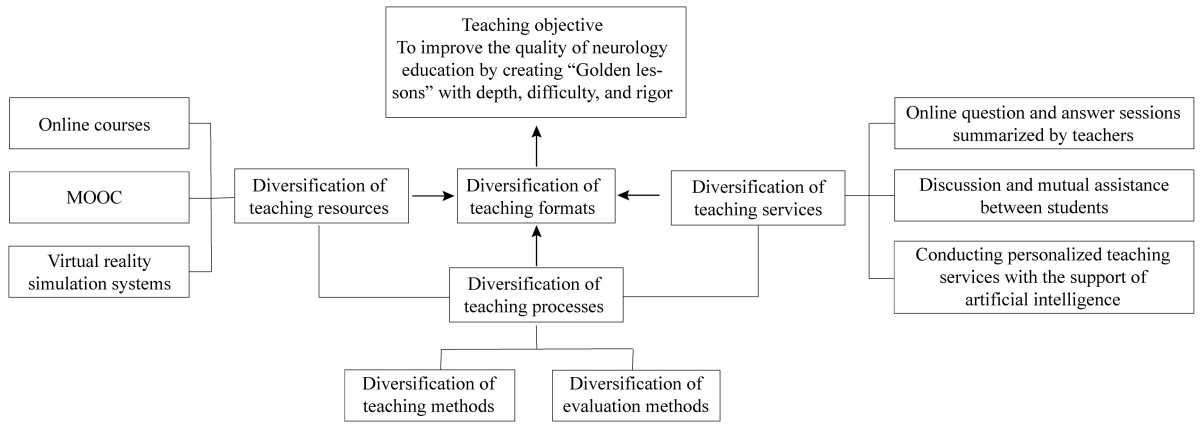

FIGURE 1
Construction of a diverse online neurology teaching method during the COVID-19 pandemic.

Hospital, Central South University and online education resources. Those sources were used to construct and enrich the positive nervous system sign image and video library (4), which greatly arouses the interest of students and helps them to deepen their theoretical knowledge without leaving home.

2.3.1.2. MOOCs

Since its launch in 2008, MOOCs have become a prominent representation of remote online teaching. The emergence of MOOCs has enabled the conversion of teaching mode from "first teach then learn" to "first learn then teach" (5). Taking neuroanatomy knowledge as an example, students had learned systemic and local anatomy during the basic medicine phase but have almost forgotten about them by the time they were enrolled for the neuroanatomy courses. However, with the help of MOOC, they can review those knowledges online, bridging the knowledge gap and receiving a more efficient learning.

2.3.1.3. Virtual reality simulation systems

Medical history collection and physical examination are indispensable for localization and qualitative diagnoses in neurology. After teachers have displayed online videos of neurological examinations for students, students can then enter the virtual reality system and select different types of neurological diseases for online simulation (6, 7). Then students are required to make a corresponding diagnosis based on the medical history and physical examinations.

2.3.2. Construction of diverse teaching services

2.3.2.1. Online question, answer, and summary from teachers

Professors are responsible for giving neurology theory while teaching assistants are responsible for the summary and the question-and-answer sessions after online courses. The teaching assistant should clearly know students' questions and provide targeted and personalized guidance for them to solve the problems. Carefully avoid directly giving them the answers. They must help students understand the problems in the diagnostic process and assist them in developing clinical thinking. In addition, heuristic guidance is needed to open their minds and give them timely feedback. The teaching assistants can also use video conference to periodically summarize knowledge in various diseases.

2.3.2.2. Discussion and mutual assistance among students

Discussions around the central topic give students the opportunities to voice their own opinion and open their minds. By doing so, they can learn from each other and have a better teamwork.

2.3.2.3. Personalized teaching services with artificial intelligence

Students' learning foundation, capability, and interest are quite different. With the help of artificial intelligence, teachers can get a clearer understanding of students' learning situation through questionnaires and tests, and further provide personalized guidance.

2.3.3. Construction of diverse teaching processes

2.3.3.1. Diversification of teaching methods

Before the course, teachers should clearly state the learning objectives. Besides cold knowledge, warm empathy and humanistic care are also essential for medical students (8). Teachers can employ CBL, PBL, or flipped classrooms to develop the initiative of students so that they can improve autonomous learning competency within a limited timeframe. In our new teaching mode, to make the clinical neurology teaching diversified and personalized, teachers make and apply microvideo chips (10–15 min) for scenario or case simulations, which hides professional knowledge (9). Students

are asked to discuss these cases based on groups, which helps them to develop clinical thinking and grasp professional knowledge better.

2.3.3.2. Diverse assessment methods

The Plan-Do-Check-Act (PDCA) cycle is currently regarded as one of the most high-quality management methods and is widely used in medicine. PDCA can improve medical processes and standardize hospital workflow (10–12). The entire PDCA cycle reflects the objective law of "understand-practice-re-understand-re-practice" in human objective cognition. It can also serve as a problem-solving mindset. Actually, teaching evaluation is a type of feedback on students' acceptance of the teaching method and content, which is equivalent to the re-understanding phase in the PDCA cycle. Teaching evaluation cannot be divorced from a rational evaluation system and a suitable evaluation entity. Besides, student evaluation from teachers, student's self-evaluation and mutual evaluation can never be ignored as well. In addition, evaluations of teachers and their teaching methods from students are also indispensable as they can point out the problems in the ongoing teaching mode. In our teaching process, we regularly obtain feedback from students through questionnaires, and accordingly make improvements and adjustments to the teaching model.

2.3.4. Specific implementation processes

2.3.4.1. Active learn before class

We established an online chat group for the communication between students and teachers during the teaching process. The teaching resources of neurology were delivered to the students before class through the online communication. Students watched the videos and other learning resources based on the learning objectives and requirements released by teachers in advance. Before the lesson, students' interest and their prior knowledge will be understood by means of pre-class test, quizzes, anonymous voting, group discussions, etc., so as to adjust the depth and progress of the following teaching content. We use a test including about 10 choice questions to evaluate the mastery of teaching content before class.

2.3.4.2. Discuss in class

In class, the professor first gives a lecture to introduce typical cases in the form of text, PPT, pictures, videos, etc., to attract students' attention and arouse their curiosity and interest in learning. Typical cases can be presented in a variety of ways, including but not limited to videos and patients simulated by doctors. Then they should set clear, appropriate, achievable and measurable learning objectives from the perspective of students to help them understand the point of this class. The problems discussed in class should be diverse and vivid, so as to improve students' interest in learning. in addition, teacher-student and student-student interactions are encouraged to help the students learn the knowledge better. These processes are conducted through Wemeet (an online meeting application).

2.3.4.2. Review after class

After class, students are asked to participate in the learning activities in a variety of interesting ways, such as personal reports, group discussions, case studies, role plays, and storytelling, so as to deepen the students' understanding and impression of what they have learned and improve their interest in learning. Students can ask questions and the assist teacher answers their questions and gives a summary through the online chat group. A task will be delivered to students, and they are asked to independently finish a diagnosis and treatment plan, including auxiliary examination, diagnosis, differential diagnosis, treatment, prognosis evaluation and preventive measures, by consulting literature and reviewing textbooks. Besides, a test including about 10 choice questions is used to evaluate the learning effectiveness of neurology after class. The test was designed by the professors of department of neurology. A questionnaire survey was conducted after that semester to obtain the attitudes from students toward the diversified online teaching method for neurology. The specific implementation processes can be seen in **Figure 2**.

2.4. Research methods

We used Wenjuanxing (an online website for questionnaire survey) to investigate the attitude of the students for this new online teaching method. The responses of the survey were scored using a 5-point Likert scale ranging from strongly disagree to strongly agree. Besides, we compared the average test scores of students who take online classes and those who take in class lessons.

2.5. Statistical analysis

The data were coded, entered, and analyzed using the SPSS statistical package, version 25.0 (SPSS Inc., Chicago, IL). The test scores were presented as means ± standard deviations (SD). An independent sample t-test was used to compare mean test scores between pre-class and post-class. $P < 0.05$ is considered statistically significant.

3. Results

As shown in **Table 1** and **Figure 3**, the average test score of students who take online classes (84.27 ± 4.64) were significantly higher than those who take offline classes (82.08 ± 6.17) ($P < 0.01$).

One hundred and thirty copies of questionnaires were sent out and one hundred and thirty were received with a coverage

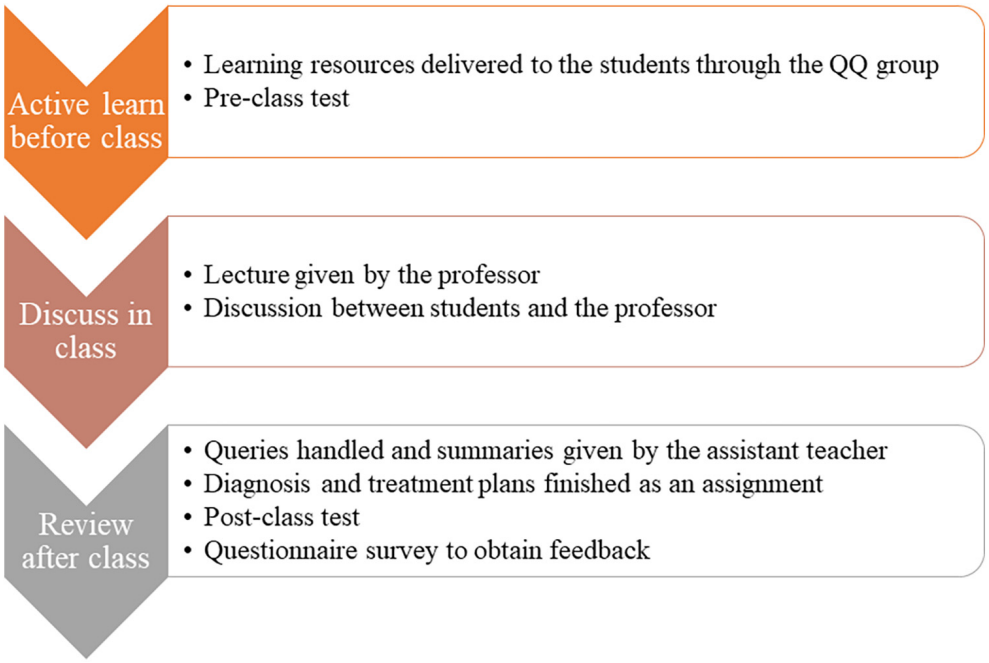

FIGURE 2
The diagram of the teaching process under the diverse online neurology teaching mode.

rate of 100%. The questionnaire results were shown in Table 2 and Figure 4. There were 71.54% (93/130) students liked this online teaching mode and 63.85% (83/130) students believed that this teaching model was innovative. 60% (78/130) of the students thought the online teaching aroused their interest in the study of neurology. In all, 64.62% (84/130) students thought it a good way of teaching.

4. Discussion

Online learning is a novel and rapidly growing field for undergraduates, graduate students and healthcare providers (13). In this article, we summarized online teaching methods for neurology and pointed out shortcomings in existing methods based on the teaching characteristics of neurology. We also pointed out and analyzed challenges in total online neurology teaching during the COVID-19 pandemic and constructed a student-centric, diversified and total online teaching method in neurology education to allow teachers to reform their current teaching practices while adhering to traditional teaching concepts.

TABLE 1 The average score of the test.

Groups	The number of students (M/F)	Test score (mean ± SD)
Online	130 (68/62)	84.27 ± 4.64**
Offline	130 (65/65)	82.08 ± 6.17

**$P < 0.01$ vs. offline group.
M, male; F, female; SD, standard deviation.

We evaluated the effect of our mode through post-class tests and questionnaire survey. The results of tests indicated that the scores of students who take online classes were significantly higher than those who take offline classes ($P < 0.01$). Probably reason could be that online classes offer more opportunities for students to acquire and consolidate their lessons via reviewing and relearning. In addition, online teaching via pictures and videos could deepen students' understanding of specialized diseases. This helps to cultivate their clinical abilities and advanced thoughts on solving complex diseases based on the learned theoretical knowledge and skills. Moreover, diversified teaching forms could promote students' interest in neurology, their communicational skills and humanistic feelings at the same time. By learning neurology through this diversified online teaching mode, students deeply mastered the teaching content. According to the feedbacks from students, online classes were more attractive to students than the conventional one. It is worth noting that, online learning put forward higher requirements for the autonomous learning abilities of students.

As the population ages, the need for neurologists increases. However, the number of medical students going into neurology cannot meet this increasing need. This is somewhat associated with neurophobia (9), i.e., fear of neuroscience and clinical neurology, and the inability to apply basic neurological knowledge to clinical practice (14). Lin et al. recently published

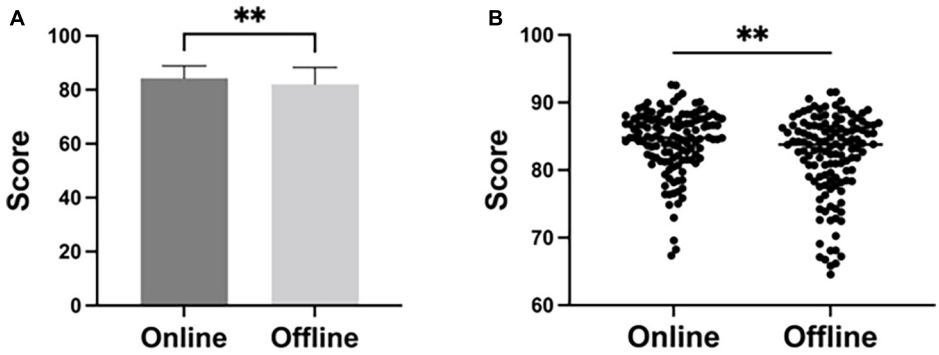

FIGURE 3
The average test scores of students taking online classes (n = 130) and taking offline classes (n = 130), analyzed by T-test. $^{**}P < 0.01$.

TABLE 2 Students' attitudes toward this novel online teaching mode.

Questions	SA	A	U	D	SD
I like this online teaching.	53 (40.77%)	40 (30.77%)	22 (16.92%)	7 (5.38%)	8 (6.15%)
The online teaching model is innovative.	29 (22.31%)	54 (41.54%)	27 (20.77%)	9 (6.92%)	11 (8.46%)
The online teaching arouses my interest in neurology.	38 (29.23%)	40 (30.77%)	36 (27.69%)	11 (8.46%)	5 (3.85%)
The online teaching provides a more three-dimensional experience for my learning.	35 (26.92%)	44 (33.85%)	31 (23.85%)	10 (7.69%)	10 (7.69%)
I like the interactive way of online teaching.	59 (45.38%)	46 (35.38%)	16 (12.31%)	5 (3.85%)	4 (3.08%)
The online teaching is a good way for learning and teaching.	40 (30.77%)	44 (33.85%)	27 (20.77%)	7 (5.29%)	12 (9.23%)

SA, strongly agree; A, agree; U, uncertain; D, disagree; SD, strongly disagree.

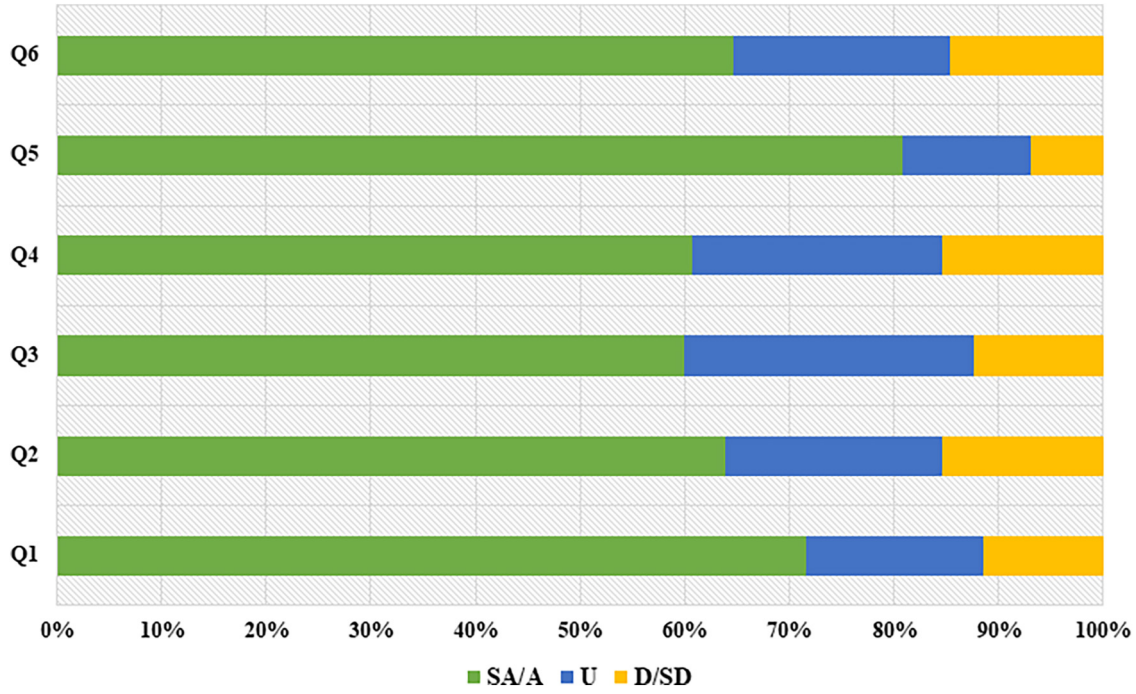

FIGURE 4
Students' attitudes toward this novel online teaching mode (n = 130). SA, strongly agree; A, agree; U, uncertain; D, disagree; SD, strongly disagree. Q1 to Q6 represent the 6 questions in Table 2.

a paper in Neurology, which emphasized the challenges in clinician education and encouraged educators to teach "the art of neurology" (4). How to improve neurology education to make it a "golden lesson" with depth, difficulty and rigor? It is a question that requires serious consideration (15). Neurology has a higher demand for students in clinical thinking and practical skills, which are mainly presented in the following two aspects: (1) The highly required combination of clinical and basic sciences: The complicated neuroanatomical structures, diverse symptoms, obscure etiologies, and similar clinical manifestations in different diseases increases the difficulty in learning neurology. Comprehensive medical history collection and physical examination are powerful tools to determine the site (localization diagnosis) and nature (qualitative diagnosis) of the lesion for diagnosis and differential diagnosis, which requires a clear and logic clinical thinking (10). The neurology education puts forward a dual test in the master of both clinical and basic knowledge for students, and the models of both theoretical (including neuroanatomy, neurophysiology and neuroimmune) and clinical (including clinical manifestations, signs and diagnostic principles) teaching for teachers. (2) Cross-disciplinary training: With the rapid development of medical imaging, medical examinations, neuroimmunology, and neurogenetics, clinical neurology is dynamically growing. This requires educators to cultivate more talents in this field with logical clinical thinking and cross-disciplinary ability to innovate and develop this fast-changing field (16).

Educators and scientists around the world are constantly exploring a better online teaching mode for neurology education. Safdieh et al. (17) provided useful resources for medical students, including a streamlined list of symptom complexes, an abundant list of recommended clinical encounters combined with midrotation feedback. Chen and Evans (9) constructed a MOOC-based flipped classroom model for neurology, bearing "students as a learning entity" in mind. They employed images, flash animations, and videos in online classes and had face-to-face interactions between teachers and students in offline classes. The combination of online and offline education not only ignites the students' interest in neurology but also promotes their self-learning ability and teamwork spirit, which compensates for shortcomings in the single problem-based learning (PBL) and case-based learning (CBL). Zhou et al. (18) incorporated online assignments, question and answer discussions, and knowledge summaries into offline courses to provide targeted teaching based on the individualized learning situation. Ding et al. (19) proposed the concept of micro-lectures to establish a teaching mode. In their project, traditional neurology teaching is combined with a micro-lecture so that students can get access to the knowledge unavailable in the traditional classroom through online courses. As a complement to traditional teaching, micro-lectures are widely used in basic medical education (20–22). However, its application in clinical education and practice looks dim nowadays as it fails to cultivate clinical thinking and skills in medical students.

With the advent of mobile internet, cloud computing, big data, and artificial intelligence, online teaching has become an important part of the modern education (23, 24). The fusion of information technology, such as MOOCs, flipped classrooms and high-quality network resources has gradually replaced traditional "spoon feeding" teaching mode and become today's new trend (9). Compared with conventional classroom teaching, online teaching has the following characteristics: (1) Flexibility: online teaching is free of time and space limitations as both teachers and students can flexibly schedule their time to give or have a lecture (25); (2) Personalization: students can pause, advance, and replay the course video according to their own learning situation, which greatly elevates their study efficiency (26); (3) Abundant teaching resources: teaching images and video libraries are timely updated and available to all users (15); (4) Reduced costs: teachers can learn from each other to improve their teaching skills (27). Besides, online lessons could receive support from ads and charities, which reduces the teaching cost and ensures the teaching quality at the same time.

Conducting rational and effective online teaching remains a challenge. It is true that online teaching can be used for basic medical classes. Students who accomplish the tasks in different chapters will have a good grasp of theoretical knowledge. However, the clinical practice is of the same importance in their medical study, such as clinical operations, clinical thinking and physician-patient communication (28). Taking neurology study as an example, medical history collection and physical examination are indispensable for localization and qualitative diagnoses. Besides, lumbar puncture, the most common neurological procedure, requires enough practice to be acquired. In addition, online teaching requires more financial and technique support while many universities lack the required infrastructure. Further, online teaching has a higher requirement not only for the students' self-discipline and self-learning ability, but also for teachers' teaching method and quality.

This diversified online teaching mode makes up for the shortcomings of traditional online and offline teaching, explore the subjective initiative in students and fill their knowledge gaps. Besides, it increases students' interest in learning, enables them to make personalized studying plans, provides them with abundant online exercises and attract them to choose online study. Diversified teaching and evaluation methods further deepen teachers' understanding of students and contribute to the improvement in previous teaching methods. Therefore, we believe that neurology teaching under this diversified teaching forms can improve students' autonomous learning and collaborative abilities, which helps them to truly internalize theoretical knowledge, to analyze and solve clinical cases better and to integrate into the clinical atmosphere. The diversified online teaching mode is also of reference and promoting value

in ensuring students' normal courses and continuing education in the face of sudden public health and safety emergencies.

5. Conclusion

In general, we constructed a diverse online neurology teaching method by combining advantages of modern information technology, scientific research, and online teaching. Our newly constructed teaching model is proven to be effective in neurology education under COVID-19 pandemic and has received recognition from students.

Moving forward from this pandemic, to maximize the benefits of offline and online teaching and to improve the efficiency of medical education in the future, we recommend that medical schools adopt a combination of both in calss and online teaching. Online teaching should be regarded as a supplement to, not a substitute for, traditional in class teaching. Further research is needed to explore the effectiveness of this novel and diversified teaching mode in remote education and tans-national education. We expect that this online teaching method can be further integrated into traditional medical education, not just in neurology, but also in other disciplines. This will combine the technological strengths with teaching strengths and achieve collaboration among networks, scientific research, and medical teaching to cultivate outstanding medical talents with outstanding clinical skills.

Data availability statement

The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of Xiangya Hospital, Central South University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

MZ conceptualized the study, acquired the funding, and administered the project. HY and YF wrote the original draft. YF and ZC provided the resources. HW, XH, and TW worked on validation. All authors reviewed and edited the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Exploring the challenges of virtual internships during the COVID-19 pandemic and their potential influence on the professional identity of health professions students: A view from Qatar University

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Introduction: COVID-19 has imposed many shared limitations on medical and health education. Just like other health professions programs at most institutions, the Qatar University health cluster (QU Health) applied a containment approach and shifted all learning online, and onsite training was replaced by virtual internships (VIs) during the first wave of the pandemic. Our study aims to explore the challenges of virtual internships during the COVID-19 pandemic and their influence on the professional identity (PI) of the health cluster students from the College of Medicine, the College of Health Sciences, and the College of Pharmacy at Qatar University.

Methods: A qualitative approach was employed. In total, eight focus groups with students ($N = 43$) and 14 semi-structured interviews with clinical instructors from all the health cluster colleges were conducted. Transcripts were analyzed following the inductive approach.

Results: The major challenges reported by students were mainly related to the lack of the required skills for navigating the VI, professional and social stressors, the nature of VIs and the quality of learning, technical and environmental issues, and the development of students' professional identity in an alternative internship environment. The challenges relating to the development of professional identity included: limited clinical (practical) experience, a lack of experience in fighting a pandemic, a lack of communication and feedback, and a lack of confidence in meeting the internship's goals. A model was constructed to represent these findings.

Discussion: The findings are important in identifying the inevitable barriers to virtual learning for health professions students and provide a better understanding of how such challenges and different experiences would be affecting the development of their PI. Hence, students, instructors, and policymakers alike should strive to minimize these barriers. Since physical interactions and patient contact are indispensable components of clinical teaching, these extraordinary times demand innovations involving technology and simulation-based teaching. There is a need for more studies that are focused on determining and measuring the short- and long-term effects of the VI on students' PI development.

KEYWORDS

virtual training, professional identity, university students, COVID-19, Qatar, health professions

1. Introduction

COVID-19 has imposed many shared limitations on medical and health education. Just like other health education programs at most institutions, the Qatar University health cluster (QU Health), which constitutes the group of Colleges of Medicine, Health Sciences, Pharmacy, and Dental Medicine at Qatar University, applied a containment approach and shifted all learning online, and onsite training was replaced by virtual internships (VI). Students from all clinical programs were removed from practice sites to reduce the risk of transmission and allow these sites to focus on essential services.

Early clinical training, which applies practice-based-learning models, is the backbone of medical education (1) and plays a pivotal role in enhancing clinical skills development across all medical professions (2, 3). There is empirical evidence that early experience in medical education strengthens medical students' learning and makes it more real and relevant (4). Several competencies that healthcare students need to build during their training and that supplement their clinical knowledge and skills have been defined in literature (4–12). Examples include interpersonal competencies (communication and collaboration), cognitive skills (problem-solving, critical thinking, and reflectivity), work-related skills (planning and time management), and professionalism (integrity, sense of responsibility, respect, and empathy). It is therefore important to facilitate and assess these competencies in the context of the complexities of real-life situations (12). Moreover, a set of important outcomes of early clinical learning include student satisfaction, adapting to clinical environments, reducing stress and enhancing confidence upon interacting with patients, and learning self-reflection and appraisal skills.

Another important outcome of early clinical learning is professional identity (PI) formation (4–10, 12, 13), where PI is defined as "the attitudes, values, knowledge, beliefs and skills shared with others within a professional group" (4). A simple model by Vivekananda-Schmidt et al. shows that medical students' perceived key factors for building their PI were their extent of participation, acknowledgment of their professional roles, and their independent practice of professional activities (14). Literature has consistently shown how PI formation is socially constructed (5, 6, 11), which allocates great importance to communities of practice-based and situated learning that incorporates experiential and reflective learning processes, formative feedback, use of personal narratives, availability of a role model, and candid discussions (5, 15). Practical competence and PI are, therefore, interlinked concepts and constitute the two important qualities that empower medical students to play an indispensable role in helping patients (3, 14, 16). Nevertheless, literature has reported several challenges to PI formation, which may be associated with the nature of healthcare settings and the extent to which these settings enable the building of essential health professional competencies (17, 18). The concept of professionalism, as one of the essential competencies, is also tightly contextual and influenced by culture (12, 19). For example, the Arab region, including Qatar, has reported a culture-related gap in some professional competencies, like the ability to learn independently, think critically, and practice reflection (17, 18).

Additionally, while evidence suggests that virtual teaching is effective (20, 21), it has been shown to present several barriers and challenges (22, 23), such as environmental challenges, a lack of technological resources and skills, and insufficient institutional support (24, 25). Institutions also continuously try to develop resources to improve student engagement and interactivity during online classes (26).

Although existing literature has extensively described the best practices for online medical education (20–23), further research is needed to understand how to apply such practices given the short time frame available when an unexpected situation arises, like a pandemic. Recent literature describes how being offsite and the lack of in-person interaction with patients and other healthcare professionals in the era of COVID-19 might add to the already existing challenges to online medical education and may prevent medical education from reaching its goals (1, 8, 26–30).

1.1. Virtual internships at QU health during the COVID-19 pandemic

During the COVID-19 pandemic, like many health professions programs around the world, QU Health was faced with the need to create safe and appropriate alternatives for onsite clinical training. Thus, onsite training was replaced by virtual internships (VI), which is practice-based learning *via* different online platforms, during the first wave of the pandemic (31).

The clerkships at the College of Medicine (CMED) were shifted to online platforms with an emphasis on the delivery of clinical knowledge and reasoning through means of case discussions. Such online sessions were delivered *via* platforms supported by QU, like Cisco Webex and Microsoft Teams. The MD program at CMED divided the time of the clerkship between online lectures and study sessions, and it replaced clinical placements until after the restrictions of clinical attachment were lifted in July 2020. Meanwhile, the program ensured that students were educated about the required clinical knowledge for their clinical placements. This time was also used for the completion of in-program assessments, such as case reports, case logs, case presentations, and work-based assessments. The assessment involved case discussion assessment. Students were asked questions about the history and physical examination findings of certain medical conditions. Questions covered medical conditions that patients would commonly present with. An assessment blueprint ensured fair distribution of questions across the curriculum content. Assessment also targeted clinical reasoning, diagnosis, investigation, and treatment across a range of clinical problems. Case discussions were conducted online, but subsequent case discussions were run in multiple mini-interview formats from home.

During the COVID-19 pandemic, the College of Pharmacy (CPH) clinical training also moved from experiential learning in the training sites to virtual internships (VI). The full-time PharmD program includes eight advanced pharmacy practice internships, each lasting 4 weeks, based on situational learning through internships. Students are continuously assessed throughout the program, through mid- and final-point evaluations, according to 23 predetermined criteria mapped to seven educational outcomes, which are assessed by their assigned preceptor for each internship. Rotation activities include journal clubs, case presentations, and therapeutic discussion topics. Students must then complete one final exit examination known as an oral comprehensive examination, all of which were conducted virtually during the spring 2020 semester.

The Department of Public Health at the College of Health Sciences shifted its health education practicum to a project-based internship (PBI), replacing their clinical training in Primary

Healthcare Centers (32). In the PBI, students constructed questionnaires after reviewing the literature to assess the needs of specific audiences regarding different public health topics. They collected online data and conducted the analysis. Then, they delivered online activities to promote the health of the chosen audiences. Students also built creative models to plan for implementing these activities and services and suggested a variety of methods to monitor the implementation process. In addition, they planned for effect evaluation by suggesting specific outcome indicators and different research designs.

The Human Nutrition internship at the College of Health Sciences is a structured program that includes rotations of clinical sites, such as cardiac, oncology, renal, food service, and other medical departments of Hamad Medical Corporation (HMC) hospitals (33). During the pandemic, most clinical rotations were immediately shifted to virtual rotations, and various student tasks were suspended, such as patient education, counseling, and working in interdisciplinary teams. These were replaced by an extended number of hours of professional development classes, where students attended workshops led by dietitians abroad and got more involved in case simulations using the telehealth concept, case studies, case presentations, and preparation of awareness campaigns and by writing articles.

Qatar has invested heavily in improving the health and education sectors recently and placed them in the top priorities of the country's vision. Given the uncertainty of the future, should the COVID-19 pandemic persist, there is a need to identify the challenges faced by university students in Qatar, across different healthcare disciplines, due to the shift to virtual internship. Understanding the students' perspectives, as well as those of faculty members, would be a way to improve their experiences with virtual training and to make sure this training continues to serve its role in shaping their identity as future health professionals. Therefore, the purpose of this study is to explore the challenges posed to students by the shift to VI in the era of COVID-19 and the potential threats to students' professional identity from the perspective of QU Health students and clinical faculty. This could be a major step in guiding plans aimed at maintaining the optimal standards of health professions education in Qatar during emergencies and beyond.

2. Methods

2.1. Study design

An inductive qualitative approach was used to capture and describe the perspectives of QU Health students and their clinical faculty members. With this approach, the researcher is not biased or occupied with predetermined assumptions and is open to understanding the phenomenon and answering the research question (34). Focus group discussion was chosen for students and was conducted in parallel with semi-structured interviews for clinical faculty members. The research team, consisting of faculty members from QU Health and College of Education, reviewed the relevant literature, discussed the findings, and then developed an interview guide and a focus group guide (see Supplementary Appendices 1, 2). The study was conducted around the end of the spring 2020 semester, during the first wave of the COVID-19 pandemic.

2.2. Sample population

Purposive sampling was conducted to recruit participants who were considered rich cases and would help us understand the challenges that the VI poses to students. The study included a total of 43 students from QU Health who registered for their clinical training. Twelve students from the PharmD program at the College of Pharmacy (CPH), 11 students from the Public Health (PH) program, 9 from the Human Nutrition (HN) program, and 11 from the College of Medicine (CMED) were invited to participate and all accepted the invite. Fourteen clinical faculty members who supervised a VI during the pandemic individually or alongside a preceptor from the clinical site were also invited.

2.3. Data collection

Emails were sent out to all QU Health students who were undertaking clinical internships and to clinical faculty members. The email included a description of the study and an invitation to participate through an online platform. The invitation included a consent form, which participants were asked to sign electronically or to sign and scan when convenient before joining the focus groups or interviews. This was followed by two reminder emails.

A date and time were communicated, along with a calendar invitation and a link to the WebEx online platform. At the beginning of the focus group discussion and the interviews, the facilitator (a trained member of the research team who is not involved in delivering the VI) reiterated the contents of the consent form, explained the rules of conduct in the group, and informed them that the sessions would be recorded. The focus groups and interviews were conducted in English, each lasting 60–70 mins and 45 mins, respectively. Data saturation was reached where no new information was reported by students and faculty members after conducting these discussions and interviews.

2.4. Data analysis

The focus group discussions and interviews were recorded *via* WebEx. Generated transcripts were validated as verbatim and used for analysis by a research team member who was not involved in the focus group discussion nor in conducting the individual interviews. Inductive qualitative analysis was employed to identify the themes and subthemes related to the challenges of VIs in the focus group discussions and individual interviews. Initial coding was conducted to identify these themes and a codebook was constructed. Coding is defined as the process of labeling, organizing, and structuring qualitative data to find themes and patterns (35). Each transcript was coded and new themes were added to the codebook as they emerged. Constant comparisons were conducted to differentiate one theme from another. With each addition of new data, themes were added and modified as needed. Finally, the themes were combined into a coherent, textural description of the phenomenon. To assist in the verification process, three members of the research team analyzed the data independently by reading through the transcripts and identifying the common themes separately. They then came together to discuss the results and reach a consensus regarding

the themes and categories. First, the focus group discussions were analyzed, followed by the individual interviews.

3. Results

In total, we conducted eight focus groups with students ($N = 43$) and 14 interviews with clinical instructors from all the QU Health colleges. The major challenges reported by students were mainly related to a lack of the skills needed to navigate the VI, professional and social stressors, the nature of VIs and quality of learning, technical and environmental issues, and the development of students' professional identity in an alternative internship environment. The themes and sub-themes emerged from the data, and their relationships with professional identity are presented in Figure 1.

3.1. Theme 1: Challenges related to a lack of the skills needed to navigate the VI

Faculty members expressed that a few students had insufficient communication and information-searching skills and needed to develop their online skills. The Public Health (PH) training coordinator mentioned that students were challenged in navigating the online skills, setting up their presentations, using the chat box, and participating in the discussions. One student explained:

> "Maybe because our topic was about COVID-19. The challenge was it is a new, emerging disease that is happening now, so the process of collecting information and also the interventions themselves" (sic) (PH Student).

Both students and faculty members of CMED perceived a need for the development of new technological skills, like reading a detailed CT scan. This was specifically applicable to some older faculty members.

> "How to open the back system, that's the X-ray system, how you show CT scan live on the WebEx that needs some help of the IT [information technology]. You can show a slice of CT scan on a little presentation… that's not the problem. But if you want to scroll a CT scan going from one pixel to another… that need a bit of IT help" (sic) (CMED Faculty 4).

3.2. Theme 2: Challenges related to professional and social stressors

To the majority of students, the VI imposed a feeling of stress and uncertainty in many ways. A student from HN expressed this challenge, saying, "I was stressed and not able to work on my training assignments and tasks as how I used to do in my usual routine before the crises" [sic]. According to a CMED faculty member, "The fear of getting and of completing on time, getting promoted to the next year, getting graduated on the expected year" [sic] were also among the main concerns that students had. Students' stress about the situation was aggravated by insufficient communication from the university regarding future plans for their training. This created a sense of frustration and uncertainty about the future regarding what they would be doing next.

> "I'm worried that, if this situation (COVID-19) continues, that we will still be lacking enough experiences on counseling patient or that some policies or guidelines changes that we may not have time to adjust to or having experience on it" (sic) (HN Student 4).
>
> "We need more communication and things need to be, at least to students, I mean, assessment, curriculum, and resources, because now we are in this situation, it is not a normal thing. So, relieving the stress of the situation can be with better communication… So the college need to decide, take some decisions, and unusual decisions and for us; everything need to be clear, the future plan, curriculum, resources and assessment" (sic) (CMED Student 9).

Students struggled with the feeling of being isolated while working from home and expressed being challenged by a lack of social interactions with their classmates and instructors, which had always been an important aspect of their on-campus life.

> "When presenting online, they [students] missed social interaction. In terms of content, everything was there, no problem. They missed the social interaction with their classmates, whom they are presenting for them" (sic) (PH Faculty 2).
>
> "It is also the culture on campus. Our students would like to, they like to meet professors, talk to them, share their concerns, hear a feedback, address their needs, and we have been good listeners to them. So, that was a big switch, big change once we were unable to meet those students as before. Sometimes, they stopped by the office three times a week and send tons of emails in normal situation. And in a sudden, we were unable to have those students in the office" (sic) (PH Faculty 1).

Being in front of screens all day instead of being on training sites and in hospitals also made students feel demotivated and in need of support and mentorship.

> "I'm struggling with motivation also, because when we used to go to the hospital, you feel motivated when you take care of the patient and you are a part of the team, whereas when you're home and you just have lecture" (sic) (CMED Student 1).
>
> "We need motivation, guidance, and kind of follow-up, which is actually the role of mentors… So if we had, for example, mentors from the college, and every four or five students with one mentor, from the staff of the college, they ask about them, they follow them, they guide them, this would be much better" (sic) (CMED Student 9).
>
> "I agree with the lack of motivation and I think the main reason for it personally, for me, is because during these online lectures, as much as the doctors are trying their best to give us the information that there's always a huge lack of interaction. And it's very hard to engage…" (sic) (CMED Student 3).

3.3. Theme 3: Challenges related to the nature of VIs and the quality of learning

Each student mentioned at least three to four examples of different issues that they thought could have adversely influenced the quality of their internship. Almost all students agreed that the

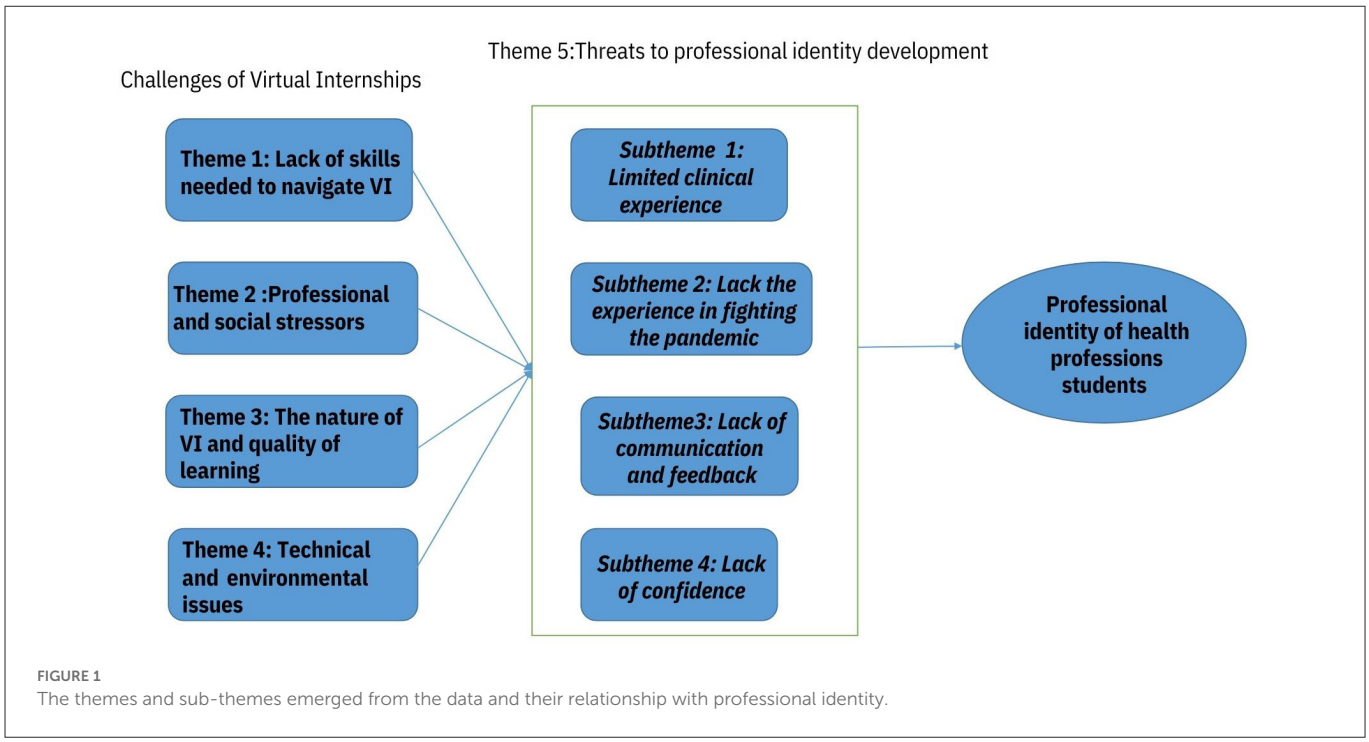

FIGURE 1
The themes and sub-themes emerged from the data and their relationship with professional identity.

online lectures were missing the interactive component and were not engaging.

> "It's very hard to engage during those. It's like listening to a recording. It's not the same and it's very difficult to concentrate sometimes… we don't get as much as we're supposed to" (sic) (CMED Student 3).

In addition, students from HN and PH expressed being overloaded with assignments and thought the VI was not resourceful and offered little benefit compared to real training. Some students explained this challenge:

> "The most challenge I have faced was the huge amount of assignments I had to do. It was very hard for me and my colleagues and it was time consuming with very little benefits comparing with real training" (sic) (HN student 3).
>
> "Some don't actually attend because it's a waste of time for some people and I feel that we have lack of resources, so there's a lot of dependence on self-directed learning (SDL) in our part, like, "Oh, here's the blueprint, it's SDL, all of it by yourself" (sic) (CMED Student 8).

3.4. Theme 4: Challenges related to technical and environmental issues

All students faced time management difficulties due to the home-working environment. It was difficult to sustain working hours from home due to the nature of the home environment and the disruptions that it caused. "It was really hard to achieve eight working in a day because you know you are at home, you still need to like to see what your family you want" [sic], one CPH student explained. They also expressed that working from home makes you work constantly with no breaks and causes issues with time management.

> "I have a hard time fixing my sleep schedule. It was easy to fix because we have to wake up early, and then we come back study, and then we're exhausted by the by ten o'clock or nine. But now, like, a hard time" (sic) (CMED Student 5).
>
> "Time management is a very big challenge. Staying at home all day and having many responsibilities beside the training made me very disorganized" (sic) (HN Student 1).

A few students also faced some technical issues related to Wi-Fi and connectivity and found it hard to spend long hours in front of screens.

> "The sound sometimes break and the Internet, and all of those distractions at the end of the lecture, we don't get as much as we're supposed to" (sic) (CMED Student 3).
>
> "The only challenge that I faced was looking at the screen for long time, which gives me headache, meaning that I will have to step away for an hour or so, which could affect me negatively, especially if I was attending a lecture or a meeting with the preceptor" (sic) (HN student 4).

3.5. Theme 5: Potential influence on students' professional identity

The majority of students were concerned about the threats that the VI posed on the development of their professional identity. Students talked about the limited clinical practice, lack of experience in fighting a pandemic, lack of communication and feedback from preceptors, and lack of confidence in meeting the training goals.

3.5.1. Sub-theme 1: Limited clinical (practical) experience

An important challenge reported by all students and faculty members was the limited clinical experience offered to students during the pandemic. This was partly due to the limited number of cases and the subsequent small number of clinical interventions imposed. Students described the quality of patient cases they were dealing with as basic. Thus, students were unable to respond to real patient cases and requests. One student, who was doing the internal medicine rotation, mentioned:

> "Unfortunately, they were barely admitting patients due to COVID-19 and they were saving the beds or rooms for COVID-19, so the patient cases or the patient that we had, they were not very interesting, and we missed the part of the follow-up" (sic) (CPH Student 4).

As a result, students were also challenged by the lack of onsite interactions with the healthcare team and the lack of opportunity to build connections with clinicians as role models, as explained by the students and faculty members.

> "Online didactic lectures, which, it doesn't be that sense of connections with clinicians. Unlike when they were taking them during the rotation, so having, you know, lack of encounter with the patients and at the same time lack of contact with clinical faculty and their expertise role modeling and all these things. I think that was also a challenge" (sic) (CMED Faculty 5).
>
> "I think there's a lot of, I would say, you know, formal and formal verbal and non-verbal communication that can be accommodated, like, good habits or good, you know, traits. And then, I think that we need to try to avoid or manage, or even resist, in order to make sure that the communication is fruitful and actually, I'd say productive in the sense of educational process" (sic) (CMED Faculty 3).

Students were not able to explore the reality of the practice setting. Students argued that being away from practice sites prevented them from practicing and gaining clinical and non-clinical skills. Hence, students were challenged by their inability to understand the healthcare team perspective as well as the patient perspective when making correct recommendations.

> "In the food service rotation, I see that we couldn't have the opportunity to see what is happening in the tray line. I was waiting for this rotation but couldn't have the ability to see what is happening there" (sic) (HN Student 3).
>
> "A lot of the times, when virtually, when you see recommendation, you have no idea why the physician chose this. But in real discussions, when you're there with the physicians, and they're telling you what they see the patients, what they're expecting and other factors that aren't usually documented" (sic) (CPH Student 10).

Similarly, CMED students faced difficulty with conducting physical examinations of patients, taking patient history, and assessing physical findings.

> "Students need to see and to face a patient also taking the history. You can't tell them, "Oh, this is possible asthma." How we can ask about history of wheezes, family history, you know the long list of, and how you play with the history. But when they face a real patient, not every patient is the same" (sic) (CMED Faculty 4).

3.5.2. Subtheme 2: Lack of experience in fighting a pandemic

When the training sites suspended training for the semester, the majority of students were disappointed and explained how gaining no experience regarding their role in fighting a pandemic would affect them as future clinical practitioners. They expressed that the VI allowed no time for them to gain such knowledge or experience, nor to help in the crisis.

> "Hamad [hospital] is already swamped with patients, so finding the time and the resources to get this information or to be exposed to the information about how to deal with pandemics at this time point is not easy" (sic) (CPH Student 2).
>
> "We signed up to be clinical practitioners regardless of what the situation is. So, I don't really see what's the difference of me or another pharmacist just being there in the front line, trying to help our patients" (sic) (CPH student 5).

Several CMED students tried to compensate by joining the fight as volunteers, and one of them expressed, "Some people say it's a risk for me as a student, and for my family, but at the end of the day, I don't like sitting down at home and not doing anything. So I prefer to volunteer during this pandemic and have an impact" (CMED Student 10).

The views of clinical faculty members widely coincided with those of students. They believed that students would be better off practicing in hospitals since this is their duty as doctors during a pandemic.

> "… How to use The PPE [personal protection equipment], how to limit the chance of getting the infection once your doctor; you cannot say, "No sorry, I got kids." Well, everybody got kids. It's our job. We are like soldiers, and you cannot say, "No I can't fight the enemy because I got kids" (CMED Faculty 4).

3.5.3. Subtheme 3: Lack of communication and feedback

A number of students expressed being challenged by the level of communication and feedback from the faculty members and preceptors, who were busy with the pandemic and not able to provide students with the extent of support that was needed. Sometimes, technical issues hinder interaction with faculty members during online sessions.

> "There was some technical difficulties, including sometime poor voice. You know, the slides share the slide. You cannot see the students if you have more than one student. The interaction being a big thing because you cannot answer all the questions the same time. You have to work a formula where you allow..." (sic) (CMED Faculty 5).
>
> "Students have the right to ask questions, find their faculty, even if we have answers for extra time. Some of the skillset they need to experience with new patients, doing some of the images,

like x-rays and CT scan, for example, we have to make sure that how a system that allows them to, even with the digital platform" (sic) (CMED Faculty 5).

The lack of face-to-face interactions posed a similar challenge to students regarding teamwork, collaboration, communication, coordination, and task distribution among their group members. One student explained, saying, "I have issues in teamwork. The communication and coordination was very difficult among us and you know online communication. Because it was online, it was a challenge to distribute the tasks among group members and review the work and what each student has to do" [sic].

The virtual nature of the internship also created another prominent challenge in regard to modes of assessment. It was difficult to assess clinical skills and the effectiveness and confidentiality of assessments suffered.

> "From the technology point of view, the challenges of using remote assessment is that the same challenges will be the voice the and on the interaction… the students, if they know you by your name and they know your background, they always think that the question about your specialty" (sic) (CMED Faculty 5).
>
> "And so, and then if we rely mostly on the OSCE [Objective Structures Clinical Examination] and MCQs [Multiple Choice Questions], and OSCEs is a major part of the assessment, and then how are we going to test the students on OSCE without having clinical replacement? So, this was the biggest challenge" (sic) (CMED Faculty 4).

3.5.4. Subtheme 4: Lack of confidence

All the above-mentioned challenges created a feeling of low confidence that the VI, being not based on real-life experience, would meet its goals.

> "For my side, I really wanted to wait and actually get an actual clinical rotation because for me, now, if I, let's say, got a job in Infectious Disease (ID), I have no idea what to do. I don't know how to approach the case, I don't know what's important, what's not important" (sic) (CPH Student 5).
>
> "If this continues throughout the next all of the clerkship phase, then I wouldn't be very comfortable or confident enough to then be put in the hospital as soon as possible; we need to be put into the hospitals again. And if there's any preparation or information regarding that, I think we would like to know as preparation for ourselves as well" (sic) (CMED Student 5).

This was echoed by faculty members who expressed that it would be challenging and exhausting for students to return to practice sites in the future.

> "So, they, you know, they may forget about that… because things that you don't practice, you know, they are more difficult to the get confidence in doing... so they're definitely not gonna be confident only from looking at videos" (sic) (CPH Faculty 1).
>
> "In the future that they might need to spend more time in the hospital, you know, they might need to... to spend to get more effort so they learn as much as they can to compensate for the period, which had been lost" (sic) (CMED Faculty 4).

4. Discussion

This study highlights a set of challenges that QU Health students faced during their VI, which represented barriers to fulfilling the purpose of their training. Our results align with the findings of two systematic reviews that summarize the main weaknesses of virtual medical education in the era of COVID-19 (26, 36) regarding technical challenges, reduced student engagement, lack of essential skill development, loss of assessments, and the negative effect on the mental wellbeing of medical students.

A comparison of our results with those of a survey conducted at a university in KSA shows that medical students faced similar challenges with their VI; however, technical difficulties were more of a concern to those students than was seen in our study. Nevertheless, the majority of students in the KSA survey demanded the integration of the online expertise garnered during the pandemic into their practice and seemed to perceive some positive impacts of the pandemic on their training (29).

Moreover, QU Health students had to adapt to the new normal of medical education and were struggling with stress and uncertainty surrounding their future, a finding that compares well with data from other countries (1, 26, 27, 36–39). Such a finding is not surprising since this population of students is considered a vulnerable population, and medical students, globally, show higher rates of depression, suicidal ideation, and stigmatization around depression (27). Additionally, students were challenged by the lack of physical and mental support from peers and instructors and the lack of social engagement. This may decrease their motivation, increase their stress levels (39), and hinder learning (40).

Of note is that students from CPH and CMED were the most challenged among all QU Health students and suffered from the lack of clinical experience and having no real-life interactions with patients and healthcare professionals. This is similar to what was reported in studies conducted in different countries (1, 26, 30, 41). Not having the chance to play any role in dealing with the pandemic was also challenging to our students, and most of them struggled with feeling their worth in healthcare. This also coincides with what was reported by medical students across universities that applied the same containment approach during the pandemic (26, 28, 36, 39). In consistency with the available literature (1, 26, 30, 39–41), students also reported challenges with the ability to gain some important clinical and non-clinical skills and competencies and the availability of guidance and feedback. This was reflected in their perceived low confidence about achieving the goals of the VI and being in practice sites in the future. Based on the literature, all the above-mentioned factors may constitute barriers against the early formation of students' PI, which is a principal goal of medical education. This is based on PI being a social construct that highly depends on the nature of practice settings, on situational learning (5, 6, 11, 14, 42), and on acquiring the essential competencies for healthcare professionals (12, 17, 18). A lack of PI has a drastic negative impact on the students' perceived value of their profession as well as on the level of confidence that they need to become advocates of their professional opinions during their future medical practice (6, 42, 43).

Since physical interactions and patient contact are indispensable components of clinical teaching in different health professions programs, such extraordinary times demand innovations involving technology, and simulation-based teaching must be utilized. It would therefore be crucial to expand collaboration with telecommunication

companies in order to provide and optimize the necessary interactive platforms for teaching and learning. The use of virtual conferences and social media should also be maintained as it was found to play a vital role in compensating for the loss of networking between students and other healthcare providers due to being away from training sites (36, 44). PI formation must be supported at all times (6), and it is crucial to avoid compromising it by creating a gap in the essential professional competencies and confidence needed to practice onsite. Given this, there is also a need for more studies that are focused on determining and measuring the short- and long-term effects of shifting to VI during the pandemic on the students' PI development.

Furthermore, problem-based learning and onsite training are the stages wherein students' professional competencies can be best measured (8, 28). Therefore, challenges imposed by the nature of VIs may additionally result in difficulty in measuring the competencies of health profession students, which is in accordance with what the faculty members and students involved in our study expressed about conducting assessments being one of the challenges faced during the VI. Our findings regarding challenges with assessments also resemble those from similar studies in the United Kingdom (UK), the Kingdom of Saudi Arabia (KSA), and Libya (29, 38, 39).

5. Study strengths and limitations

To enhance the rigor of our research study, we followed triangulation in different ways. First, we used multiple data sources to understand the challenges that the VI posed to students by conducting focus group discussions with students and individual interviews with clinical faculty members. Second, a different research team member who was not involved in the focus group discussion nor in conducting the individual interviews reviewed the transcribed data for validation. Third, independent data analysis was conducted by three members of the research team. In addition, the findings from some participants (preceptors/students) were confirmed by directing questions about them to the participants of other focus groups and interviews. However, this study has some limitations. We were not able to have the themes validated by the study participants, mainly due to time constraints. The study did not apply one specific validated framework, so focus group and interview guide questions did not specifically measure or assess the impact of shifting to VI on PI formation.

6. Conclusion

The impact of COVID-19 on health professions program training is only one part of the global impact it had on all aspects of normal daily activity and businesses. Meanwhile, remote teaching and Vis for students from different health professions programs, with all their challenges and drawbacks, have enabled medical education to continue despite the effects of the pandemic (39). Thus, our study results play an important role in identifying such challenges, among which are some inevitable barriers to virtual learning for medical students (26). Measures to help students adapt when faced with such challenges are essential given the uncertainty around the future persistence of the pandemic. It is necessary to provide students with mental health support, which can be facilitated by assigning mentors to help students adjust more rapidly to the COVID-19 crisis (45, 46). Our results also provide a better understanding of how such challenges and different experiences affect the development of students' PI. Hence, students, staff members, and policymakers alike should strive to minimize these barriers.

Finally, our study aligns with existing efforts to identify current issues and implement the necessary changes in a way that ensures that health professions education preserves its value, maintains its standards, and meets its ultimate goals.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Qatar University Institutional Review Board (QUERG-CHS-2020-1). The patients/participants provided their written informed consent to participate in this study.

Author contributions

HB, AE-A, AA-M, HA, and XD: conceptualization of the study, designing the interview guides, and critical review of the manuscript. RS: write-up of the manuscript. JM: data collection and write-up of the manuscript. GA-J: conceptualization of the study, designing the interview guides, data collection, data analyses, write-up of the manuscript, critical review of the manuscript, journal submission, and response to reviewer comments. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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The role of secure instant messaging applications in medical education: Evaluating student satisfaction in a case-based learning program using Siilo

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Background: Instant messaging applications for mobile phones have recently grown in popularity among medical personnel, including both physicians and medical students. During the COVID-19 pandemic, medical education was largely transferred to virtual platforms, making such applications an increasingly important tool for medical education. "Siilo" is a secure instant messaging application that was designed for medical professionals, and offers several advantages over other instant messaging services that are vital for its use in medical settings, including information security, data encryption, and a built-in blurring tool to maintain patient privacy. In addition, Siilo allows for the creation of individual folders for each case, enabling users to conduct separate discussions about multiple patients simultaneously.

Objective: To evaluate student satisfaction in a case-based learning program using Siilo as a medical education tool in improving student learning outcomes and motivation.

Methods: A case-based learning program was conducted with 24 fifth-year medical students using Siilo to evaluate its effectiveness as a medical education tool. The program was evaluated through the use of pre- and post-program questionnaires and focus group discussions to assess student satisfaction.

Results: The majority of students (83.3%) were highly satisfied with the Siilo platform and felt that it enhanced their learning experience, and a majority of students (79.1%) reported that the program was highly effective. Students reported that the platform was easy to use and provided a clear and organized way to follow discussions about cases. The focus group discussions further revealed that students appreciated the real-time communication and felt that the use of Siilo helped to improve the quality of communication and collaboration during the learning process. The use of Siilo as a medical education tool was found to contribute to positive relationships between doctors and students and improve student motivation for learning and outcomes.

Conclusion: These findings suggest that Siilo can be a valuable resource for medical education, particularly due to its secure and convenient features, which are well-suited for use in medical settings. The use of Siilo in a case-based learning program was found to be effective in improving student satisfaction and learning outcomes and contributed to positive relationships between doctors

and students. These results highlight the potential for utilizing mobile instant messaging apps as a tool for enhancing clinical teaching in medical education.

KEYWORDS

medical education, instant messaging, mobile application, case-based learning, Siilo application

Introduction

Instant messaging apps for mobile phones have gained popularity among medical professionals in recent years, particularly during the COVID-19 pandemic when medical education was largely conducted virtually (1). "Siilo" is a secure instant messaging app specifically designed for medical professionals, with features such as data encryption and personal password protection to ensure medical confidentiality. The app's interface is partially modeled after the popular instant messaging application WhatsApp (2).

Siilo has several features that make it an optimal choice for use in the medical field. Information security and data encryption are given high priority to ensure medical confidentiality. The application meets European standards for information security and requires a personal password for each login (3). User authentication is conducted through verification of medical license numbers and additional personal details. In addition, Siilo includes a built-in blurring tool to maintain patient privacy by obscuring personal details. These features demonstrate Siilo's commitment to security and confidentiality in medical communication.

One of Siilo's particularly useful features for medical education is the ability to create individual folders for each case. These folders can store text messages and relevant media files, such as pictures, videos, and documents, allowing users to easily follow discussions about each patient. This feature enables users to conduct separate discussions about multiple patients at the same time, without the risk of confusion. In summary, this function enhances the organization and clarity of medical discussions on the platform.

Siilo offers convenience, as cases can be accessed at any time and location, and discussions can be conducted asynchronously. This allows for the possibility of student groups being gathered from multiple sites within or outside their country. Additionally, Siilo is compatible with any smart mobile device and a desktop version has been developed as well, making it widely accessible. These features contribute to the user-friendliness of the platform.

Several studies have examined the use of instant messaging applications in medical education and have reported increased motivation for learning (4, 5), higher satisfaction with the learning process (6–8), and improved outcomes (e.g., better test scores) (5, 8) among students who used such tools. These applications have also been shown to foster positive relationships between doctors and students (9).

Given the prevalence of digital communication in the lives of students and physicians, and the unique advantages of Siilo over other instant messaging applications, we sought to examine how its special features could be utilized to enhance clinical teaching of medical students through a case-based learning program developed on the Siilo platform. Our primary objective was to evaluate student satisfaction with this approach.

Abbreviations: COVID-19, Coronavirus disease 2019.

Methods

This was a survey-based study, including details of the survey questionnaire. A total of 24 fifth-year medical students participated in the case-based learning program using Siilo.

A Siilo group was created for fifth-year medical students who were completing their clinical rotation in the Obstetrics and Gynecology Department. After acquiring the necessary theoretical knowledge, these students were invited to participate in case-based educational activities during the last week of their clinical rotation. These activities included three evolving cases that were specifically prepared for the students on the topics of gynecologic ultrasounds, obstetrics, and fertility. Each case was introduced with a brief description and related questions, and it evolved based on students' questions and additional relevant data.

To measure the students' engagement and activity in the case-based learning, we collected data on the number of students actively or passively participating in the case-based learning, the number of messages exchanged, the number of media files shared, and the average time spent on the Siilo platform. We also tracked the evolution of the cases by monitoring the progression of the discussions and the students' questions, in order to assess the effectiveness of the case-based learning approach in promoting critical thinking and problem-solving skills.

Case details

Three cases were included in the case-based educational activities, covering the topics of gynecologic ultrasound, obstetrics, and fertility.

The gynecologic ultrasound case consisted of 54 messages, including 37 text messages, seven ultrasound videos, six ultrasound images, two graphs, one PDF file, and one link to a YouTube video. One physician and seven students actively participated in this case, while seven additional students observed without active participation.

The obstetrics case included 78 messages, comprising 68 text messages, three ultrasound images, two PDF files, two graphs, two diagrams, and one picture. Nine students participated in the discussion, and five additional students observed without active participation.

The fertility case contained 108 messages, including 107 text messages and one photo. Nine students participated in the discussion, and five observed without active participation.

Data collection

The data collection for this study involved administering a questionnaire consisting of four questions rated on a five-point Likert scale. The purpose of the questionnaire was to assess the effectiveness of the case-based learning approach in promoting critical thinking and problem-solving skills among the participants. The questionnaire consisted of two questions prior to the training, aimed at evaluating participants' expectations, and post-training, four questions, administered to assess the effectiveness of the case-based learning approach in promoting critical thinking and problem-solving skills.

The pre-training questions were as follows: (1) "I anticipate that participating in the case-based learning program during the round will enhance my learning experience" and (2) "I believe that utilizing the Siilo instant messaging software will facilitate communication during the case-based learning program." The post-training questions were as follows: (1) "Did the case-based practice with Siilo prove to be effective for you?" (2) "Did the case-based practice with Siilo adequately prepare you for the exam that took place at the end of the round?" (3) "Do you find the use of the Silo software to be convenient?," and (4) "Would you be receptive to engaging in more practices through the Silo platform during the round?"

The study utilized a five-point Likert scale, with scores ranging from 1 to 5, to assess various aspects of the case-based learning program and the use of Siilo as an educational tool. The Likert scale was adapted to various questions, including efficacy, level of preparation, ease of use, and desire for additional training. The scores were interpreted as follows: Efficacy—1: Ineffective, 2: Somewhat Ineffective, 3: Effective, 4: Highly Effective, and 5: Extremely Effective; Level of Preparation—1: Not Prepared, 2: Poorly Prepared, 3: Adequately Prepared, 4: Well Prepared, and 5: Extremely Well Prepared; Ease of Use—1: Difficult to Use, 2: Challenging to Use, 3: Easy to Use, 4: Very Easy to Use, and 5: Extremely Easy to Use; Desire for Additional Training—1: No Desire, 2: Little Desire, 3: Some Desire, 4: Strong Desire, and 5: Extreme Desire.

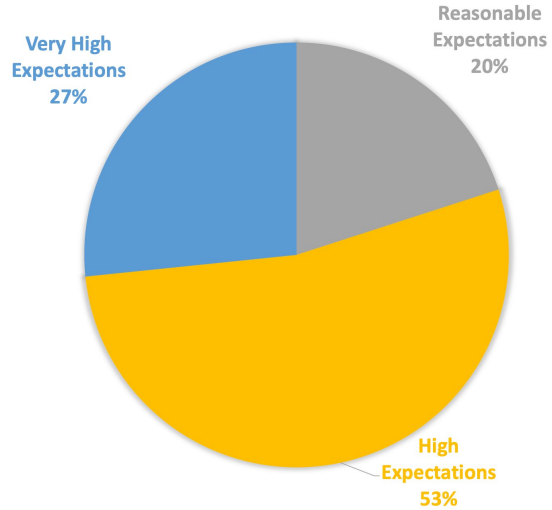

FIGURE 1
Students' expectations before joining the case-based learning program. A survey was conducted among students before they joined the study, asking them to share their expectations. The graph shows that 80.0% of the respondents anticipated that participation in the study group would be beneficial.

It is important to note that these scores were used consistently across all questions to ensure the comparability of results.

Data analysis

The data analysis of the data collected from the pre- and post-program questionnaires was performed using an Excel sheet. To assess the effectiveness of this teaching method, we administered two surveys: one before each teaching session to evaluate participants' expectations, and another after the session to gauge their satisfaction with the program. The data collected from the pre- and post-surveys were analyzed using a Likert scale as presented at the data collection section. Descriptive statistics, including statistical indices (means, percentages), were used to summarize the data. In addition, we conducted a qualitative analysis of the students' questions and discussions on the Siilo platform, to evaluate the effectiveness of the case-based learning approach in promoting critical thinking and problem-solving skills. The focus group discussions were transcribed and analyzed using thematic analysis. The transcripts were read several times to identify recurring themes and patterns in the data. These themes were then organized to provide a comprehensive summary of the students' perceptions and experiences.

Results

A total of 24 fifth-year medical students participated in the case-based learning program using Siilo.

Participants' feedback

Before joining the study groups, a majority of students (73.3%) believed that participating in evolving clinical cases during their ward rotation would aid in acquiring the required theoretical knowledge (Figure 1). Students expressed their expectations to "have a clear review of basic, common cases," "practice clinical thinking and understand the implications of treatment options," and "receive good clinical instruction with timely and helpful technical support, minimizing technical difficulties as much as possible."

Following the completion of the learning sessions, a majority of students (79.1%) reported that the program was effective, highly effective, or extremely effective, with a mean satisfaction score of 3.4 on a Likert scale. The majority of students (83.3%) believed that the "Siilo" case studies contributed to their exam preparedness, with a mean of 3.41 on a Likert scale. In addition, 87.5% found "Siilo" easy, very easy, or extremely easy to use, with a mean of 3.66 on a Likert scale. A large proportion of students (80.0%) expressed some, strong, or extreme desire to participate in additional "Siilo" case studies during their clinical rotations, with a mean of 3.54 on a Likert scale (Figure 2).

When asked to summarize their overall experience, several students provided insightful feedback on the case-based learning program and the Siilo instant messaging software. One student stated, "This platform is excellent for learning and practicing during clinical rotations." Another student praised the design of the exercise, saying, "The exercise was well done and covered a range of important topics." A third student commented, "I believe the program was excellent and would have benefited from additional opportunities." These comments

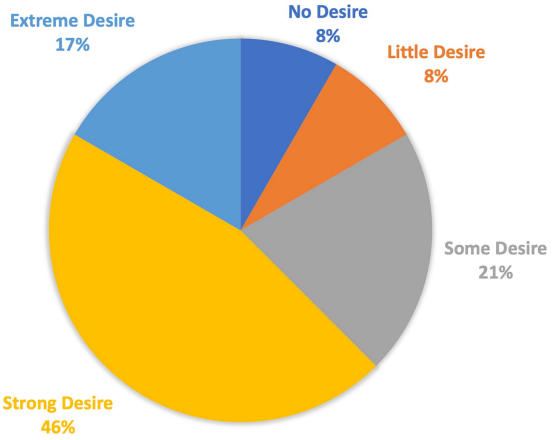

FIGURE 2
Students' satisfaction after the study. A survey was conducted among students to assess their satisfaction with their participation in the study. The graph shows the percentage of students who expressed a desire to participate in another session.

provide valuable insights into the effectiveness and value of the case-based learning approach and the Siilo software in promoting critical thinking and problem-solving skills among medical students.

Discussion

In this study, medical students reported a high level of satisfaction with case-based learning using the "Siilo" instant messaging mobile application. Students' participation, cooperation, and self-reported satisfaction on a feedback questionnaire demonstrated the effectiveness of the experimental educational program. The majority of students found the teaching sessions easy to use and believed they contributed to their exam success. There was a strong desire among students to participate in similar educational exercises in the future.

Multiple studies have explored the use of communication applications in medical education. Zulfikar et al. (4) found that the use of instant messaging mobile applications increased motivation and knowledge among students. Dar et al. (6), Meerasai and Mohesh (7) and Hossain et al. (9) all demonstrated increased student satisfaction with learning using instant messaging applications and improved relationships between medical students and doctors. Mohanakrishnan et al. (10) found messaging applications to be effective for transferring relevant information and preparing for frontal lectures, and Dyavarishetty and Patil (5) observed higher exam scores among students who participated in case-based learning through educational messaging groups compared to their non-participating peers.

This study represents the first evaluation of the use of the "Siilo" instant messaging application for virtual case-based teaching sessions for medical students. The "Siilo" app, specifically designed for use by medical professionals, was found to be a user-friendly, secure platform suitable for teaching clinical skills to students. It allows users to create and manage separate case discussions in parallel, and its use may help to educate future doctors on the importance of secure communication tools for protecting patient privacy. Additionally, the "Siilo" app has the potential to facilitate the organization and management of complex medical cases that require collaboration among multiple teams, through the use of a dedicated, orderly platform.

This study has several limitations that should be considered when interpreting the results. First, the sample size of the study is small, which could affect the generalizability of the findings. Second, internet access is required to use the "Siilo" application, which may be limited in certain areas. Additionally, the small screen size of smartphones may make it difficult to view images with fine details or figures with many items. Finally, not all students may have smartphones that are suitable for using the "Siilo" app, although a desktop version of the app is available.

To further assess the effectiveness of "Siilo" as an educational tool, future research should consider evaluating the application's satisfaction levels among a larger sample of students. Additionally, it would be valuable to compare the success rates of students who utilized "Siilo" in their education with those who did not. It would also be useful to examine the efficiency and ease of use of the application among medical teams managing real-time cases.

Conclusion

The "Siilo" instant messaging application appears to be a promising tool for facilitating case-based learning in a medical setting. The application, designed specifically for use by medical professionals, was found to be user-friendly and secure, with a high level of satisfaction reported by participants. These findings suggest that the use of "Siilo" in medical education may be an effective way to enhance clinical instruction for students. Future research should explore the use of "Siilo" in larger student samples and compare its effectiveness to other methods of medical education. In addition, further studies should evaluate the efficiency and ease of use of "Siilo" among medical teams providing real-time medical case management.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Hadassah IRB. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

TS, OT, UD, SP, MS, YE, and DK reviewed the literature and wrote the paper. DK performed the statistical analyses for this study. TS and DK designed the data collection. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Students' and lecturers' perspectives on the implementation of online learning in medical education due to COVID-19 in Germany: a cross-sectional pilot study

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Background: During the coronavirus disease 2019 (COVID-19) crisis, many things changed in universities around the world. In-person learning was not possible. Instead, courses were offered in digital form. The sudden change posed enormous challenges to universities, students, and teachers. The aim of this study was to investigate the disadvantages as well as the advantages and opportunities of digital learning.

Objective: This study investigated the evaluation of an elective module by medical students and teachers in the traditional in-person and virtual teaching forms during the COVID-19 pandemic.

Methods: Using the elective module "Sports Medicine," which includes both lectures and practical units, the opinions of the medical students about conventional teaching compared to digital instruction were evaluated. In the winter semester of 2019/2020, all classes were taught face-to-face but had to be switched to virtual teaching in the summer semester of 2020 on an *ad hoc* basis due to the pandemic. The students were asked to answer questions on general conditions, participant behavior, instructor evaluation, skill acquisition, topic selection, and overall evaluation after both forms of teaching. Likewise, the lecturers of both courses were queried in semiqualitative interviews about the same topics. Descriptive data analysis was performed to process the data.

Results: The students perceived digital teaching to be superior in most subareas compared to in-person teaching in terms of framework, instructor evaluation, skill acquisition, topic selection, and overall rating. Medical students seemed to feel better with digital teaching in most areas of evaluation. The lecturers found the new form of teaching rather unsettling and criticized the lack of verbal and especially nonverbal communication as well as the short preparation time for the new challenge. The instructors were uncomfortable with some aspects of the virtual teaching format.

Conclusion: In the wake of the COVID-19 pandemic, medical schools should rapidly digitize their teaching offerings and support faculty members in their computer-based competence with continuing education opportunities and time resources.

KEYWORDS

digital teaching, virtual teaching, sports medicine, e-learning, medical education, COVID

Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which caused COVID-19, is one of the most aggressive and deadly infectious diseases (1). COVID-19 was declared a pandemic by the WHO on 30 January 2020 (2). Therefore, most countries implemented physical distancing measures to decelerate the infection rate (3–5). The pandemic dramatically disrupted many areas of life. Teaching was digitized in most medical schools to prevent the rotation of students between departments and hospitals, which might cause them to become potential vectors in the transmission of the disease (6). Previous formats for imparting knowledge such as lectures, seminars, group lessons, and practical exercises have to be terminated and abruptly converted into online-based variants (7). This change required consideration from both sides, the teachers and the students. In a very short time, the whole world was dealing with the challenge of maintaining high-quality education through new digital platforms. There have been no historical records of such a vast sudden shift toward e-learning (8). It has long been acknowledged that online instructional methods are efficient tools for learning (9). However, aspects such as limited nonverbal communication, limited interaction between students and professors, accessibility of materials, and time management were also discussed as critical influencing factors of the students' opinions on online courses (10). The main difference between traditional and online-learning sessions is that the latter allows students to learn from their preferred locations (11, 12). Technological solutions allow lessons to be delivered to groups and real-time processing of individual student responses. Online meeting tools like virtual web-based platforms such as Zoom®, GoToMeeting, WebEx Meeting, Adobe Connect, and many more can be used for providing instructions. They also allow synchronous sessions and multiple users to participate at the same time (13). The instructor of the session must plan for the learning curve required for students to use virtual web-based platforms effectively and not assume that all students have the necessary practical knowledge to use them. In addition, students may engage in other activities during the lecture and not actively participate. However, there are concerns that practical medical content will be rather poorly delivered through digital forms of instruction (14, 15). The fruitful use of technology in medical education depends on the willingness and expertise of the faculty to use this technology to facilitate learning. Training physicians with these skills requires a break from traditional teaching methodology (16). Therefore, it seems that training in the mastery of computer technology is a neglected skill among faculties that should be mandatory for the improvement of medical universities. An organized and clear institutional approach is needed to formulate a well-regulated and efficient system that can facilitate the adoption of structured methods by faculty members during the implementation of an online-learning module (17).

The aim of this study was to evaluate the students' and lecturers' perspectives on digital and conventional teaching of a well-established elective module at a mid-sized multicultural German medical school.

Methods

Study setting

This mixed-methods study took place at the medical school of a German University hospital in the context of the quick change from traditional teaching to digital teaching due to the COVID-19 pandemic, which was realized in 2020. At the time of the study, approximately 2090 students were enrolled at the medical school. Sample calculation was not carried out but was defined based on the course participants. Digital teaching in medical studies has not been regularly practiced there before. During clinical semesters, undergraduate students in the third to the fifth year of training must choose elective modules from a variety of course programs covering different medical fields that are usually not covered by the mandatory curriculum. The modules are in direct competition with the students' interests and comprise 28 teaching hours (45 min each). Each student must attend at least 80 lectures in an elective subject. Only the most-selected modules by the students were taught. Due to the COVID-19 pandemic, lectures had to be converted into a digital format in a very short time for them to take place. Some lectures could not be completely digitized and many had to be canceled. In the elective module "Sports Medicine," 14 events of 90 min each were held by three lecturers in person. After conversion to an internet web-based platform, the lectures took place in a slimmed-down version with eight events of 45 min with the same three lecturers. The elective is a multifaceted teaching format consisting of practical applications, case studies, and demonstration of examination methods from the field of sports medicine.

Study design

A mixed-methods approach was chosen that consists of an abductive qualitative study based on semi-structured interviews and a cross-sectional study using course evaluation questionnaires

at the end of the course. An abductive analysis of the interview transcripts and the results of the open-ended questions of the faculty questionnaire was conducted to identify the predominant themes (18). The predefined themes included teaching formats and learning objectives. Qualitative data included interview transcripts and results of the open-ended questionnaires. For the qualitative interviews, we did not test whether saturation was achieved because only 3 interviewees participated in digital and face-to-face instructions. Items from the questionnaire with a five-point Likert scale as the response format were considered quantitative data. The use of the mixed method was deliberately chosen by the authors for this study so that the qualitative and quantitative research approaches can be combined to address the specific research interest, namely the influence of digital teaching during the COVID-19 pandemic in direct comparison to face-to-face teaching in medical higher education with complex, practice-oriented teaching in the clinical section. The mixed methods approach allows our research question to be viewed from different perspectives (students and lecturers).

Ethical approval and consent to participate

The ethical approval for this study was granted by the local ethics committee of the University of Jena (2019–1456–Bef). Participation in the study was voluntary. Informed consent for the study was obtained by voluntarily submitting the questionnaire. Written informed consent was obtained regarding the voluntary nature of participation and all data were collected anonymously. Minor participants were not represented in the cohort. The ethics committee explicitly waived the requirement for written informed consent from participants.

Inclusion and exclusion criteria

The inclusion criteria for the students were as follows: must be over the age of 18 years, must be a student of Human Medicine at the University of Jena in the clinical section, and must participate in the elective subject tutorial Sports Medicine. The inclusion criteria for the lecturers were as follows: must be over the age of 18 years and must be a lecturer of Human Medicine at the University of Jena for the elective subject tutorial Sports Medicine.

Data collection

Between December 2020 and February 2021, semi-structured interviews with three lecturers of both face-to-face and digital lessons in the elective module "sports medicine" were conducted. We developed the interview guidelines according to the questions (Table 1) and tested and adjusted the questions during pilot interviews within the research team. The interviews were conducted in German *via* phone calls and were recorded and transcribed by the interviewer. The median interview length was 19 min (range 11–28 min). The questions were asked in German.

TABLE 1 Questions of the structured interview.

How did you feel about the framework of both face-to-face and digital instruction formats?
How did you find the contact with the students during the lecture?
How did you feel about the implementation of your own competencies as a lecturer in the lecture formats?
How did you feel about the knowledge transfer and prior knowledge of the students?
How did you feel about the two lecture formats as a lecturer?

Students' evaluation

The standardized student evaluation takes place at the end of the elective subject tutorial sports medicine. The student evaluation questionnaire was given to the students on the last day of the module as a paper version for the in-person lessons ($n = 25$) in January of the winter semester 2019/2020, i.e., before the pandemic and digitally for the virtual lessons ($n = 26$) in July of the summer semester 2020, i.e., during the pandemic. No incentive or compensation was given to the survey participants. There was a difference in the number of students who attended the face-to-face and digital format lectures. This was due to logistical circumstances. Before the start of the respective elective, the maximum number of participants is determined by the medical faculty. For the in-person attendance phase, the maximum number of students was 25 and for the digital format, the maximum number of students was 26. The evaluation form included 29 questions using a Likert scale (1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree, and 5 = strongly agree) regarding the framework conditions of the lessons (5 questions), the participants and their behavior (3 questions), the lecturers and their structure of the lecture (6 questions), the qualification, which could be imparted by the lecture (7 questions), the interest of the students and their assessment of the rate of referrals and existing knowledge (4 questions), and the overall assessment of satisfaction with the lecture (4 questions). Furthermore, the students were asked about some epidemiological data, the time required for preparation, the expected amount of work, and the amount of work performed. A place for open comments about good and bad findings at the lectures was provided. The questions were asked in German.

Data analysis

We performed an abductive analysis of the interview transcripts and the results of the open-ended questions from the lecturers and students to identify the predominant themes. Descriptive data analysis of the questionnaire items was conducted using Microsoft Excel 2020 (version 16.35). The *P*-values were calculated using the Mann–Whitney U test with the Statistical Package for the Social Sciences, SPSS (version 17.0, SPSS Inc. Chicago, IL, USA). A *P*-value of <0.05 was considered significant.

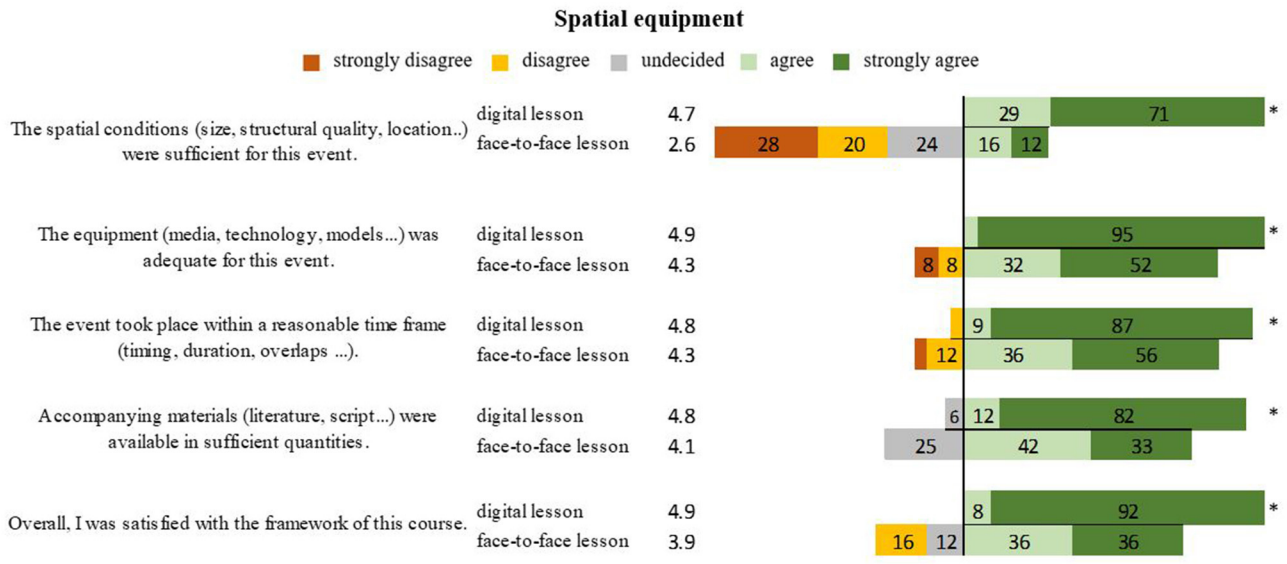

FIGURE 1
Representation of students' opinions on issues related to space in digital teaching and face-to-face teaching in percentages. *Marks significant differences.

Response-bias

To reduce bias errors, the research design was constructed in such a way that the respondents are not exposed to intentional or unintentional misrepresentations. Due to the maximum anonymity of the survey, the questionnaires were answered without personal contact with the lecturers as the questionnaires were distributed and collected again by independent members of the medical faculty (questionnaires on paper) or the questionnaires were digitally distributed directly to the students (online). The faculty interviews were conducted by an independent person who is also a member of the medical faculty. The study participants had enough time to fill in the questionnaires. The questionnaire for the students was previously tested on a small group of 10 students. The questions were then modified. The questions for the lecturers were created according to a standardized scheme (see Methods section). The possible number of lecturers is only three as only they were allowed to teach the elective subject. All three lecturers participated in the interview.

Results

We constructed this mixed-methods study based on interviews with three lecturers of sports medicine and a student evaluation questionnaire of digital and face-to-face lessons.

Quantitative results

Virtual teaching showed better ratings for all questions regarding spatial and equipment needs (spatial conditions $P < 0.001$, equipment $P = 0.001$, time frame $P = 0.016$, helpful accompanying materials $P = 0.001$). The overall rating of digital teaching was 4.9 and that of face-to-face instruction was 3.9 ($P < 0.001$) (Figure 1).

The students rated that participation in virtual classes was better ($P = 0.025$) than it was for in-person participation ($P = 0.939$), and there was no significant difference in their overall behavior in digital (4.8) and in-person classes 4.6 ($P = 0.180$) (Figure 2).

There was no significant difference noticed by the students in lecturers' competencies in terms of communication of goals and structure ($P = 0.052$), thus allowing questions and assistance ($P = 0.178$) and creation of a stimulating working atmosphere ($P = 0.104$) in both lesson forms. In terms of taking up suggestions and questions regarding content ($P = 0.017$) and placing individual aspects in the overall context ($P = 0.004$), lecturers were significantly able to better demonstrate their competencies to the students in the virtual form of lessons than in the conventional form with an overall impression of instructor performance being 5.0 and 4.7 ($P = 0.026$), respectively (Figure 3).

The qualification improvement with new knowledge ($P = 0.001$), research procedures ($P = 0.005$), practical knowledge ($P = 0.023$), the acquisition of key competencies ($P < 0.001$), and the competence of independent and autonomous working ($P = 0.006$) showed overall better ratings with 4.9 points for digital teaching and 4.4 ($P = 0.005$) for in-person teaching. The application of knowledge from both lesson forms was equally evaluated ($P = 0.346$) (Figure 4).

Further aspects such as awakening interest in the topic ($P = 0.588$) and linking to previous knowledge ($P = 0.842$) were equally evaluated in the lesson forms. The digital form was recommended to fellow students ($P = 0.011$), outweighing the conventional teaching, with the overall rating of 4.9 for the digital form being

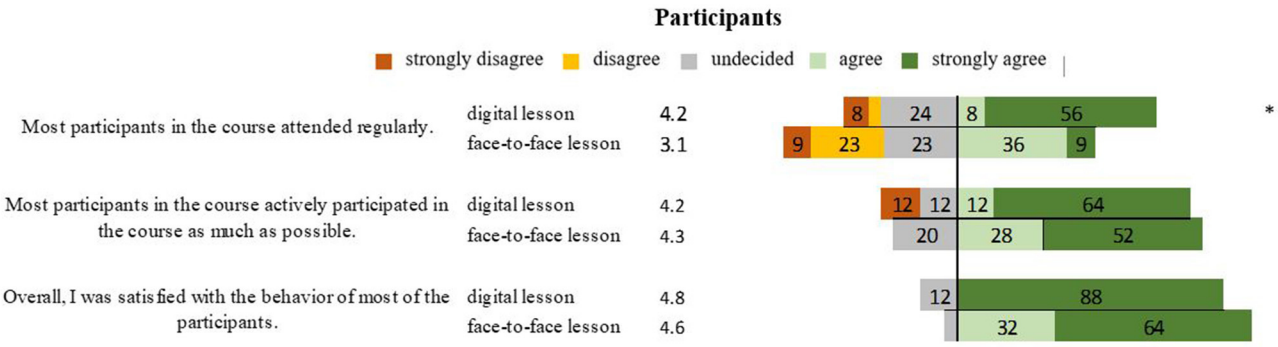

FIGURE 2
Representation of students' opinions of participation in digital and face-to-face teaching in percentages. *Marks significant differences.

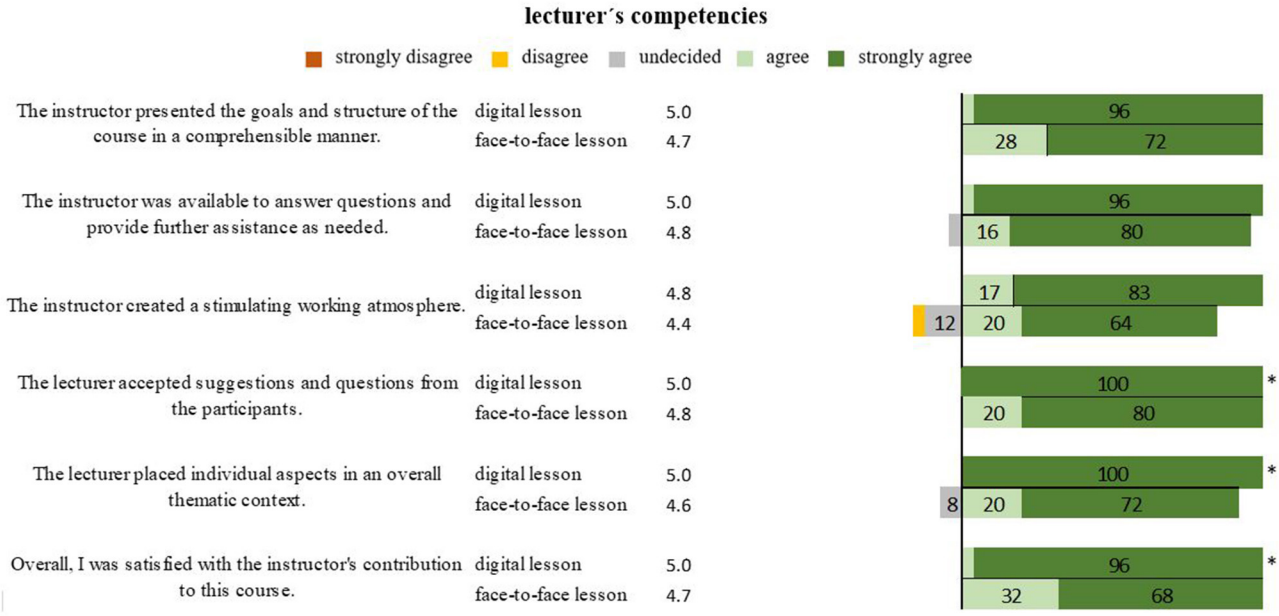

FIGURE 3
Representation of students' opinions of lecturers in digital and face-to-face teaching in percentages. *Marks significant differences.

significantly better than 4.4 ($P = 0.013$) for conventional teaching (Figure 5).

The overall satisfaction with the course (4.9 vs. 4.4; $P = 0.013$) and the gain in skills (4.9 vs. 4.4; $P = 0.005$), and the satisfaction with the instructors (5.0 vs. 4.7; $P = 0.026$) were predominant for digital teaching. The overall satisfaction with the participants was equally evaluated for both forms (4.7 vs. 4.6; $P = 0.596$).

Qualitative results

Table 2 visualizes the qualitative results, specifically the five themes with the most-relevant specified subthemes.

Framework conditions

According to the instructors, a controversial picture emerged. The lecturers welcomed the advantages of time management without tiresome travel, the search for parking spaces, and the correct premises. At the same time, they favored their own rooms with a pleasant indoor climate. However, the deficits in the technical conditions of the conventional lecture with compatible equipment (laptop) to the university equipment (connections) also became apparent.

Contact with the students

Contact with the students was experienced as distant and impersonal in the digital lectures compared to conventional in-person events. Lively discussions on the topics did not arise. The lecturers experienced the students as performance-oriented and focused on the lecture. The usually accompanying networking after the lecture, for example as a search for doctoral theses or mentoring partners, was not possible in the digital form of teaching.

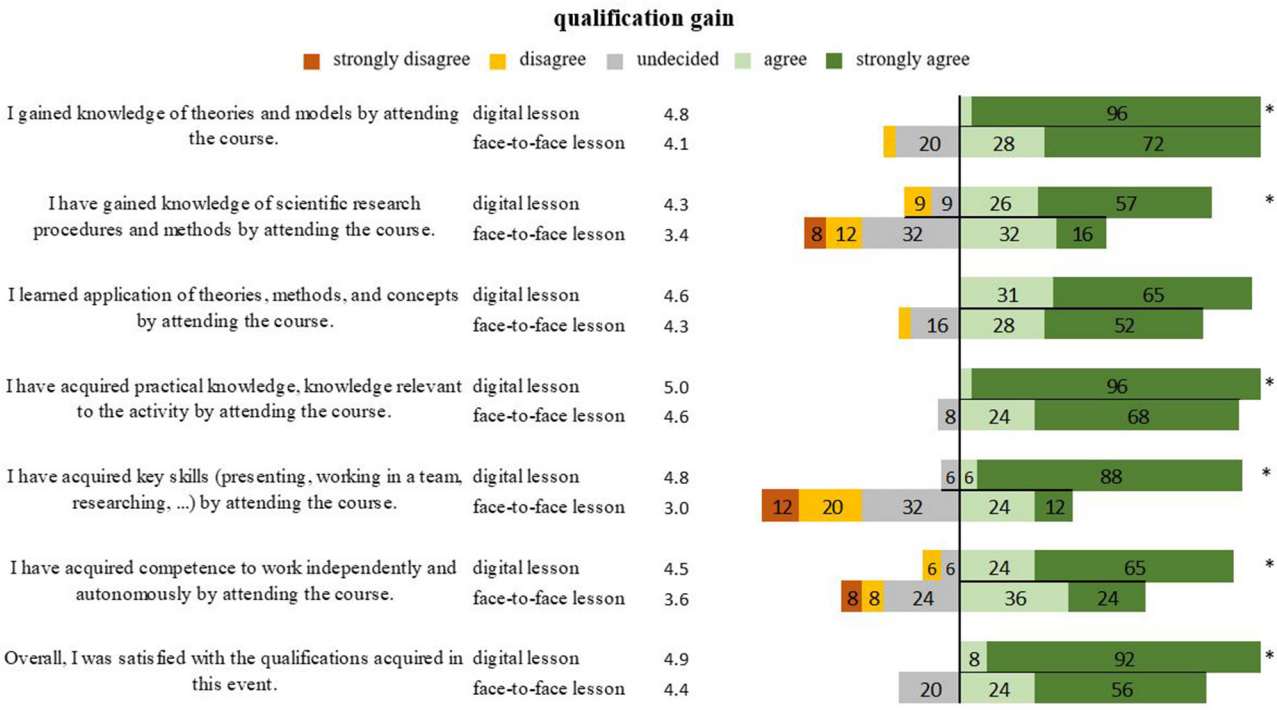

FIGURE 4
Representation of students' opinions on the skills and knowledge acquired in digital and face-to-face teaching in percentages. *Marks significant differences.

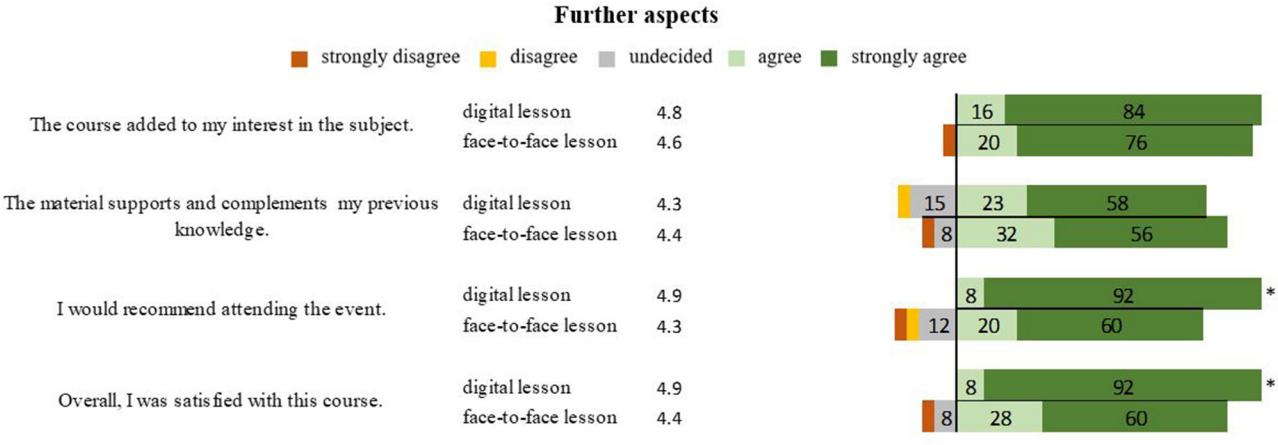

FIGURE 5
Presentation of students' opinions on the aspects of interesting and recommendable design in digital and face-to-face teaching in percentages. *Marks significant differences.

Lecturer's own competencies

When asked to self-reflect on the teaching given, the lecturers found it more difficult to convey the teaching, especially the lecture on sports medicine with high practical components as illustrative materials or demonstration of the examination techniques were not possible. The technical innovations required the lecturers to improve their computer situation both with hardware, software, and skills. The acquisition of new skills usually had to be done on one's own initiative and proved to be very time-consuming. All lecturers found it more difficult to assess their teaching success due to the lack of verbal and nonverbal feedback from the students.

Knowledge transfer

The lecturers found the digital lecture form to be more time-consuming for preparation to illustrate the practical parts of the lecture. In particular, the examination techniques could not be demonstrated or improved by practicing. The missing illustrative

TABLE 2 Representation of the lecturers' opinions and qualitative results.

Framework	No time pressure Suitable equipment/less compatibility problems No cramped quarters Pleasant environment
Contact to students	Impersonal Inactive lecture format No network beyond lecture More distant formal atmosphere Performance oriented More concentrated
Own competencies	High practical part less teachable without practical applications Action–reaction missing Feedback missing New competencies through handling of technology New acquisition of techniques Time-consuming initiative
Knowledge transfer	Longer preparation time Lack of accessibility due to lack of feedback Little practical relevance of examination techniques/materials for visualization
Lecture format as lecturer	No direct contact with students and other lecturers Unpleasant due to unfamiliar structure Impersonal Higher pressure/pressure to perform to convey content Lower self-confidence

Within the 5 themes and specified subthemes.

materials, such as bandaging options could not be demonstrated for better understanding. Overall, it remains more difficult for all the lecturers to assess what the students learned.

Lecturers' opinion on format

The main criticism of virtual lectures in the Sports Medicine course was the unfamiliar impersonal atmosphere. The lecturers found it not only more difficult to assess their teaching success but also more pressure to redesign the lecture for knowledge transfer. They felt diminished self-confidence to teach without student feedback.

Discussion

COVID-19 is an ongoing pandemic and continues to impact everyday life (19). Due to the ongoing pandemic status, the digital *ad hoc* teaching formats established at the beginning of the COVID-19 pandemic have been established in everyday teaching in the last three pandemic years. Both the students and the lecturers have become accustomed to the new circumstances of knowledge transfer and digital teaching formats at medical universities as they are regularly established as a result (20). This can have advantages as well as disadvantages for both the students and the lecturers. With digital teaching formats, sick students can follow the teaching material from home and sick lecturers can teach from home without quarantine or other people (groups) being infected or endangered (20).

In addition to these advantages, there was also a permanent change compared to digital teaching concepts from the point of view of the students and lecturers. At the beginning of the pandemic, the establishment of digital teaching formats was often viewed negatively from the point of view of the lecturers since the implementation was a major challenge for the lecturers and the medical universities (21). At the beginning of the establishment of digital teaching concepts, the students had a positive attitude, although this attitude changed over the course of the pandemic years (22). The once divergent picture between lecturers and students is getting closer over the course of time. Lecturers were able to acquire digital skills and taught more digitally as students wanted to create more teaching formats in attendance. Therefore, the different reasons are known (23). As one of the main reasons, the explicit students of study by Olmes et al. named the poor quality of the teaching formats in digital form, the lack of human exchange with other students, or even the lecturers (24). In addition, it was complicated and difficult to convey practical teaching content to students through digital teaching formats. There were various reasons and the demand for newly created digital teaching concepts for this topic was great (25). To be able to establish new teaching concepts in the long term, it is important to know the attitude students and lecturers have toward digital teaching formats with complex and practical teaching contents (25). At this point, the present study analyzes the view of the students and lecturers on digital teaching formats and classroom teaching and examined which teaching concept can be applied to complex, practice-oriented teaching contents for the subject of sports medicine in both study groups.

A key advantage of digitization is the ability to automate processes. Many processes in teaching can be automated by digital solutions. These solutions speed up the processes and reduce the barriers from both the students' and lecturers' points of view, as well as reduce the costs of room rentals, travel routes, and energy costs. The biggest challenge is the transformation of classroom learning formats into digital learning formats. From the lecturers' point of view, there are no standardized courses of action for medical teaching at universities. Thus, the implementation of digitization depends or falls on the will and ability of the lecturers (26). As aforementioned in other studies and consistent with the results of the present study, digital formats are used in the longer term if they are user-friendly. This study served as a basis for this. The aim was to survey and verbalize the demands and attitudes of students and lecturers at a medical university during the *ad hoc* digitization process due to the COVID-19 pandemic. In this way, the present findings can contribute to improving the digitization processes for medical students and lecturers during the current semester. In addition to the positive effects of time management, the lecturers also expressed the reduction in long commuting distances within the clinical routine. This may have a positive effect on practicability; as even in the case of illness, teaching can be carried out by a substitute person or from home. This, in turn, has advantages for the students, as there is less teaching or they feel that they are a burden in the clinical routine of the lecturers. In addition, practical and complex teaching content can be taught using digital processes and manifested from the student's perspective. In the present study, for example, the students rated virtual teaching better for the preparation of active participation in attendance-based courses. The lecturers felt that the digital lecture format was more time-consuming in preparing and illustrating the practical parts of the lecture. In particular, the testing techniques

could not be demonstrated or improved by practicing. The missing illustrative materials, such as bandages, could not be shown to better understand these possibilities. Overall, it is still more difficult for all lecturers to assess what the students have learned. Certainly, today's generation of students have grown up in the digital world, while the teachers have had to learn it (27). Sandars et al. (27) showed that students felt that their instructors were willing to improve their digital literacy skills and that some online teaching formats would persist after the COVID-19 pandemic (24). These were confirmed by Theoret and Ming, who found that online teaching and continued online communication could become pillars of medical education (28). Indeed, online teaching has been shown to promote self-learning, be as successful as traditional didactics, and provide an enjoyable experience for participants (29, 30). Overall, although most German medical educators were directly involved in patient care, and therefore, currently under significant stress, the COVID-19 pandemic has offered numerous opportunities for the use of digital media (31). Due to the uncertainty of the lecturers in dealing with digital media and the lack of time resources, the faculties must intervene in a supportive manner. There may be long-term changes due to the pandemic toward teaching using virtual media. Hopefully, the current wave of digitization will continue and the positive effects will persist.

Limitations

The study is based on a survey study. Response bias can skew both student and faculty results. In addition, the maximum number of lecturers surveyed is limited to three. Therefore, the results are only of limited significance and do not reflect the views of lecturers from all the medical universities in Germany. This also applies only to the perspective of the surveyed students. These cannot be transferred uniformly to all students. In addition, the survey of the participants took place only at the University of Jena.

Conclusion

The digital establishment of new tools and formats in teaching is not enough—they must also use sensible and planned basis so that they can also be used sustainably in the field of medical education. The basic prerequisite for the application is to know the attitude and the user needs of the students and lecturers. Regarding this purpose, this study was able to provide fundamental insights. In summary, it can be deduced that digital teaching is actively implemented by the lecturers and students due to the coronavirus pandemic. From a student perspective, digital formats could be used for the preparation and delivery of complex and practice-oriented teaching content. But from the lecturers' point of view, this requires more resources and requires the lecturers to have digital skills. In general, it can be observed that digital formats are in no way inferior to in-person teaching formats, as was assumed for a long time, but positively affects the quality of teaching.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

IG and SH conceived and planned the experiments. MK performed the analysis. FL, DB, and ES provided critical feedback and helped shape the research, analysis, and manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

MK was employed by the company Jenoptik AG.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationship that could be construed as a potential Conflict of interest.

Publisher's note

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Cloud classrooms enhancing continuing medical education during COVID-19 in China

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KEYWORDS

cloud classrooms, COVID-19, continuing medical education (CME), online, medicine

1. Introduction

During the COVID-19 pandemic, many measures were taken, including social distancing and isolation in China. Offline academic meetings were largely suspended to prevent spread of COVID-19. Instead, online courses, known as "cloud classrooms," have been held worldwide (1–4). This resulted in online meetings or courses becoming the main source for physicians to obtain information and improve their knowledge as well as to exchange academic viewpoints, which are an important component of the cloud classroom, especially in China. With advances in Chinese software such as Tencent Meeting, BizConf Video and MCMeet, and other software including Zoom, 100doc, etc., the content of meetings and online courses could be stored online and educational content can be accessed at any time, which comprise the characteristics of a cloud classroom.

The medical profession requires lifelong learning. With advances in technology, continuing medical education (CME) has continuously undergone innovative development. The foundation of innovation is active learning and advances of the Internet have resulted in teaching activities undergoing diversified development in medical education (5). Massive Open Online Courses (MOOC) have been popular in several countries for years to provide education for students who are training to become health care professionals (6–8). For example, the course Clinical Terminology for International and US Students provided by the University of Pittsburgh targets freshmen-level students in the medical field (9). The course Going Out on a Limb: Anatomy of the Upper Limb of the University of Pennsylvania supplements conventional medical education and can even replace traditional lectures such that time spent with the professor can be used for more meaningful discussions. Especially in recent years, there has been a largely increased implementation of MOOCs, which have reached over 220 million learners (40 million new learners in 2021 alone), with over 19,400 courses available, compared with only 35 million learners in 2015 (10).

The COVID-19 pandemic has become a major cause of rapid globalization and digitization for CME projects in China. We have become increasingly more skilled at utilizing the Internet to conduct online academic communication as it is not constrained by region, environment, venue, and traffic. For example, the Brightness Center jointly organized by the Bethune Charitable Foundation and National Clinical Research Center for Eye Diseases of China held 824 online academic meetings in 2022, involving more than 15,000 physicians, which included 12 nationwide meetings. This has provided greater opportunities for more physicians to participate in academic exchange. Details regarding advantages and disadvantages of cloud classrooms in CME warrant further examination.

In this perspective paper, we demonstrated the effects of cloud classrooms on CME during the COVID-19 pandemic from the perspective of physicians in China.

2. Discussion

2.1. Teaching content strengths of cloud classrooms

Cloud classrooms provide a large amount of learning content, different perspectives on diseases, summarized disease characteristics and diagnosis key points, particularly differential diagnosis, and cover research progress nationally and internationally. The cloud classroom has important advantages in terms of scale, openness, and convenience and has become an important educational resource. The cloud classroom also has important effects and a large impact on traditional teaching and provides a brand-new educational option for CME (11–13). Physicians can select content based on their interests, clinical need, or weak areas that require strengthening. It provides greater learning and exchange opportunities for professors to attend more meetings/courses without running around different cities.

Cloud classrooms in China include different types of content, including seminars, special lectures, case discussion, explanation of surgical techniques, surgery video recordings, multidisciplinary consultation meetings, standardized resident physician training, etc. The characteristics of different types of cloud classrooms are as follows.

a. Seminars. These revolve around a theme to be discussed among experts in different hospitals. Consensus can be reached for problems and thoughts can be shared regarding controversial topics. In debates among experts, physicians with different levels of training can be exposed to new ideas regarding clinical diagnosis and treatment and humanistic knowledge in dialectics.
b. Special lectures. An attending physician or professor selects a topic to teach in which they are an expert, and theory and clinical practice experience are included in the course content. These lectures can update understanding on disease diagnosis and treatment, improve diagnosis and treatment levels.
c. Case discussion. The case discussions provide many opportunities for physicians to participate in discussion and make it convenient for departments in different regions to help each other. Case discussions allow one-on-one assistance by clarifying thought processes, highlighting key points in differential diagnosis, and providing solid theoretic knowledge. Diagnosis and treatment levels can be improved by summarizing experiences of treatment outcomes. Especially in China, there are some differences in medical level between developed and underdeveloped cities. By explaining typical or difficult cases, physicians in areas with lower medical level can make faster improvement.
d. Explanation of surgical techniques. Experienced surgical experts show surgery videos for a topic and explain the surgical techniques involved. These can be used as educational materials for young surgeons to learn and improve surgical techniques and are indispensable and valuable resources for surgeon training.
e. Surgery video recordings demonstration. This is a platform for physicians to demonstrate their learning outcomes and where experienced experts can provide critiques to help physicians efficiently improve their surgery competency.
f. Multidisciplinary consultation. Online meetings enable multidisciplinary consultation to be simpler. Different departments do not only discuss the patients' conditions but also an overarching theme, from the perspective of different specialties. This allows physicians to learn about research progress in other specialties. This results in more comprehensive understanding of disease and facilitates coordination between departments.
g. Standardized resident physician training. This is a course designed for inexperienced residents that focuses on foundational knowledge and basic procedures. These are considered to be entry-level courses for residents.

2.2. Cloud classrooms stimulate motivation to learn among physicians and promote active over passive learning

Conventional education emphasizes the dominant role of teachers, and students are willing to accept the information provided by teachers. In addition, students often avoid to ask their teacher questions or being asked questions by the teacher/senior physician. Cloud classroom fully encourages enthusiasm and participation among physicians and cultivates independent learning capacity (14, 15). During meetings/courses, physicians can discover their own problems and weaknesses and can identify courses/meetings that are suitable for them in a targeted manner. During courses, physicians can also develop clinical thinking through talks given by lecturers and flexibly using various types of foundational knowledge rather than being constrained by these (16). And also, they are able to use fragments of time to learn and can repeatedly review areas in which they have problems or difficulties (17). This is a change from waiting for knowledge and clinical experience to be imparted by teachers to active learning and personalized learning.

2.3. Cloud classrooms make up for differences owing to unbalanced regional development

Regional development can be uneven and levels of health care may differ greatly between regions in China. Regions that are poor and remote have fewer channels for obtaining external information and physicians in these areas have low foreign language proficiency and capacity to read the published literature. Because these regions are remote, transportation is inconvenient and not all physicians are able to attend meetings to acquire the latest medical information owing to constraints of time and venue. Cloud classrooms avoid these problems as courses can be attended online and physicians have opportunities to participate

in discussion or receive critiques from well-known professors and achieve one-to-one remote guidance (18). This is important for improving the diagnosis and treatment levels of these physicians. In cloud classrooms held during the COVID-19 pandemic, large-scale hospitals in developed areas have set up assistance teams and provided clinical guidance via the Internet, which has help to improve regional health care levels and decrease differences in health care levels among regions in China.

2.4. Shortcomings of cloud classrooms

In comparison with offline face-to-face meetings, there are differences in targeting, affinity and reliability of online learning (19). Face-to-face interactions between people are not limited to lectures and presentations but also involve gestures, postures, and facial expressions. Direct contact tends to improve mutual trust, thereby helping to develop important exchange relationships and allowing strangers to become familiar with each other. Meeting dialogs help deepen friendships and understanding of each other and improves closeness in relationships (20). These are all important interpersonal interactions. Strengthening the ability to communicate with different groups or individuals is also the foundation for becoming an outstanding physician. In face-to-face meetings, the lecturer can adjust the content based on the level of the audience and onsite feedback and can provide more targeted courses. Lecturers can also engage in detailed communication in exchanges outside the course and facilitate questions.

A cloud classroom is rich in content but the viewpoints of lecturers may not be similar. Different viewpoints allow physicians to think for themselves. However, there is a possibility of misjudgment when young physicians hear different viewpoints from different physicians and they may choose to follow a viewpoint that is suitable for their own patients in clinical practice (21). However, "trial and error" is not permitted in clinical practice as injury to patients must be minimized. Hence, tertiary diagnosis and treatment is extremely important in clinical practice. Senior physicians should seek to understand the thinking of junior physicians and promptly correct errors and guide junior physicians to correctly understand the viewpoints of other physicians in a course. Junior physicians should seek advice from senior physicians to avoid errors and make preparations for attempts under the guidance of senior physicians. Therefore, guidance from senior physicians is also required during cloud classroom learning (22).

Cloud classrooms involve an active learning process for physicians but lack of supervision and monitoring. It has been reported that the dropout levels were higher in MOOCs than in offline courses (23). Also, the physician's thirst for knowledge and level of proactivity also affects learning outcomes. Although attendance at meetings may be recorded to ensure that students are online so as to supervise and monitor learning and to ask questions to assess students' learning outcomes, differences between classroom teaching remain. The reliability of and affinity for cloud classrooms are far lower than those of face-to-face exchange.

Cloud classrooms have deficiencies in humanistic education and communication cultivation capacity. Clinical work involves communication with different patients, listening to the hidden meanings behind patients' statements, identifying patients' actual complaints, determining the duration of symptoms from a patient's description, and prompt identification of important positive and negative signs during patient examination, all of which cannot be taught in a cloud classroom (24).

The reliability of the content of cloud classrooms might also be questionable. Cloud classrooms are increasing and their organizers range from societies and associations to well-known large-scale hospitals. The types of meeting range from provincial/municipal meetings and classes at national, municipal, and county levels. All these meetings must have undergone review and approval. Existing units can organize a meeting or class via the collaboration of one or more experts, but a rigorous review system is still lacking. Moreover, information overload and unreliable sources on the Internet can pose a challenge to information acquisition by physicians.

A cloud classroom is highly dependent on network communication. Meeting information can be easily obtained through communities and the Internet in major cities. However, it may still be difficult for physicians in remote cities and hospitals that have lower levels of health services to obtain relevant information, or the information obtained is not as rich as that obtained by physicians in major and mid-level cities. Hence, regional differences are still present. Furthermore, the ease of operation of software affects the selection of audience.

2.5. Future expectations

The outbreak of the COVID-19 pandemic caused rapid digitalization of the healthcare industry in teaching and training making it one of the great transformations in medical education. Incorporation of digital approaches such as cloud classrooms in medical training makes healthcare professionals better communicate with less limitations. It is necessary to improve the accessibility of cloud classrooms, which requires developing more intuitive and user-friendly software to achieve a better understanding of user interface. The integration of advanced technical means, such as 5G communication, virtual reality, metaverse and so on, into cloud classrooms is expected to provide a better use of experience, improve educational efficiency and effectiveness (25). On this basis, opening the learning resources and curriculum review function can help the physicians master the learning knowledge better. In the future as social interaction becoming more and more unrestricted, how to combine online and face-to-face approaches more reasonably and make different forms exert the maximum advantage is a problem that all medical educators should consider together.

3. Conclusion

Rapid growth in medical technology is immensely changing in medical education, during COVID-19 epidemic. Medical practitioners will be composed of a generation that actively uses digital technology to obtain information instantly. Cloud classrooms will play an important role in achieving a higher level of proficiency by providing more effective and standardized training,

providing educators with new roles and designing and promoting better learning experiences with the help of digital technology.

Author contributions

YH provided the idea and designed the manuscript. XC, TZ, XY, LL, JL, HH, and YH contributed to the conceptualization, writing original draft, and writing—review and editing. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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Innovative digital technology adapted in nursing education between Eastern and Western countries: a mini-review

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Advanced digital technologies have overcome the limitation of on-site teaching, especially after the COVID-19 epidemic. Various newly-developed digital technologies, such as e-learning, virtual reality, serious games, and podcasts, have gained renewed interest and come into the spotlight. Podcasts are becoming increasingly popular in nursing education as they provide a convenient and cost-effective way for students to access educational content. This mini-review article provides an overview of the development of podcasts in nursing education in Eastern and Western countries. It explores potential future trends in the use of this technology. The literature review demonstrates that nursing education in Western countries has already integrated podcasts into curriculum design, using the podcast to convey nursing education knowledge and skills and to improve students' learning outcomes. However, few articles address nursing education in Eastern countries. The benefits of integrating podcasts into nursing education appear far greater than the limitations. In the future, the application of podcasts can serve not only as a supplement to instructional methodologies but also as a tool for clinical practicing students in nursing education. In addition, with the aging population increasing in both Eastern and Western countries, podcasts have the potential to serve as an effective delivery modality for health education in the future, particularly for the older adult, whose eyesight declines with age, and those populations with visual impairments.

KEYWORDS

digital technology, e-learning, podcasts, nursing education, mobile learning

1. Introduction

In recent years, rapid technological change has driven innovation in teaching strategies. Educators have combined digital technology with teaching methods and administrative strategies in ways that suit course goals, settings, and subject matter. With the rise of the COVID-19 pandemic, many schools had to conduct distance education, over long periods and in repeated intermittent waves, in response to the unpredictable occurrence of new outbreaks. Several countries have adopted educational strategies that integrate newly-developed technology devices into courses, e.g., e-learning (1, 2), augmented reality (3, 4), virtual reality (5, 6), mixed

reality (7, 8), educational chatbot (9, 10) or podcasting (11–14). Newly-developed technology was used, springing up throughout the field of education. These devices have overcome many challenges throughout the education field, especially nursing education. Nursing education courses implement many skills by students' hands and training how to achieve critical thinking. Of these technologies, podcasts have emerged as a more easily accessible and engaging tool for supplementing educational content. Recently, they have become increasingly important learning tools (15, 16). This mini-review article aims to overview the application of podcast technology and its current state in nursing education, which may shed light on possible future trends.

1.1. The origins and development of podcast

Podcasts start back to the 1980s. At that time, digital technology was booming, leading radio to evolve into new, far-reaching forms. The term "podcast" is derived from "iPod" combined with "broadcast." The term *podcast* was first coined by the journalist Ben Hammersly from The Guardian in a newspaper article in 2004 (17). The definition of a podcast is an audio frequency launching via the internet, a platform homepage, or certain online portals, e. g., iTunes, or YouTube (17). With the advent of social media and the cloud, podcasting featured a decentralized open architecture in which audio content is stored on the website and allows users to link and download via RSS, aka. "Rich Site Summary" (or "Real Simple Syndication"). RSS was first developed by Dan Libby and Ramanathan V. Guha at Netscape in 1999, and by adding the open RSS into Apple's platform, the podcast was transformed into a digital medium for mass consumption with the first business models stemming from the United States since 2012 ("the second age of podcasting") (18). The podcast is soon becoming popular in Western countries because of its convenient properties, such as fast delivery, lower cost, and exceptional user-friendliness (15, 19). In addition to independent and amateur users, podcasts are also applied by educators for knowledge exchanges, e.g., the University of Oxford provided 254 free podcasts of entire courses and lessons on iTunes in 2013. Moreover, podcasts played an integral role in the continuing education development in emergency medicine and critical care (18, 20). In Eastern countries, such as Taiwan, podcasting did not gain a high profile until 2020 when two local companies–SoundOn and Firstory– provided a high-quality Chinese interface with convenient access technology via smartphones, Bluetooth, and an internet discount package to create a suitable podcast development ecosystem (21). In 2000, Taiwan only had 300 podcasts in the market, but it increased to more than 870 new podcasts in the first half of 2020. Furthermore, the frequency of downloads in Taiwan's podcasts in December 2020 was 446 times and even 579 times in January 2021 compared to Jan. 2020 (22). Currently, podcast programs have grown drastically and steadily month-to-month by about 67% in Taiwan since 2020. Taiwanese's favorite podcast programs are related to *entertainment*, *interests*, and *professional knowledge*, subsequently. *Society/culture*, *news/politics*, and *gossip* topics were the general interests.

In general, using podcasts can benefit educational pursuits. For example, podcasts reduced visual fatigue levels, enabled cyclical listening to heighten learning effectiveness, and improved the learning experience. According to the 2020 Edison Research survey, more than half of American audiences over 12 have the habit of listening to podcasts (23). Sixty percent of Taiwanese podcast listeners are of the average age of 23–32, among which nearly 95% have a college degree or above, and more than half of them have the habit of listening to podcasts (24). In Taiwan, the government promoted distance learning in higher education in the early 1990s (25). Taiwan is a global front-runner in digital technology development. Taiwanese nursing educators continually work with new technologies and innovations to apply various high-technology devices in nursing curriculum teaching strategies. However, podcasts were rarely used in healthcare-related education in Taiwan.

2. Method

Five major electronic databases, including PubMed database (MEDLINE), EBSCO Essentials (EBSCO), EMBASE (EMB), and Scopus, from 2008 to March 2023, were compiled in our review. All articles were from the Science Citation Index (SCI) and Social Science Citation Index (SSCI) databases. Upon conducting a thorough literature review, we extracted relevant keywords with a high frequency of occurrence to be used as search queries. These keywords include: 'Podcast,' 'podcasting,' 'webcasts as a topic,'; 'mobile learning,' 'digital storytelling,' 'e-learning,'; 'nursing students,' 'baccalaureate nursing students,'; 'nursing undergraduates,' 'midwifery,' 'nursing,' 'students'; 'nursing education,' 'education,' 'nursing,' all within the context of nursing education. Similar articles included in references were also screened. The inclusion criteria were reports or peer-reviewed studies of nursing education and training programs; peer-reviewed studies, accepted articles for publication, e.g., electronic publications (Epubs), and proceedings written in English. The exclusion criteria were conference abstracts, unpublished manuscripts, and whitepapers available online; articles not published in English.

3. Results

As we have already mentioned in Methodology, a total of 104 relevant articles was screened from the database: 32 from PubMed, 20 from EBSCO, 14 from EMB, and 38 from Scopus. After duplicates were removed, only 34 articles were assessed for eligibility.

3.1. Current literature reviews of podcasts applied in nursing education

Although podcasts were widely applied in medical education 20 years ago (20), the nursing education field only began to include podcasts in 2006 (26). According to the literature of synthesis evidence, 242 articles from a comprehensive literature database search related to the use of podcasts in nursing education were screened to identify 26 articles distinctly associated with the use of podcasts in nursing or midwife education. Podcasting was applied to a wide range of course topics (27), including basic medical courses, such as pharmacology (28), pathophysiology (29), microbiology or biology (16); professional knowledge in the nursing field such as evidence-based care research (30), donor egg recipients (31), training critical

thinking or reflective thinking (32), The integrative review article confirmed that nursing educational material in podcasts as an assistance learning instrument applied to train nurses and midwives seemed particularly effective for learning new knowledge and skills (27).

In contrast to its limited use in nursing education, the podcast has been effectively applied to English and Chinese language learning courses in Taiwanese education (33–35). In nursing education, there are a few known instances of Taiwanese nursing educators using podcasts for master's courses. In these cases, the master's students were preceptors who were trained to design clinical nursing practice related to issues from the podcast contents. This process was followed up with discussion, reflection, and educational strategies for improving the preceptors' instruction for beginner-level educational strategies. Hence, nursing educators are mulling over podcasts from social media, which can be regarded as a kind of nursing education material, especially for courses that must be committed to memory, require deep comprehension, skillful step-by-step clinical ability, and training in critical thinking (32, 36, 37).

3.2. The benefits and negative impact of the podcast application in nursing education

During COVID-19, podcasting brought convenience and entertainment to people worldwide while gaining popularity as a useful mobile digital device. In the past, the application and discussion of podcasting in nursing education were relatively unclear regarding its benefits and negative impacts. However, conducting a literature review regarding the use of podcasting in nursing education elicited its positive and negative effects, as outlined below.

3.3. The positive impact of the podcast on nursing education

3.3.1. To obtain specialized knowledge and effectiveness of learning

Previous studies showed that courses using podcasts were designed to maximize their advantages, including the opportunity to listen repeatedly to the contents of the subject matter for better understanding (38). Most nursing students agreed that specialized basic medical knowledge could strengthen memory via listening to podcasting. Hence, raising learned effectiveness through podcasts in the nursing education field is a highly recommended teaching strategy.

3.3.2. To raise comprehension and improve proficient clinical skills

Listening to podcasting helped students review clinical skills and knowledge during examination preparation, such as newborn infant physical examination (37). Results showed that most students preferred professional courses that blended podcasting, which could be accurately and consistently used to deliver information for each student (37). In addition, helping students pay attention to omitted issues in the lecture and revise error items of the examination through podcasting (37, 39). Other studies found that students reported better understanding by repeatedly listening to course content through podcasts (19, 29, 38), and about 83% of students use podcasts to help revise course content and enhance learning (16, 39). Therefore, podcasts were integrated into the curriculum, and through continued listening and repeated practice, students' comprehension could be greatly improved, and further students' motivation to learn was initiated (19).

3.3.3. To improve self-confidence and communication skills

Nursing education integrated podcasts into lectures, which not only enhanced the self-confidence of nursing students but also improved the students' communication skills (40, 41). When students had a strong self-efficacy for learning, their learning motivation was greatly improved (42). Another study showed that digital storytelling strategy design was applied to nursing students' clinical practice via a podcasting device; students acquired other perspectives of care experience and recipients' requirements, which furthered their learning of how to apply the concept of care for patients in the same situation (40, 43). More than 80% of students were willing to accept its course learning different experiences to deal with clinical issues (40). Other study results showed that nursing students positively apprised the use of podcasts to promote their knowledge and confidence about delirium awareness, and 96.32% of nursing students deemed that the podcast met their learning needs about delirium (44). Two studies also used podcasting to deliver palliative care and health information concepts (43, 45). Demonstrate that nursing philosophy knowledge can be released to students through broadcasts not limited to lectures. However, in nursing core competencies such as caring concepts, teamwork communication skills, and critical thinking are essential professional core competencies for nursing students, where podcasting as an emerging educational tool can assist students in this essential core competency learning (46).

3.3.4. To provide a useful tool for lectures revision and strengthen supplementary perception

Other studies found that podcasts benefit students as a tool for review in the education field (16, 28, 46, 47) and provide instructor diversity in learning strategies and supplementary material (48). Furthermore, other studies found that podcasting was practical and convenient when students needed to shift places or take transportation (29, 31, 36), and most students deemed podcasting a useful learning tool (16, 28). Through the literature reviews, the advantages of podcasting have been summarized in Table 1.

3.4. The negative impact of the podcast on nursing education

The disadvantage of podcasting is that students must arrange their study timetables. This leaves the efficiency of their education at the discretion of their motivational or organizational limitations., Similar results were reported that undergraduate and graduate assignments overloaded nursing students to the point that podcast usage decreased (27). In addition, some educators reported that blending podcast use with their course design decreased students' attendance rate (49), although others reported that students' class attendance did not decline while using podcasts (48, 50, 51). However, it seems clear that the advantages of the podcast outweigh its disadvantages.

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TABLE 1 Thematic extraction from podcast applications in nursing education.

Study	Purpose	Methods	Results
Theme 1: To obtain specialized knowledge and effectiveness of learning			
Abate (36)/United States	Evaluation of the effectiveness of pharmacology courses by podcasts promoted knowledge retention and application in nursing students.	Design: This pilot study with a randomized controlled study Participants: A convenience sample of 35 female undergraduate nursing students were randomly assigned to one of three groups: traditional lecture ($n = 12$), unsegmented podcast lecture ($n = 11$), or segmented podcast lecture ($n = 12$). Intervention: The face-to-face lecture was about 90 min. The nonstop podcast lecture was just over 57 min. The segmented podcast lecture, just over 51 min long, consisted of three sections. Podcasting by computer or MP3.	Students of the segmented podcast lecture group showed higher scores on multiple-choice and case-study assessments than those in the other two groups.
Mostyn et al. (16)/United States	This study was to explore nursing students' perceptions of the usefulness of supplementary biology podcasts.	Design: A mixed methods study Participants: The first-year diploma/BSc nursing programmed students ($n = 153$) received Biological science podcasts supplementary learning tools and conducted two focus groups interview ($n = 6$) Intervention: Nine live biological science lectures were recorded by staff on each of the university teaching sites and podcasts were made available to students across both sites via WebCT.	Students reported podcasts aided revision and helped promote understanding of course content 83 and 72%, respectively from the focus group participants who discussed finding podcasts especially useful in terms of revision.
Strickland et al. (30)/United Kingdom	Evaluation of the effectiveness of evidence-based nursing linked between the theoretical content and research in practice through podcasts.	Design: Not explicitly stated. Participants: A convenience sample of two cohorts of students (cohort 1, $n = 228$; cohort 2, $n = 233$) from the Research and Evidence-Based Practice module were asked to evaluate the use of podcasts as part of the module evaluation process. Intervention: A series of five podcasts linked to the podcasting host service at appropriate times within the module content in WebCT. The students could subscribe to the podcast feed and have these podcasts delivered automatically to their mobile devices	Total 77% of participants that they were easy to understand course content through podcast learning and increased student/tutor relationships leading to greater engagement.
Abedian et al. (31)/Iran	Evaluation of the effect applied the podcast on midwifery students to obtain knowledge and education on donor eggs.	Design: The quasi-experimental study design. Participants: Sixty undergraduate midwifery students were s simply randomly allocated to a podcast intervention group and workshop group ($n = 30$ for each group). Intervention: podcast group received three separate 25-min audio files and discussed them in a Telegram-based group.	The mean scores of knowledge pre- and post-intervention podcast groups were greater than the workshop group.
Theme 2: To raise comprehension and improve proficient clinical skills			
Clay (37)/United Kingdom	Evaluation of the effectiveness that mobile devices applied whether learners' learning motivation was increased and enhanced skills in clinical practice	Design: Not explicitly stated. Participants: A convenience sampling recruited eight postgraduate midwives who attended the newborn infant physical examination modules. Intervention: A handheld mobile device (iPod) with several Reusable Learning Objects (RLO) content which was related to newborn infant physical examination to be used in the clinical setting.	The results reported mobile learning afforded flexibility in the time and place of learning and captured their interest in the learning material.

(Continued)

TABLE 1 (Continued)

Study	Purpose	Methods	Results
Kardong-Edgren and Emerson (19)/United States	Evaluation of the effectiveness of podcast lectures was used and viewed by students	Design: A descriptive study design Participants: Undergraduate nursing students ($n = 210$) Intervention: Students can listen to the lecture from their computers or download it to an iPod or MP3 player on three courses (pathophysiology, pharmacology, and acute and chronic illness in adults and childbearing)	The results showed podcasts of advantages that 82% of students deemed podcasts helped them to understand the subject matter better, 87% aided clarification concepts, and 85% helped to review for homework and examinations.
McKinney and Page (29)/ United Kingdom	An evaluated nursing students' views on the variety of multimedia resources approach to facilitate the learning of pathophysiology.	Design: Not explicitly stated. Participants: Using convenience sampling recruited students ($n = 125$) from the final year of the undergraduate nursing sciences program. Intervention: Making a vodcast or podcast was delivered to iPods, MP3 players, and personal computers in the Applied Biomedical Sciences module course.	A total 89% of students deemed podcasts or vodcasts to improve their understanding of the pathophysiology. Additionally, using the podcast was convenient and flexible when students moved to other places.
Theme 3: To strengthen self-confidence and improve communication skills			
McSwiggan and Campbell (42)/United Kingdom	To explore students' experiences of using podcasts for assessment guidance and feedback.	Design: Exploratory qualitative study Participants: Purposive sampling recruited 18 third-year undergraduate nursing students. Intervention: Applying the self-efficacy theory illuminates students' use of guidance and feedback podcasts.	The structured, logical approach of assessment guidance podcasts appeared to strengthen self-efficacy by providing readily accessible support and by helping students convert intentions into action.
Rogan and San Miguel (41)/ Australia	To evaluate an innovation to assist nursing students with English as a second language (ESL) to develop their clinical communication skills and practice readiness by providing online learning resources, using podcast and vodcast technology.	Design: Action research approach Participants: The first-year undergraduate nursing students ($n = 376$), ESL students comprised almost half of each cohort of study participants, primarily from China, Korea, Nepal, and Vietnam, most of whom did not complete high school in English Intervention: The clinical words with 200 audio records with associated images from online were converted to the podcast. Six vodcast scenarios of nurses communicating with patients and staff.	The results showed that the podcast teaching strategy improved their clinical preparation and confidence by increasing their understanding of expectations, clinical language, and communication skills to reach the standards required of nursing graduates and registration authorities.
Theme 4: To provide a useful tool for lecture revision and strengthen supplementary perception			
Meade et al. (28)/United Kingdom	To evaluate both the subjective (student perception) and objective (student use and exam results) usefulness of podcasts of pharmacology lectures.	Design: A cohort study Participants: Graduate nurse non-medical prescribing ($n = 69$) Intervention: Seven key pharmacology lectures were recorded to be divided up into bite-size chunks of lecture material, each containing one or two key concepts, and made available as podcasts to two cohorts of non-medical prescribing students.	The results showed that 93% of students used podcasts to revisit a lecture, 85% used podcasts for revision, and 61% used podcasts when they had a specific question. The majority of students deemed podcasts helpful as a learning and revision tool to understand.

4. Discussion

The impact of podcasting on humans cannot be underestimated, especially since remote learning became a standard method during the pandemic. In the past, nursing education has mainly used traditional, lecture-based learning methods, where the teacher is the leader in the classroom through demonstrations or presentations (11), and course content is guided in detail. This situation can lead to students learning to become passive and lacking the ability to problem-solve, think critically, and practice sound judgment (46). Through a synthesis review, we found that nursing course design blended with podcasting showed the following results: that study qualities were low to medium, indicating the studies' validity as statistical conclusion validity, internal validity, constructive validity, and external validity had to be further confirmed. However, innovative teaching is necessarily integrated into nursing curriculums to bridge the gaps in traditional education.

In Western countries, innovative teaching in nursing has delivered concepts of core nursing such as general clinical skills, communication and teamwork capability, critical thinking, caring, and ethics through podcasts to train nursing students to learn basic nursing core concepts over the past 10 years. Taiwan's nursing education innovation teaching has become gradually more active. Many educators applied newly-tech learning to teach basic medical and nursing professional knowledge. However, nursing educators seldom use newly-tech learning to teach nursing core concepts. Additionally, podcasting is also rarely applied in nursing education by Taiwan's nursing educators for the following reasons: podcasts may be lack visual stimulation so which cannot attract students' concentration, they have a poor internet connection, underestimated ability of podcasting to affect students positively, and insufficient understanding regarding the benefits of podcasting. Nevertheless, research illustrates that podcasting benefits student learning and is a valuable tool to supplement course content. Therefore, podcasts have value and deserve to be promoted in nursing education.

5. Conclusions and suggestions

The integration of digital technology has blended with educational teaching strategies to become a trend–podcasting is no longer a new digital technology. Podcasts have already been integrated into nursing education courses in Western countries for a long time. Podcasting has gained attention again with the COVID-19 pandemic. However, there are few podcasts blended into nursing education courses in Taiwan by nursing educators. Based on the above literature review and synthesis, podcasts are more suitable for clinical practice students in nursing education. Repeated listening can help them master clinical professional knowledge and skills. In the future, nursing educators can research whether podcasts can improve nursing students' knowledge and clinical practice skills. The limitations of this review encompass a limited number of articles that cover approximately 10 years, lacking evidence articles related to the podcast, and no appraisal articles to use the objective instrument.

Considering the wide range of people who access podcasts and the aging population in Taiwan, this should be an especially welcomed trend. Vision declines with age, and others with visual challenges also have reduced visual contact with their surroundings. Hence, efforts to apply the digital technology of podcasting to medical care delivery and the spread of health information will improve society's physical well-being and increase the external stimulus for people with visual challenges in the future. Furthermore, future research should aim to provide additional evidence regarding the effectiveness of podcast multimedia teaching strategies in nursing education.

Author contributions

M-CW and J-ST contributed to the conception of the study. J-ST organized and revised the database and references. M-CW analyzed and drafted the manuscript. C-CC revised the manuscript. C-LS supervised the study. Y-PL commented on important views about our revised version. All authors contributed to the article and approved the submitted version.

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Conflict of interest

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Application of virtual simulation in clinical skills and operation courses

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Aim: This study investigated the effectiveness and prospect of applying virtual simulation operation (VSO) as a novel teaching tool in clinical skill and operation courses.

Methods: A comparative test and survey study on the teaching effect of VSO was conducted with the clinical skill and operation course as the test course. The test group students received offline courses combined with online VSO practice. In contrast, the control group students received offline courses combined with instructional video review. The two groups were assessed using the Chinese medical school clinical medicine professional level test and a questionnaire survey.

Results: The test group students scored significantly higher than the control group in the skills test (score difference: 3.43, 95% CI: 2.05–4.80) (p<0.001). Additionally, a significant increase in the percentage of high-and intermediate-score ranges and a decrease in the percentage of low-score ranges was observed (p<0.001). According to the questionnaire survey, 80.56% of the students were willing to continue using virtual simulation in their subsequent clinical skill and operation learning. Further, 85.19% of the students believed that the VSO is superior because it is unrestricted by time and space and can be performed anywhere and anytime compared to traditional operation training.

Conclusion: VSO teaching can improve skills and examination performance. An entirely online operation that does not need special equipment can break through the spatiotemporal limitations of traditional skills courses. VSO teaching also suits the ongoing COVID-19 pandemic situation. Virtual simulation, a new teaching tool, has good application prospects.

KEYWORDS

virtual simulation, clinical skills and operation, clinical medicine course, online teaching, COVID-19

1. Introduction

We have focused on developing a virtual simulation program for clinical skills since 2013 and established an online platform called "Virtual Hospital." The virtual simulation operation (VSO) played a key role during COVID-19, owing to the requirement of conducting online classes. Accordingly, the virtual simulation program entered a new stage of development.

Using computer technology, virtual simulation generates virtual scenes, instruments, characters, and experimental animals based on real teaching content, allowing teachers and students to engage in a virtual-reality environment with computers, cell phones, and other terminal devices. Virtual simulation operation (VSO) can effectively avoid the risk entailed in real operations and is characterized by simulation, interaction, and openness (1). Clinical medicine has its features compared to other disciplines because its object of study is the human body. Additionally, most operations involving real people are risky. Therefore, the development of VSO teaching programs is particularly suitable for clinical medicine (2).

The rapid advancement of information technology has significantly changed the underlying technology of virtual simulation. There is also an increasing demand for teaching clinical skills in medical schools. Particularly, COVID-19 led to a surge in demand for online teaching. Virtual simulation, based on networking, is particularly suitable for online teaching (3). Our college started to explore the development of a VSO teaching program as early as 2013. We have always been dedicated to the construction of high-quality virtual simulation programs, from the initial FLASH to today's cross-terminal platform based on HTML5 and UNITY. We also extensively collected user feedback during the development process, which laid the foundation for future improvement and optimization.

Mobile Internet has penetrated all aspects of life. However, conducting VSO teaching programs before 2014 (3G era) was impossible due to the limitations of cell phone performance, network speed, and cost (4). Therefore, the personal computer (PC) was the mainstream teaching terminal device at that time. Additionally, FLASH was the most used development software owing to its superiorities such as low development cost, low difficulty, and cross-terminal operation (5). The first attempt to develop a VSO program using FLASH in our college was the "Virtual Hospital" information system (Figure 1). The feedback from students was very positive after the system went live. Most students felt that the VSO teaching program was novel and could stimulate their interest in learning. The research team designed a questionnaire on their own based on previous survey practices (6) and after discussion with our pedagogical experts, in conjunction with this study. The questionnaire was statistically calibrated and had reasonable reliability and validity. The questionnaire survey revealed that 93% of the students found the virtual simulation teaching to be novel. The students' objective structured clinical skills examination scores also improved significantly after the application of the "Virtual Hospital" to assist teaching.

However, the backward screen performance, unreasonable use of equipment resources, and software vulnerabilities led to the gradual withdrawal of FLASH from the historical stage. In 2020, Adobe, the parent company of FLASH, announced that it would stop supporting Flash Player, starting from December 31, 2020. Its successor, HTML5, with its exceptional superiority, could completely replace FLASH in all aspects and become the mainstream web technology language in the new era (7).

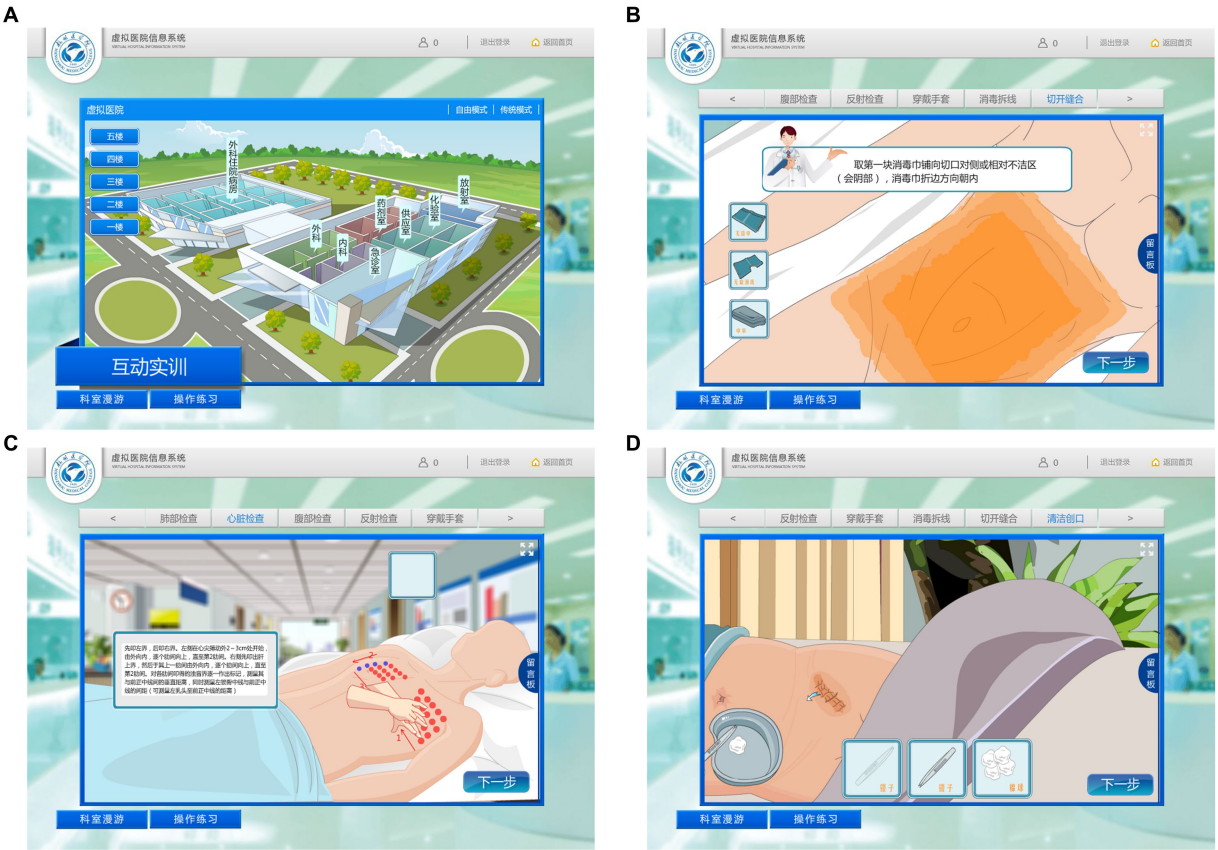

FIGURE 1
"Virtual Hospital" information system. **(A)** Appearance scene of the virtual hospital. **(B)** Surgical patient disinfection and surgical drape operations. **(C)** Heart percussion operation. **(D)** Surgical dressing-change operation.

The "Virtual Hospital V2.0" system has been basically developed. The system, developed based on HTML5 and UNITY, has completely surpassed its old version in terms of screen performance and user experience, and it has achieved multi-terminal coverage. In the era of mobile Internet, smartphones have become the most frequently used terminal by students. Therefore, the new version of the system has been optimized for compatibility with cell phones.

Virtual simulation technology is very mature in commercial games, in which students have been exposed to very realistic and high-end game graphics. However, there is presently a gap between the graphic expressiveness of the virtual simulation software for teaching and commercial games due to the former's non-profit nature (8). Therefore, some students have a comparison mentality when using virtual simulation teaching software and are dissatisfied with its poor quality and rough graphics. However, technological progress makes virtual graphics increasingly realistic. Accordingly, the virtual simulation program screen for teaching is also becoming increasingly exquisite. Some foreign teaching teams have directly been applying the commercial game engine Unreal Engine 5 to develop teaching programs (8, 9). While developing the "Virtual Hospital V2.0" software, more attention has been paid to the quality of graphics and ambient light rendering. Additionally, the three-dimensional (3D) human modeling is more proximate to the real human data, and the action screen is more exquisite and smoother (Figure 2).

Unlike augmented reality (AR) and virtual reality (VR) simulation, the VSO is fully online and does not require additional special equipment. Therefore, teachers and students can use the system anytime and anywhere, only with a terminal device that can be connected to the Internet.

This study discussed the role of VSO in teaching clinical skills based on a teaching reform experiment conducted in a recent teaching cycle. Further, the future trends of virtual simulation teaching and learning were also explored.

2. Methodology

Teaching effectiveness has been repeatedly observed and tested in the ongoing development of the virtual simulation skill practice program. A comparative study was conducted in a recent teaching cycle in which four classes were randomly selected as the test group ($n = 108$) and the remaining four classes as the control group ($n = 116$), using a random number table method from a total of eight classes ($n = 224$) of students in the same year of clinical medicine. The test course was a clinical skills and operation course (course ID: 39 AC032) involving clinical skills operations related to internal medicine, surgery, obstetrics and gynecology, pediatrics, and emergency medicine (Appendix 1). This was consistent with the operational assessment items of the Chinese medical school clinical medicine professional (undergraduate) level test. The test group students received offline courses combined with VSOs. They used both the medical model for practice and the online VSOs for review. The research group's studies were all based on the premise that the normal teaching content and order would not be affected, the school's talent training program and syllabus would not be violated, and reasonable compliance would be achieved before considering the use of VSO teaching tools for teaching. Moreover, we conducted a survey of the students in the experimental group in the course of conducting the study and analyzed the feedback in a timely manner. Participants were notified that their participation was voluntary and that they could choose to end their participation at anytime during the training.

In contrast, the control group students received an all-offline course. They practiced with the medical model and reviewed using instructional videos. The baseline analysis compared the age, gender ratio, China national college entrance exam (CNCEE) scores, and prior clinical course scores of the students in both groups; no statistical differences were observed ($p > 0.05$). All students had the same prior course curriculum and the same faculty. After one complete teaching cycle, the performance of both groups was compared using the Chinese medical school clinical medicine professional (undergraduate) level test as an evaluation index. The assessment items of this test include clinical skills and operations related to internal medicine, surgery, obstetrics and gynecology, pediatrics, and emergency medicine, which are consistent with the items taught in the test course. Further, a questionnaire with a reliability Cronbach's α coefficient of 0.905 and a validity Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) value of 0.879 was distributed to the test group students at the end of the semester. In total, 108 questionnaires were collected, with an efficiency rate of 100%.

Quantitative data were tested for normality using the Shapiro–Wilk method, and normal data were expressed as mean ± standard deviation and compared by t-test. Skewed data were expressed as median (p25, p75) and compared using the Wilcoxon Mann–Whitney test. Categorical data were compared using the Chi-squared test or Fisher's exact test, and the score differences were analyzed using the Hodges-Lehmann method. Additionally, $p < 0.05$ suggested statistical significance. All statistical analyses were performed using SPSS25.

3. Results

Baseline analyses were performed on both groups to ensure comparability, including age, sex, CNCEE scores, and average scores in prior clinical courses. No statistical differences were found between the two groups in terms of these variables ($p > 0.05$; Table 1).

The Shapiro–Wilk method-based normality test indicated skewed score distribution ($p < 0.05$) in both groups. The median scores of the test and control groups were 84.08 (80.71, 87.59) and 81.27 (76.35, 83.97), respectively. Statistical differences were observed in the distribution of scores between the two groups ($Z = -4.852$, $p < 0.05$). The test group students scored significantly higher than the control group students in the skills examination, with a difference of 3.43 (2.05–4.80) points (Table 2).

Constituent ratio analysis was conducted on the scores of both groups, where scores <80 were defined as a low-score range, 80–90 as an intermediate-score range, and >90 as a high-score range. Fisher's exact test analysis indicated a 6.5 and 0.0% of high-score range for the test and control groups, respectively. Thus, significant differences ($p < 0.05$) were observed in the distribution of score ranges between the two groups. Using post-hoc tests (bonferroni), we found significant differences between the <80 score band and the >90 score band in both groups (Table 3).

According to the questionnaire survey, 68.52% of the students had not been exposed to similar VSOs before. Additionally,

FIGURE 2
"Virtual Hospital V2.0" information system. **(A)** Simulated consultation. **(B)** Debridement operation. **(C)** Resuscitation scene of a cardiac arrest patient in a subway station. **(D)** External chest compression (select compression site). **(E)** Airway opening and artificial respiration. **(F)** AED operation.

85.19% of the students believed that the VSO's superiority lies in the fact that it is unrestricted by time and space and can be conducted anywhere and anytime compared to traditional operation training. Moreover, 62.96% of the students believed that VSOs can provide equipment that is difficult to access in reality. However, 71.3% of the students stated that the extent of virtual simulation is not high, and it differs from real clinical operations. Additionally, 58.33% of the students complained that VSOs cannot be conducted on real patients, which is not helpful for hands-on practice. Overall, 80.56% of the students wanted to continue using virtual simulation in their subsequent clinical skills learning (Table 4).

The last item of the questionnaire was an open-ended question asking students about their experience with VSO and suggestions for improvement. Based on the responses collected from the survey, a hot word map was created, in which the more central the position of words and phrases, the more frequently they appeared in the responses (Figure 3).

4. Discussion

The COVID-19 pandemic ravaged the whole world in early 2020 and had a significant negative impact on teaching and learning in higher education. Online teaching has become the preferred contingency solution for schools to ensure the proper delivery of teaching assignments due to the hindrances to traditional face-to-face teaching (10). The virtual simulation of clinical skills based on the Internet is available to students and faculty with devices that have access to the Internet. Therefore, VSO teaching is an alternative to traditional offline clinical skills courses (11).

Compared to theoretical courses, teaching clinical skills operation courses online is more difficult because students cannot engage in actual operation training online. Virtual simulation with the Internet is apt for the current teaching needs. The introduction of various new information technologies, such as 3D display and perspective view of the internal structure of the human body, can present richer teaching materials and teaching effects than traditional offline courses; these

TABLE 1 Baseline analysis results.

	Test group	Control group	Statistical value	*p*-value
Age (in years)	22 (22,23)	22 (22,23)	$Z = -1.437$	0.151
Sex	Male 49 (45.4) Female 59 (54.6)	Male 56 (48.3) Female 60 (51.7)	$\chi^2 = 0.19$	0.689
CNCEE scores	604 (597, 610)	603 (596, 609)	$Z = -0.649$	0.517
Average score in prior clinical courses	77 (68, 83)	77 (71, 87)	$Z = -1.103$	0.27

TABLE 2 Comparative analysis of the Chinese medical school clinical medicine professional (undergraduate) level test.

Group	M (P_{25}, P_{75})	Median of the difference (95% CI)	Wilcoxon Mann–Whitney test	
			Z	*P*
Test group	84.08 (80.71, 87.59)	3.43 (2.05–4.80)	−4.852	<0.001
Control group	81.27 (76.35, 83.97)			

TABLE 3 Comparative analysis of score constituent ratio.

Group	Total (*n*)	Low-score range (<80) [*n* (%)]	Intermediate-score range (80–90) [*n* (%)]	High-score range (>90) [*n* (%)]	Fisher's exact test
					P
Test group	108	25 (23.1)*	76 (70.4)	7 (6.5)*	<0.001
Control group	116	47 (40.5)	69 (59.5)	0 (0.0)	

*Statistically significant difference compared with the control group ($p < 0.05$).

also entail high-quality online teaching tools for clinical skills courses (12).

The present teaching experiment corroborated the idea that VSO contributes to high-quality engagement in clinical skill courses. The test group students scored significantly higher than the control group students in the skills examination, and it has increased the number of students in the high-scoring band (>90) and reduced the number of students in the low-scoring band (<80). This indicates that in this trial, VSOs can improve students' skill assessment scores relatively evenly, rather than working for only some students. This indicates that students who used VSO increased their skill assessment scores compared to those who did not, with other teaching tools and content remaining the same, so we believe that VSO can improve students' clinical skill operations and is a new promising teaching tool. A good teaching tool, in addition to being effective, should also be enjoyed by students. According to the questionnaire survey, most students were highly receptive to virtual simulation. Furthermore, lots of the students believed that the VSO's most prominent superiority is that it is not limited by time, space, and equipment, which is consistent with our original intention of developing the VSO program.

The ultimate purpose of the VSO teaching program is to serve the curriculum, which is the core element of talent training. The promotion of teaching reforms with information technology is precisely the entry point of VSO teaching program development in the construction of high-quality clinical courses. VSO, together with online open courses and online and offline hybrid courses, should be used as a tool to promote the construction of first-class courses and create a multi-dimensional medical curriculum system. Particularly, clinical skills courses are more suitable to be built as online and offline hybrid courses. During the COVID-19 pandemic, building clinical skills courses into an online-offline hybrid form, wherein medical models are used in offline teaching and virtual simulation is used in online teaching, can solve the teaching problems of clinical skills courses more perfectly; thus, this teaching reform direction should be extensively promoted (13).

The construction of large-scale open online massive open online courses (MOOCs) is a very successful model in the teaching reform of theory courses (14). Drawing on the successful experience of MOOC, an important construction direction of VSO teaching is shared construction. The funds and efforts required for VSO teaching programs are incomparable to those of theoretical courses. Therefore, it is difficult to establish a complete and program-complete virtual simulation teaching system in one institution alone. The construction of the VSO teaching platform and sharing of teaching resources and network resources with partner institutions worldwide can ensure the maximum utilization of resources, which is a necessary way for virtual simulation course construction (15).

COVID-19 has facilitated the "internetization" of traditional courses. VSO program construction has also ushered in a good time to accelerate the construction and promote the application in the general environment of comprehensive construction of a first-class curriculum. The VSO teaching program, which has an Internet attribute, can replace the traditional clinical skills course under the new mode of online teaching to fully tap the sensory perception of students to participate in the VSOs. Therefore, it is a teaching tool that is in line with the trend of the times and has a broad development prospect (16). The construction of the current VSO program has taken shape. Integrating VSOs more deeply into the curriculum and creating a first-class VSO course will be a new trend in the reform of clinical medicine teaching (17).

This study verified the effectiveness of VSO through a comparison study and also gained the approval of students, but there are still

TABLE 4 Main results of the questionnaire survey (*N* =108).

Questionnaire item	Agree (*n* [%])
Superiority	
It is not limited by time and space and can be conducted anywhere	92 (85.19)
VSOs can provide equipment that is difficult to access in reality	68 (62.96)
Repeat training is possible with no consumable loss and is environmentally friendly	67 (62.04)
Weakness	
The extent of virtual simulation is not high with some differences from real clinical operations	77 (71.30)
VSOs cannot be conducted on real patients, which is not helpful for hands-on practice	63 (58.33)
The interactivity of the simulation platform is still lacking, and there is still room for improvement in the user experience	48 (44.44)

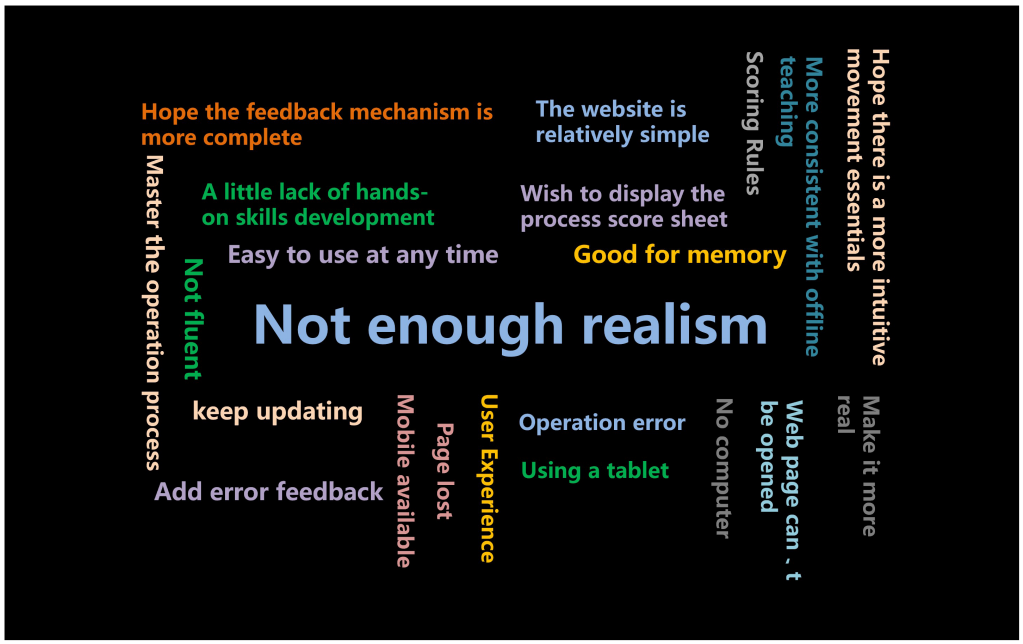

FIGURE 3
Hot word map of students' opinions on VSOs in the questionnaire. The more middle the position the words and phrases, the higher the present frequency in the questionnaire.

shortcomings in this study. The current VSO program still has limitations. According to the questionnaire survey and hot word map, most students believed that the extent of simulation in the current virtual simulation program is not high enough and vastly differs from reality. Additionally, VSO is a purely screen-based operation, which is not conducive to the development of hands-on skills. Some students even complained that "the website is still a bit rudimentary." Students have high expectations regarding the quality of virtual simulation programs. Therefore, the developers of VSO programs should invest more efforts and funds to create more exquisite and higher-quality VSO programs.

In addition, the result showed that the test group students scored significantly higher than the control group, raising questions about the ethics of withholding the VSO intervention from the control group. In fact, the research team had applied to the Medical Ethics Committee for ethical review, but our application was not accepted on the grounds that the study was not a biomedical study and the Declaration of Helsinki did not apply and that the content and quality of the lectures. However, we fully informed all students before administering the VSO teaching method. We explained that there were also risks in the experimental group because it was not certain before the trial that the VSO teaching method would actually be effective. If there were unwilling students after informing them, they were placed in traditional teaching classes, but their performance did not enter into the comparison of experimental data. We conducted random sampling on the basis of informed consent of all. In practice, all students participated voluntarily in this teaching study. In addition, both of the experimental and control groups met the requirements of the university's talent training program and syllabus, and complied with our laws and relevant industry regulations at the policy level.

The study team suggests continuing to improve the quality of VSOs and promoting online teaching models for clinical skills practice courses to be ready for special situations where offline teaching cannot be conducted.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics staement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

LW: funding acquisition and writing of the original draft. FZ: analyzed the data and revising the manuscript. HX: research implementation guidance and manuscript revision. All authors have accepted responsibility for the entire content of this manuscript and approved its submission.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Appendix 1

Catalog of clinical skills and operation items:
1. Physical examination
2. Thoracentesis
3. Celiocentesis
4. Bone marrow aspiration
5. Lumbar puncture
6. Pre-operative aseptic preparation by surgeon
7. Sterile preparation of the patient's surgical area
8. Incision and suturing
9. Debridement
10. CPR and AED
11. Obstetrical and gynecological examination
12. Gastric tube insertion
13. Urinary catheterization
14. Intravenous injection
15. Putting on and taking off isolation gown

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A systematic review of self-medication practice during the COVID-19 pandemic: implications for pharmacy practice in supporting public health measures

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Introduction: Since the COVID-19 pandemic, self-medication had become highly popular due to the risk of virus infection and overwhelming medical resources. Pharmacists are well-positioned to provide public health education and disease prevention. This study aims to provide an overview of the research about self-medication during COVID-19 and the role of pharmacists in ensuring the drug safety related to self-medication.

Methods: Databases (PubMed, Google Scholar, Scopus, EBSCO host, and Web of Science) were searched for published studies on the practice of self-medication in COVID-19 pandemic without restriction in population and location. Primary search terms were "self-medication," "self-care," "self-management," "non-prescription drugs," "2019nCoV," and "COVID-19." Studies conducted during the pandemic but not exclusively for COVID-19 disease were eligible for inclusion.

Results: The database search yielded a total of 4,752 papers. After appropriate screening, 62 articles met the inclusion criteria. Most of the studies were cross-sectional in nature. The review highlighted a very high prevalence of self-medication during COVID-19, ranging from 7.14 to 88.3%. The purpose of self-medication was mainly to treat and prevent COVID-19; fever, body aches, cough, headache, and sore throat were the most frequently mentioned indications. Categories of drugs commonly used in self-medication included antibiotics, herbs, vitamins, and analgesics, most of which came from pharmacies. Information about self-medication usually obtained from relatives and friends, social networks and health care professionals. Common reasons for self-medication included saving money and time, prior experience and mild illness; reasons associated with COVID-19 were mainly fear of contracting the virus and poor access to doctors. Gender, age, education, marital status, and concern about COVID-19 were the most usual associated factors. The role of pharmacists in self-medication included sources of information, advice on medication use, and management of adverse reactions.

Conclusion: During the COVID-19 pandemic, self-medication practices were widespread and varied across countries and populations. Self-medication has emerged as an important component of health care, but also as a huge global challenge. The engagement of healthcare administrators and policy makers

are essential to regulate self-medication practices. The expertise and favorable conditions of pharmacists make them positioned as key roles in public health interventions for self-medication.

Systematic review registration: https://www.crd.york.ac.uk/prospero/display_record.php?RecordID=395423, identifier CRD42023395423.

KEYWORDS

self-medication, pharmacist, COVID-19, public health, systematic review

1. Introduction

Self-medication is defined by WHO as treatment of self-recognized disorders or symptoms by use of medicines without prior consultation by a qualified health professional or intermittent/continued use of medicines previously prescribed by a physician for chronic/recurring diseases (1). Self-medication is a widespread habit throughout the world and is considered an essential part of health policy in various countrie (2–7). This is especially evident during a pandemic such as the COVID-19 infection. Makowska et al. showed that a number of people experienced their first involvement in self-medication during the pandemic (8). A study in Kenya also found that the total prevalence of self-medication among health care workers increased to 60.4% during the COVID-19 pandemic from 36.2% before the pandemic (9). In Pakistan, the rate of self-medication behavior among medical students during the pandemic was as high as 83% (10). Self-medication behavior was also prevalent among the general public in India (59.9%) (11).

Since the COVID-19 pandemic, self-medication had become highly popular due to a number of reasons. Initially, due to the known risk of contracting the virus, people are afraid to go to clinics or hospitals (12). Also, there are challenges in accessing medical settings due to lockdown and restriction policies (12). Furthermore, COVID-19 may make the issue of poor access to healthcare even worse, particularly in nations with underdeveloped health systems (13). With the unexpected patient burden and inadequate healthcare human resources resulting from healthcare worker infections, healthcare services may be hampered (14). Quite a few governments have also urged people to self-medicate for minor symptoms to avoid crowding out medical resources. All of these may have contributed to people opting for self-medication.

Self-medication, when properly used, can benefit both individuals and health systems in a number of ways, including reducing the amount of time spent waiting in line for medical appointments, preventing limited medical resources from being used on minor conditions, reducing the workload of doctors, lowering health care costs, and lowering absenteeism from work (15, 16). Regardless of the unquestionable benefits obtained from self-medication practice, there are undesired outcomes that may result from improper usage. These have been mentioned in studies where self-medication may have involved risks of misdiagnosis, administration of an excessive dose, improper duration of use, and adverse drug reactions associated with improper medication use (17, 18). Inappropriate self-medication may lead to irrational use of drugs, waste of resources, increase in polypharmacy, and interactions with other frequently used drugs and delays in treatment (19). Additionally, antibiotic overuse fuels the emergence of drug-resistant pathogens worldwide (3).

Pharmacists play a crucial role in recognizing, resolving, and avoiding drug-related problems in order to achieve the best possible patient outcomes and quality of life (15). They are professionally trained to support and assist patients in making informed health decisions (20). Considering that the products used for self-medication is mostly accessed through the pharmacy (21), pharmacists are well-positioned to deliver public health education and disease prevention. Notably, pharmacist involvement in the use of over-the-counter (non-prescription) medications is widely recognized and has the potential to improve patient outcomes (22). The International Pharmaceutical Federation (FIP) report "Pharmacy as a gateway to care: Helping people toward better health" emphasizes the idea of facilitated or advised self-medication as well as the role that pharmacists can play as facilitators to the self-care decisions consumers take in the selection and use of over-the-counter (non-prescription) medicines (23).

Nevertheless, little has been reported about the interface between self-medication during the COVID-19 pandemic and the role of pharmacists. Previous studies have explored the use of self-medication for COVID-19 disease (21, 24, 25). However, a broader systematic review is necessary to integrate all self-medication behaviors during the pandemic to provide better insight into public health in this resource-constrained setting. Also, there is a lack of research on the role of pharmacists in self-medication during the pandemic, and understanding this situation would contribute to the promotion of the pharmacists' role. Therefore, the objective of this review was to provide an overview of the research about self-medication during COVID-19 and the role of pharmacists in ensuring the drug safety related to self-medication. The overall goal is to promote responsible self-medication, thus making contributions to public health in future pandemics.

2. Methods

This systematic review was conducted and reported in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (26) (Supplementary material 1). The study protocol has been registered on the PROSPERO systematic review database (CRD42023395423).

2.1. Search strategy

Online digital libraries were used to search for relevant papers on July 22 2022. We systematically searched the following

electronic databases: PubMed, Scopus, EBSCO host, Web of Science and gray literature sources (Google Scholar). Search terms were derived from two main keywords: "self-medication," and "COVID-19." Primary search terms were "self-medication," "self-care," "self-management," "self-treatment," "non-prescription drugs," "otc drugs," "drug utilization," "2019nCoV," and "COVID-19." The specific search equations utilized for each database are shown in Supplementary material 2. Additionally, bibliographic citations of included studies were reviewed to identify other relevant studies.

2.2. Eligibility criteria

All original articles published in English concerning self-medication practices during COVID-19 were reviewed. Studies conducted during the pandemic but not exclusively for COVID-19 disease were eligible for inclusion. The selection of articles did not include any population and location restrictions. Self-medication was defined as taking medicines to treat health conditions or symptoms without prescription or diagnosis from a qualified healthcare professional (9). It might involve a range of production including, but not limited to, over-the-counter drugs, antibiotics, traditional and complementary medicine (including herbal product and dietary supplements). If a study provided a definition of self-medication in the article or if the medication addressed in the article did not require a medical prescription, we regarded that study as having investigated about self-medication. Case reports, book, comment, letter, reviews, news, preprint article and editorials were excluded.

2.3. Study selection

The PRISMA Flow Diagram was used to select the articles for this review. Results of our searches were imported EndNote, where duplicates were removed. Two reviewers, YZ and JY, independently screened studies based on eligibility criteria. They manually reviewed the databases' search results first by title and abstract in accordance with the inclusion criteria. After that, they examined the full text of the relevant papers to decide whether they were suitable for inclusion in the study. Any divergences between the two reviewers were discussed. Should reviewers not reach accord, a third reviewer CU participated in the process to make a final decision on inclusion or exclusion.

2.4. Data extraction

Utilizing a Microsoft Excel spreadsheet, two authors (ZY and JY) independently extracted the following details for the review: author, year of publication, study area, study population, study design, sample size, sampling technique, date of data

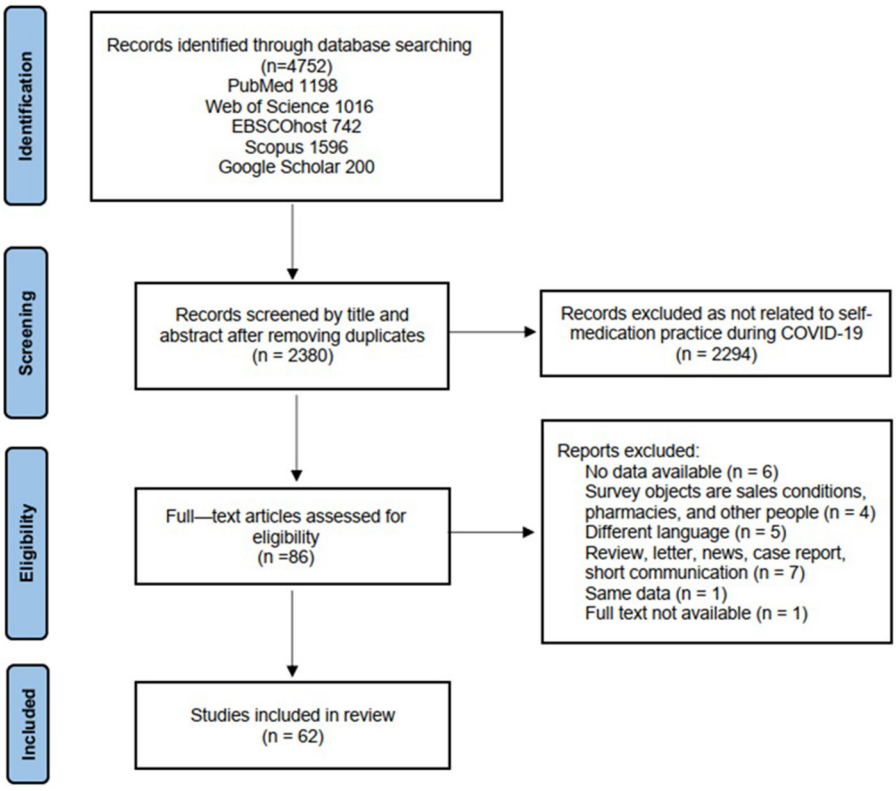

FIGURE 1
PRISMA flowchart showing selection strategy.

collection, how was self-medication assessed, prevalence of self-medication, types of self-medication, condition for self-medication, reasons to practice self-medication, and factors associated with self-medication, sources of drugs, sources of self-medication information, adverse event, knowledge as well as attitudes associated with self-medication.

3. Results

3.1. Study selection

In total, 4,752 articles were kept through our preliminary database search. When the duplicate articles were adjusted, there were 2,380 articles left. After screening the titles and abstracts of the remaining 2,380 studies, 2,294 records were excluded since they didn't match the criteria for inclusion. We retrieved and reviewed the full text of 86 articles. As a result, 62 articles met the inclusion criteria. The remaining 24 papers were removed (five beyond the required language, seven article types out of scope, six studies without available data, one article full text is not available, one article had the same data, and four articles were not targeted at the participants themselves; Figure 1).

3.2. Study characteristics

3.2.1. Basic information of the included studies

The 62 included studies reported about the practice of on self-medication during COVID-19 in 29 different countries, of which 35 studies were from the Asian region namely Iran ($n = 5$) (12, 27–30), China (31), Indonesia ($n = 2$) (32, 33), Thailand (34), India ($n = 8$) (11, 35–41), Pakistan ($n = 5$) (10, 42–45), Turkey ($n = 3$) (46–48), Bangladesh ($n = 5$) (49–53), Saudi Arabia ($n = 3$) (54–56), Jordan (57), Nepal (58); seven from Europe continent, Romania (59), Poland ($n = 2$) (8, 60), Netherlands ($n = 4$) (61–64), Ireland (62), Norway ($n = 3$) (62–64), Switzerland ($n = 2$) (62, 64), UK ($n = 2$) (62, 64), Sweden (63), Belgium (64); four from South America, Peru ($n = 3$) (65–67), Colombia (68); three from North America, Mexico ($n = 3$) (69–71); one from Oceania, Australia (72); and 12 from Africa, Kenya ($n = 2$) (9, 73), Togo ($n = 2$) (74, 75), Ethiopia (76), Nigeria ($n = 6$) (77–82), and Sub-Saharan Africa (83).

Regarding the population, 30 studies were conducted targeting the general population (8, 11, 30, 31, 34–36, 38, 40, 42, 44, 47, 49–51, 54–57, 61, 63, 65, 67, 68, 70, 72, 75, 79, 81, 83), 10 was conducted in students (10, 33, 39, 41, 43, 53, 58, 60, 71, 78), four in dental visit (12, 29, 45, 46), three in healthcare workers (9, 80, 82), three in individuals visited medical stores and medical store owners (73, 76, 77), two in older adult (28, 48), two in patient (27, 66), one in COVID-19 recovered patients (52), one in mothers with school-age children (32), one in pregnant and breastfeeding women (62), one in pregnant and postpartum women (64), one in adults with a history of taking allopathic medication in the last month (37), one in five doctors with different specialties (interviews) and adults (survey) (59), one in people with symptoms related to anxiety and depression (69), and one in workers from five sectors (health care, air transport, police, road transport, and informal) (74).

The vast majority of the selected studies used a cross-sectional survey design and 1 used mixed-method (i.e., cross-sectional surveys with qualitative work) (59). All studies together included 75,262 participants with sample sizes ranging from 80 to 16,724. The majority of the study were conducted in 2020 and 12 in 2021. Studies were performed from January 2020 to December 2021.The study characteristics collected from the reviewed literature are fully described in Table 1.

3.3. Self-medication practice during COVID-19 pandemic

3.3.1. Prevalence of self-medication during COVID-19

The prevalence of self-medication during COVID-19 differed across the study populations, ranging from 7.14 to 88.3% (Table 1). Six studies did not calculate overall prevalence, of which two articles investigated self-medication behavior by scale (33, 59), three articles explored only consumption/use of different medication types separately (32, 36, 50), and one article only mentioned the proportion of symptoms corresponding to product use (42).

The study with the highest prevalence (88.33%) was a public survey conducted in Bangladesh that investigated self-medication for prevention of COVID-19 and treatment of COVID-19-like symptoms (51). However, also in Bangladesh, the prevalence of self-medication for prevention or treatment of COVID-19 was only 11% among patients recovering from COVID-19 (52). The study with the lowest prevalence (7.14%) was also from Bangladesh and investigated self-treatment of sleep disorders in the general population during the pandemic (49). There are seven studies reporting the prevalence of self-medication in India, ranging from 25 to 84.5% (11, 35, 37–41). Of these, self-medication use for anxiety in general population with medium to high socioeconomic status showed the lowest prevalence rate. Two studies reporting self-medication among the student population also showed different results [34.4% (39); 73.85% (41)]. Self-medication was a common practice among several Iranian populations, including dental patients [56.1% (12); 53.9% (29)], COVID-19 patients [56.1% (27)], the older adult [56.4% (28)], and the general public [84% (30)].

In student populations, the prevalence of self-medication during the pandemic ranged from 20.4 to 83% (10, 39, 43, 53, 58, 60, 71, 78). The prevalence of self-medication among health workers in the included studies had a wide span of 15.9% (82), 36.3% (80), and 60.4% (9), respectively. In the older adult, the prevalence of self-medication was 48.7% (48) and 56.4% (28). There was a generally high prevalence of self-medication among pharmacy clients and pharmacy owners, ranging from 68.5 to 78% (73, 76, 77). Additionally, throughout the pandemic, the rate of self-medication for dental issues ranged from 53.9 to 86.25% (12, 29, 45, 46).

3.3.2. Major of health conditions managed with self-medication during COVID-19

Of the included studies, 35 publications examined self-medication behavior regarding COVID-19 disease, involving

TABLE 1 Characteristics of the included studies.

No.	References	Country	Study design	Sample population	Sample size	Collection period	Purpose of self-medication	Prevalence of self-medication %	Type of product used for self-medication
1	Khami et al. (12)	Iran	CS	Dental visits	756	mid-4 2020 to mid-7 2020	Dental problem	Before pandemic 26.5% After pandemic 56.1%	Amoxicillin 22.7%, incomplete information 14.8%, azithromycin 4.7%, co-amoxiclav 3.8%, amoxicillin and metronidazole 3.5%, metronidazole 2.3%, penicillin 1.7%, cefixime 0.9%, doxycycline 0.9%, clindamycin 0.6%, and azithromycin and penicillin 0.3%
2	Lam et al. (31)	China	CS	General people	632	2020.11.2–2020.12.18	Prevention of COVID-19 and others	All 54.1% Before pandemic 48.4% During pandemic 44%	Vitamins or other dietary supplements 25.3%, Chinese herbal medicine 19.3%, and Western herbal medicine 5.1%
3	d'Arqom et al. (32)	Indonesia	CS	Mothers with school-age children	610	2020.7–2020.12	Prevention and/or treatment of COVID-19	NR	Medication: Antibiotics 42%, antivirus 16%, antimalaria 5%, and others 37%; Vitamins: Vitamin C 39%, multivitamins and minerals 32%, vitamin E 11%, vitamin D 8%, Zinc 6%, and Selenium 1%; Herbs/Natural product: Ginger 31%, honey 30%, curcumin 22%, eucalyptus 5%, and other 12%.
4	Goodwin et al. (34)	Thailand	CS	General people	1,000	2020.4.20–2020.5.3	Prevention of COVID-19	15.0%	Vitamins or other medicines
5	Onchonga et al. (9)	Kenya	CS	Healthcare workers	379	NR	Treatment for specific symptoms	Before pandemic 36.1% After pandemic 60.4%	NR
6	Mahmoudi (27)	Iran	CS	COVID-19 patients	436	2020.3.11–2020.10.13	Treatment of COVID-19	56.1%	Antibiotics
7	Sarkar and Rajamani (35)	India	CS	General people	200	2020.8–2020.11	Treatment for specific symptoms	65%	Diclofenac and paracetamol
8	Arain et al. (42)	Pakistan	CS	General people	698	2020.4–2020.9	Treatment for specific symptoms	NR	OTC, antibiotics, and others (sedatives)

(Continued)

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TABLE 1 (Continued)

No.	References	Country	Study design	Sample population	Sample size	Collection period	Purpose of self-medication	Prevalence of self-medication %	Type of product used for self-medication
9	Sadio et al. (74)	Togo	CS	The healthcare, air transport, police, road transport and informal sectors	955	2020.4.23–2020.5.8	Prevention of COVID-19	34.2%	Vitamin C 27.6%, traditional medicine 10.2%, chloroquine/hydroxychloroquine 2.0%, and azithromycin 1.2%.
10	Oktarlina et al. (33)	Indonesia	CS	Medical faculty students	252	2020.1.1–2020.1.10	Treatment for specific symptoms	NR	Supplement and drugs
11	Coman et al. (59)	Romania	Mixed method (interview and survey)	Interviews: five doctors with different specialties. Survey: predominantly adults and student	543	2021.1–2021.4	Prevention and treatment of COVID-19	NR	Symptomatic medicines for allergies, respiratory, gastric, pain, anxiolytic antibiotics, vitamins, anti-thermics, oral disinfectants, antispasmodics, anti-diarrheals, and non-steroidal anti-inflammatory medication (ibuprofen, diclofenac, etc.)
12	Tossou (75)	Togo	CS	Households	1,946	2020.7.8–2020.7.17	No specific indication	61.41%	NR
13	Tandon et al. (36)	India	CS	General people	312	NR	Prevention of COVID-19 and others	NR	Prophylactic therapy with the perception to prevent COVID-19 infection ($n = 4$), VC ($n = 2$), hydroxychloroquine ($n = 1$).
14	Mansuri et al. (54)	Saudi Arabia	CS	General people under lockdown	388	2020.3–2020.4	Prevention and treatment of COVID-19	Self-medication for fever 35.1%	NR
15	Sen Tunc et al. (46)	Turkey	CS	Parents who applied to dental clinic regarding their children's dental problems	389	2020.7–2020.10	Dental problem	70.2% (self-medicated their children)	Analgesics 98%, antibiotics 38.1%, mouthwashes 13.1%, and herbal medicines 8.8%
16	Sikdar et al. (49)	Bangladesh	CS	General people	2,941	2020.11.25–2020.12.4	Sleep disturbances	7.14%	NR
17	Tekeba et al. (76)	Ethiopia	CS	Community-pharmacy clients	416	2020.6.1–2020.6.30	Treatment for specific symptoms	73.6%	Painkillers 83.7%, antibiotics 10.5%, cough syrup 1.6%, antacid 1.6%, oral contraceptive 1.3%, and other 1.3%
18	Soriano-Moreno et al. (65)	Peru	CS	General people	3,610	2020.9.7–2020.9.21	Prevention and treatment of COVID-19	Prevention: 8% Treatment: 16.4%	Chlorine dioxide

(Continued)

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TABLE 1 (Continued)

No.	References	Country	Study design	Sample population	Sample size	Collection period	Purpose of self-medication	Prevalence of self-medication %	Type of product used for self-medication
19	Merwid-Lad et al. (60)	Poland	CS	The students during the academic year 2020/2021	624	2021.11.14–2021.12.23	Anxiety, depression, or sleeping problems and others	70%	Dietary supplements: Magnesium or a combination of magnesium with vitamin B6, *Melissa officinalis* L. (melissa, lemon balm), melatonin, a Vitamin-B group complex, *Valeriana officinalis* L. root (valerian root), *Matricaria recutita* L. (wild chamomile), *Withania somnifera* L. (ashwagandha), *Humulus lupulus* L. (hop), cannabidiol (CBD) oil, ginseng, vitamin D with or without menaquinone-7 (MK7), vitamin C, vitamin B12, multivitamin preparations, zinc, iron, and omega-3 fatty acids OTC: Antihistamines, analgesic, antipyretic, and anti-inflammatory drugs
20	Yusuf and Sarkinfada (77)	Nigeria	CS	Individuals that visited medical stores and medical store owners	332	NR	Treatment for specific symptoms	During pandemic 68.5% Before pandemic 64.2%	Artemisinin combination therapy 39.5%, Co-trimoxazole 16.0%, amoxicillin 14.1%, ciprofloxacin 12.9%, ampicillin-cloxacillin 6.7%, tetracycline 6.7%, and chloroquine 3.7%
21	Bello et al. (78)	Nigeria	CS	Nigerian undergraduates	356	2020.5–2020.8	Prevention and treatment of COVID-19	65.4%	Vitamin C 52%, paracetamol/panadol 43%, herbs 28.7%, anti-malaria 24.7%, food supplements 15.7%, cough syrup 8.1%, slimming pills and teas 6.5%, piriton 3.4%, anti-diarrhea 2.2%, tramadol 2%, hydroxychloroquine 2%, and other 15.2%
22	Gupta and Chakraborty (37)	India	CS	Adults with a history of taking allopathic medication in the last month	170	2020.8	Treatment for specific symptoms	57.7%	Pain suppressor 46.9%, antibiotics 43.9%, anti-acidity 39.8%, and anti-allergics (including cough suppressants) 16.3%

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TABLE 1 (Continued)

No.	References	Country	Study design	Sample population	Sample size	Collection period	Purpose of self-medication	Prevalence of self-medication %	Type of product used for self-medication
23	Akintunde et al. (83)	Sub-Saharan Africa	CS	General people	536	2020.8.18–2020.8.24	No specific indication	38.8%	NR
24	Saleem et al. (43)	Pakistan	CS	Undergraduate students	520	2020.3–2020.6	Treatment for specific symptoms	58.1%	Analgesics 55.96%, antibiotic 38.74%, antipyretic 34.44%, antihistamine 20.86%, vitamins 17.55%, antiemetic 9.27%, antidiarrheal 8.28%, antacids 5.96%, laxatives 4.97%, food supplements 4.30%, and others 13.58%
25	Tobaiqi et al. (55)	Saudi Arabia	CS	General people	281	2020.7–2020.9	Treatment for specific symptoms	58%	Analgesics 42.9%, antibiotic 14.1%, herbs 13.5%, vitamins 9.2%, eye drops 6.1%, antacid 4.9%, roquia treatment 2.5%, laxatives 0.6%, and other 6.1%
26	Heshmatifar et al. (28)	Iran	CS	Older adult>60	342	2020	Prevention of COVID-19	56.4%	Pain reliever 52%, vitamins and supplements 47%, anti-cold 44%, sedative 42.6%, antibiotics 27.1%, gastrointestinal drugs 25.9%, and cardiac drugs 17%
27	Mulder et al. (61)	Netherlands	CS	General people	1,004	2020.5.22–2020.5.27	Prevention and treatment of COVID-19 and others	59.4%	Homeopathic remedies 10.2%, Bach flowers 4.1%, and Herbal medicine 19.0%: Echinacea, Passiflora, curcumin, red yeast rice (Xuezhikang), milk thistle (Silybum marianum), ashwagandha (Withania somnifera), cranberry, black cohosh, ginseng, and ginkgo biloba Vitamins/minerals 55.0%: Multivitamins, vitamin C, vitamin D, vitamin B, selenium, zinc, iron, magnesium, and calcium Other CM 14.0%: Omega 3, 6, 9, co-enzyme Q10, protein drink/shake, probiotics, and glucosamine-chondroitin-MSM

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TABLE 1 (Continued)

No.	References	Country	Study design	Sample population	Sample size	Collection period	Purpose of self-medication	Prevalence of self-medication %	Type of product used for self-medication
28	Elayeh et al. (57)	Jordan	CS	General people	1,179	2020.3.26–2020.4.16.	Prevention and treatment of COVID-19	80.4%	Antibiotics: azithromycin and doxycycline; Analgesics and antipyretics: paracetamol, ibuprofen, and diclofenac; Minerals: zinc, magnesium, and iron salts; Vitamins: vitamins C, D, and B and multivitamins; Herbals and supplements: propolis, omega 3 fatty acids, and immune boosting supplements; Antithrombotic drugs: aspirin and enoxaparin; Cold and cough preparations; Antihistamines; Others: antiseptic lozenges, nasal solutions containing normal saline or sea water, clove oil, and menthol rub.
29	Chopra et al. (38)	India	CS	General people with middle and high socioeconomic status	1,100	2020.5.1–2020.5.10	Anxiety	25%	NSAIDS 36%, antiulcer drugs 18%, H1 Anti-histaminics, 15%, multivitamins 7%, antimicrobials 6%, herbal drugs 3%, and hydroxychloroquine 1%
30	Azhar et al. (56)	Saudi Arabia	CS	General people	290	2020	Prevention of COVID-19	53%	Allopathic medicines: Azithromycin 21.5%, cough syrup 16.7%, soften 15.6%, disprin 5.2%, ivermectin 3.3%, dexa methasone 3%, and hydroxychloroquine 2.6% Herbals: Sana makhi tea 32.6%, green tea 4.8%, homeopathic medicines 3.3%, lemon tea 2.4%, ginger tea 2%, joshanda tea 1.6%, and tootsiah syrup 0.4% Vitamins: Vitamin C 27%, surbex Z 18.9%, vitamin D 18.5%, Tab. calcium 14.8%, multi-vitamins 2%, centrum 0.4%, and folic acid 0.4%

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TABLE 1 (Continued)

No.	References	Country	Study design	Sample population	Sample size	Collection period	Purpose of self-medication	Prevalence of self-medication %	Type of product used for self-medication
31	Amuzie et al. (79)	Nigeria	CS	General people	469	2021.10–2021.11	Prevention and treatment of COVID-19	30.3%	Herbal products 43.7%, anti-malarials (ACTs) 34.5%, vitamin supplements 28.2%, azithromycin 23.9%, ivermectin 12.7%, analgesics 12%, calcium supplement 8.5%, hydroxychloroquine 8.5%, and ciprofloxacin 4.9%
32	Okoye et al. (80)	Nigeria	CS	Health care professionals	669	2021.3–2021.4	Prevention and treatment of COVID-19	36.3%	Ivermectin 9.5%, azithromycin 9.1%, vitamin C 7.4%, chloroquine 5.7%, and zinc sulfate 2.0%
33	Acharya et al. (58)	Nepal	CS	Medical students and staffs	383	2021.11.1–2021.11.30	Prevention and treatment of COVID-19	50.4%	Paracetamol 18.9%, vitamin C 18.6%, zinc 12.7%, multivitamins 11.1%, vitamin D 9.6%, azithromycin 8%, cough syrup 7.8%, ibuprofen 6.8%, calcium 3.2%, ivermectin 1.2%, montelukast 0.7%, dexamethasone 0.6%, chloroquine 0.3%, and other 0.4%

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TABLE 1 (Continued)

No.	References	Country	Study design	Sample population	Sample size	Collection period	Purpose of self-medication	Prevalence of self-medication %	Type of product used for self-medication
34	Gaviria-Mendoza et al. (68)	Colombia	CS	General people	397	2020.6.30–2020.9.14	Prevention of COVID-19 and treatment for specific symptoms	34.3%	Nervous system: Analgesics 86.0%, acetaminophen 85.3%, and other (psycholeptics and psychoanaleptics) 5.9% Musculoskeletal system: Anti-inflammatory and anti-rheumatic products 47.1%, muscle relaxants 3.7% Respiratory system: Antihistamines for systemic use 26.5%, cough and cold preparations 24.3% Alimentary tract and metabolism: Vitamins 21.3%, drugs for acid-related disorders 16.9%, and other (drugs for constipation, anti-diarrheals, etc) 6.6% Anti-infectives for systemic use: Anti-bacterials for systemic use 12.5%, anti-mycotics for systemic use 2.2% Blood and blood forming organs (antithrombotic agents) 13.2% Antiparasitic products, insecticides, and repellents: Antiprotozoals 3.7% and anthelmintics 2.9% Other: Systemic hormonal preparations 2.2%, cardiovascular system 1.5%, dermatologicals 0.7%, and other (natural products) 19.1%

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TABLE 1 (Continued)

No.	References	Country	Study design	Sample population	Sample size	Collection period	Purpose of self-medication	Prevalence of self-medication %	Type of product used for self-medication
35	Rafiq et al. (44)	Pakistan	CS	General people	920	2020.3–2020.8	Treatment for specific symptoms	Total 63.7% Among adults 67.3% Among teenagers 46.9%	NR
36	Vasquez-Elera et al. (66)	Peru	CS	Patients hospitalized in COVID-19 areas of the Cayetano Heredia Hospital who self-medicated before admission.	301	2020.5–2020.6	Treatment of COVID-19	54.8%	Ivermectin 85.5%, azithromycin 71.5%, corticosteroids 46.7%, and NSAIDs 31.5%
37	Wegbom et al. (81)	Nigeria	CS	General people	461	2020.6–2020.7	Prevention and treatment of COVID-19	41%	Vitamin C and multivitamin 51.8%, other antimalarial drugs 47.1%, amoxicillin 24.9%, ciprofloxacin 14.6%, herbal products 10.2%, metronidazole 8.5%, erythromycin 5.3%, and hydroxychloroquine and chloroquine 3.2%
38	Quispe-Cañari et al. (67)	Peru	CS	General people	3,792	2020.6.5–2020.6.17	Prevention and treatment of COVID-19	33.4%	Acetaminophen 27%, ibuprofen 7.4%, azithromycin 4.8%, penicillin 2.3%, antiretrovirals 1.6%, and hydroxychloroquine 0.7%
39	Yasmin et al. (10)	Pakistan	CS	Medical Students	489	2021.1.25–2021.2.20	Prevention and treatment of COVID-19	83%	Paracetamol 65.2%, multivitamins 56.0%, ibuprofen 29.0%, cetirizine 27.8%, azithromycin 25.6%, hydroxychloroquine 8.8%, antivirals 7.2%, ivermectin 4.5%, doxycycline 3.9%, and others 11.4%
40	Zhang et al. (72)	Australia	CS	General people	2,217	2020.3.16–2020.4.1	Prevention of COVID-19	19.5%	Antibiotics
41	Makowska et al. (8)	Poland	CS	General people	1,013	2020.6.8–2020.6.15	Prevention of COVID-19 and others	45.6%	NR
42	Ceulemans et al. (62)	Ireland, Norway, Switzerland, The Netherlands, and United Kingdom (UK)	CS	Pregnant and Breastfeeding Women	7,260	2020.6.16–2020.7.14	No specific indication	Pregnant women: 22.0% Breastfeeding women: 16%	Medications, folic acid, multivitamins, iron-containing preparations, omega-3 fatty acids, and other products (including but not limited to pre- and probiotics, herbal remedies and homeopathic products)

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TABLE 1 (Continued)

No.	References	Country	Study design	Sample population	Sample size	Collection period	Purpose of self-medication	Prevalence of self-medication %	Type of product used for self-medication
43	Alonso-Castro et al. (69)	Mexico	CS	Population with symptoms associated with anxiety and depression	2,100	2020.3–2020.6	Anxiety and depression	61.9%	Orange blossom ($n = 524$), chamomile ($n = 508$), valerian ($n = 419$), tilia ($n = 360$), passion flower ($n = 353$), cinnamon ($n = 171$), ginkgo ($n = 153$), toronjil ($n = 134$), hierba de San Juan ($n = 110$), aloysia citrodora ($n = 90$), and marijuana (n=44)
44	Karataş et al. (47)	Turkey	CS	General people	389	2020.4.1–2020.4.30	Prevention of COVID-19	39.3%	Herbal medicines 30.8% and nutritional supplements/vitamins 23.8%
45	Ruiz-Padilla et al. (70)	Mexico	CS	General people	16,724	2020.3–2020.11	Prevention of COVID-19	35.3%	Acetaminophen, aspirin, ibuprofen, dexamethasone, hydroxychloroquine, chloroquine, azithromycin. ivermectin, chlorine dioxide, transfer factor, green tea, zinc, vitamin C, lemon, curcuma, ginger, propolis, and ginseng
46	Ahmed et al. (50)	Bangladesh	CS	General people	1,222	2020.6.27–2020.7.20	Prevention of COVID-19 and treatment for specific symptoms	NR	Allopathic medicines 15%: Arsenicum album 30.4%, vitamin supplements (vitamin C, D, B, and multivitamins) 27.1%, mineral supplements (mostly zinc) 19.9%, paracetamol 16.0%, antihista, mines (fexofenadine, desloratadine, and chlorpheniramine) 11.6%, antiasthmatics (mostly montelukast) 8.8%, and ivermectin 5.5%, Herbal 56.7%: Tea (normal and herbal) 70.9%, ginger 56.5%, black seed 32.8%, honey 30%, clove 28.8%, cinnamon 23.0%, garlic 16.9%, lemon 13.6%, black pepper 8.8%, cardamom 2.8%, bay leaf 2.1%, and tulsi 1.8%

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TABLE 1 (Continued)

No.	References	Country	Study design	Sample population	Sample size	Collection period	Purpose of self-medication	Prevalence of self-medication %	Type of product used for self-medication
47	Kristoffersen et al. (63)	Norway, Sweden and the Netherlands	CS	General people	2,494	2020.4–2020.6	Prevention or treatment of COVID-19 and treatment of COVID-19 related symptoms	62.8%	Herbs 18.2%: Ginger 6.8%, curcumin 5.8%, garlic 4.2%, green tea 4.0%, herbal tea 4.0%, cranberry 3.9%, blueberry/blueberry extract 3.5%, oregano 2.6%, echinacea 2.1%, aloe vera 2.0%, ginseng 1.8%, red yeast rice (xuezhikang) 1.8%, rhodiola rosea 1.0%, passiflora 0.7%, ginkgo biloba 0.6%, Indian ginseng 0.5%, actaea racemosa (black cohosh) 0.5%, chaga 0.3%, lady's thistle 0.2%, and Other herbs 3.1% Vitamins and minerals 49.9%: Vitamin D 21.2%, Multivitamins 17.5%, Vitamin C 15.7%, Magnesium 11.4%, Vitamin B 7.8%, Calcium 4.7%, Iron 4.2%, Zinc 2.7%, Selenium 1.1%, and Other vitamines and minerals 5.3% Homeopathic remedies 4.7% Bach flower remedies 2.3% Dietary supplements 29.2%: Omega 3, 6, or 9 including cod liver oil 22.2%, Protein shake 4.5%, Probiotic 3.1%, Glucosamine 1.9%, Q10 0.8%, and Other dietary supplements 2.5%
48	Mutua et al. (73)	Kenya	CS	The pharmacy customers and the pharmacy workers	80	2020.6–2020.7	Treatment for specific symptoms	78%	Anti-pyre-tics, NSAIDS, antibiotics, sedatives and hypnotics, nutritional supplements, and herbal/traditional medicines
49	Farooq et al. (39)	India	CS	Dental students and interns	100	2021.9–2021.11	Treatment for specific symptoms	34.4%	Acetaminophen 41.9%, combination of paracetamol, propyphezone & caffeine 18.3%, ibuprofen 14%, aspirin 8.6%, diclofenac 3.3%, mefenamic acid 3.2%, and ketoprofen 1.1%

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TABLE 1 (Continued)

No.	References	Country	Study design	Sample population	Sample size	Collection period	Purpose of self-medication	Prevalence of self-medication %	Type of product used for self-medication
50	MCPS and Malik (45)	Pakistan	CS	Dental patients	451	2020.9.20–2020.12.5	Dental problem	86.25%	Pain relievers 68.5%, antibiotics 35.5%, other 18.6%, and steroids 6.5%
51	Aitafo et al. (82)	Nigeria	CS	Health workers	220	2021.1.2–2021.3.2	Prevention and treatment of COVID-19	15.9%	Vitamin C 97.1%, zinc 80.0%, azithromycin 68.6%, anti-malarials (not hydroxychloroquine) 45.7%, hydrochloroquine/chloroquine 34.3%, multivitamins 31.4%, combination of antibiotics 14.3%, amoxicillin/clavulanic acid 8.6%, erythromycin 5.7%, amoxicillin 5.7%, ciprofloxacin 2.9%, and metronidazole/flagyl 2.9%
52	Ikiisik et al. (48)	Turkey	CS	Older adult >65	390	2021.2.22–2021.3.19	Prevention of COVID-19 and treatment for specific symptoms	48.7%	Analgesics 75%, anti-gribal 14%, antibiotics 5.7%, and vitamin 5.2%
53	Nasir et al. (51)	Bangladesh	CS	General people	626	2020.4–2020.5	Prevention of COVID-19 and treatment for specific symptoms	88.33%	Ivermectin 77.15%, azithromycin 54.15%, montelukast 43.13%, calcium supplements 41.37%, doxycycline 40.25%, hydroxychloroquine 20.44%, zinc 19.81%, and vit-d 13.58%
54	Alavi Namvar et al. (29)	Iran	CS	Dental patients	306	2020.10–2021.4	Dental problem	53.9%	Ibuprofen 23.6%, salt and water mouthwash 20.9%, amoxicillin 17.7%, acetaminophen 10.7%, metronidazole 2.9%, novafen 2.7%, mefenamic acid 1.9%, penicillin 0.3%, and others (herbs, garlic, onion, honey, lime juice, local analgesics, local salt, lidocaine, and Dentol) 19.3%
55	González-González et al. (71)	Mexico	CS	University students	284	2021.2–2021.4	Prevention of COVID-19	20.4%	Vitamins 53.9%, medicinal drugs 17.1%, herbal 10.5%, alcohol 6.6%, chlorine dioxide 3.9%, and others 7.9%

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TABLE 1 (Continued)

No.	References	Country	Study design	Sample population	Sample size	Collection period	Purpose of self-medication	Prevalence of self-medication %	Type of product used for self-medication
56	Chellappan et al. (40)	India	CS	General people	478	2020.9.1–2020.11.30	Prevention of COVID-19	84.5%	Home remedies 50.2%, Allopathy 46.3%: Vitamins and other dietary supplements 51.7%, medication to reduce fever 14.1%, antibiotics 12.1%, hydroxychloroquine 7.2%, painkillers 4.2%, ivermectin 3%, other medication 7%; homeopathy 32.2%, ayurveda 16.6%, naturopathy 4.5%, siddhi 3.5%, unani 0.5%, and other systems 0.2%
57	Likhar et al. (41)	India	CS	Medical students	394	NR	No specific indication	73.85%	Allopathy 43.65%: antibiotics 53.04%, anti-pyrectics 17.25%, anti-fungal 3.29%, anti-malarial 0.2%, any other 30.20%; homeopathy 8.12%, ayurvedic 7.86%, mixed 11.42%
58	Sujan et al. (52)	Bangladesh	CS	COVID-19 recovered patients	360	2020.9–2021.2	Prevention/treatment of COVID-19	11%	Paracetamol 30.6%, herbal products/drugs 30%, and antibiotics 29.7%
59	Mir et al. (11)	India	CS	General people	168	2021.5	Treatment of COVID-19-like symptoms	59.9%	Paracetamol 85.0%, azithromycin 58.0%, cough syrup 30.0%, ivermectin 18.0%, doxycycline 16.0%, ibuprofen 13.0%, dexamethasone 7.0%, hydroxychloroquine 4.0%, famotidine 3.0%, penicillins 3.0%, remdisivir 2.0%, budesonide inhalations 1.0%, and others 19.0%
60	Gerbier et al. (64)	Norway, Belgium, Switzerland, the Netherlands, and the United Kingdom	CS	Pregnant and postpartum women	5210	2021.6.10–2021.8.22	No specific indication	Pregnant women: 18.0% Postpartum women: 22.5%	Pregnant women: paracetamol 32.8%, alginic acid 5.2%, ordinary salt combinations as antacids (combinations of calcium, aluminum, and magnesium) 4.6%; Postpartum women: paracetamol 76.6%, ibuprofen 29.2%, and cetirizine 4.1%

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TABLE 1 (Continued)

No.	References	Country	Study design	Sample population	Sample size	Collection period	Purpose of self-medication	Prevalence of self-medication %	Type of product used for self-medication
61	Dehghan et al. (30)	Iran	CS	General people	782	2020.4.20–2020.8.20	No specific indication	84%	Medicinal herbs 48.8%: chamomile, thyme, ginger, mint, cinnamon, Imam Kazim medicine (a mixture of myrobalan, fennel, and brown sugar), hollyhocks, lavender, pennyroyal, buttercup, jujube, rosemary, viper's-buglosses, fennel, and a mixture of apple cider vinegar and honey Nutritional supplements 61.3%: vitamin D, vitamin C, multi-vitamin, and others, including vitamin B6, vitamin B complex, vitamin E, zinc, calcium, iron, omega-3, and folic acid, or a combination of supplement
62	Johora et al. (53)	Bangladesh	CS	Medical Students	916	2020.10.1–2020.10.31	Prevention of COVID-19 and treatment for specific symptoms	51.6%	Paracetamol 88.37%, anti-histamine 48.20%, vitamin C 39.96%, zinc 31.08%, ORS 20.51%, NSAIDs 20.30%, vitamin D 19.03%, vitamin E 15.01%, montelukast 14.16%, calcium 13.95%, anti-ulcerants 9.73%, sedatives 9.30%, anti-emetics 9.10%, bronchodilators 5.71%, antispasmodic 4.65%, antitussive 4.02%, herbal 3.17%, oxygen 0.63%, and others 5.50%

Abbreviations: CS, cross-sectional study; NR, not reported.

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prevention of COVID-19, treatment of COVID-19, and post-recovery prevention of COVID-19. Thirteen articles discussed self-medication behaviors to treat specific symptoms during the pandemic, but not limited to COVID-19 disease. Four articles considered self-medication during the COVID-19 pandemic in terms of psychological problems, another four discussed dental problems, and six articles did not clearly express the purpose of self-medication.

Altogether, 29 studies reported indications for self-medication. The most common condition was respiratory symptoms/infections, with seven studies referring to this general category. The corresponding specific symptoms included cold/flu ($n = 7$), cough ($n = 15$), runny nose ($n = 7$), nasal congestion ($n = 3$), rhinitis ($n = 1$), and sore throat ($n = 13$). Following were fever/any high body temperature ($n = 21$), body ache or joint and muscle pains ($n = 20$), headache or migraine ($n = 14$), gastrointestinal symptoms ($n = 9$) including diarrhea, vomiting, gastritis, and loss of taste and smell ($n = 6$). Other areas covered dental problems ($n = 6$), sleep problems ($n = 4$), allergy ($n = 4$), fatigue ($n = 5$), superficial wound/skin rash ($n = 2$), urinary tract infection ($n = 1$), and dysmenorrhea ($n = 1$; Table 2).

TABLE 2 Major health conditions managed with self-medication during COVID-19 pandemic.

Condition	No. of studies	References
Any high body temperature/fever	21	(10, 11, 33, 35, 37, 40, 42–44, 51, 53–58, 66, 67, 73, 76, 77)
Joint and muscle pains/body ache	20	(9–11, 28, 33, 38–40, 42, 43, 51, 53, 55–58, 67, 68, 73, 76)
Cough	15	(10, 11, 33, 37, 40, 42, 43, 51, 53, 55, 56, 58, 66, 67, 76)
Headache and migraine	14	(9–11, 28, 33, 38, 39, 42, 43, 53, 55, 66, 67, 76)
Sore throat	13	(10, 11, 28, 40, 43, 51, 53, 55–58, 67, 76)
Diarrhea	9	(33, 43, 44, 51, 53, 56, 58, 66, 76)
Cold/flu	7	(33, 37, 39, 40, 42–44)
Running nose/Sneezing	7	(9–11, 40, 53, 55, 67)
Respiratory infection/symptom	7	(10, 42, 66–68, 73, 77)
Loss of smell and taste/anosmia	6	(10, 51, 53, 56, 58, 66)
Dental problem	6	(12, 29, 39, 45, 46, 55)
Weakness and lethargy/fatigue	5	(10, 28, 40, 53, 67)
Allergy	4	(42–44, 76)
Nasal congestion	3	(10, 11, 67)
Sleeping problem	4	(38, 42, 53, 76)
Vomiting	4	(33, 53, 66, 76)
Superficial wound/skin rash	2	(53, 73)
Rhinitis	1	(44)
Gastritis	1	(76)
Neurological diseases	1	(28)
Cardiovascular disorders	1	(28)
Pseudo corona symptoms	1	(28)
Systemic symptoms	1	(68)
Urinary tract infection	1	(42)
Dysmenorrhea	1	(73)

3.3.3. Types of medications frequently used in self-medication

The type of drug used for self-medication was reported in mostly all articles, with only eight articles failing to do so. Of the remaining studies, 18 studies didn't specify agents but instead supplied category terms, such as antibiotics, analgesics, herbal products, vitamins, and dietary supplements, in contrast to 36 studies that provided the precise names of agents, such as amoxicillin, ibuprofen, and vitamin c. A significant amount of research investigated multiple types of self-medication, while a few studies ($n = 7$) were limited to specific types of self-medication conditions, such as the use of antibiotics, painkillers, herbal medicines, and chlorine dioxide. The specific types of medications for each literature are described in detail in Table 1.

In included studies, antibiotics ($n = 35$) were the most frequently mentioned class of drugs, followed by herbs and natural products ($n = 25$), vitamins ($n = 23$), analgesics and antipyretics ($n = 21$), dietary supplements ($n = 19$), and minerals ($n = 17$; Table 3). Also common are anti-malarials ($n = 16$), antihistamines ($n = 12$), ivermectin ($n = 12$), and cough suppressants ($n = 9$). Furthermore, preferences for use varied across studies. According to the questionnaire results from different studies, painkillers like paracetamol, acetaminophen, or vitamins like vitamin C were always the most frequently used drug classes in the responses (Table 1). However, according to two research from Nigeria (79) and Turkey (47), herbal medicines were shown to be the most popular type of medication. In a similar vein, three surveys (51, 66, 80) discovered that ivermectin was the drug used for self-medication the most commonly.

3.3.4. Major reasons for the practice of self-medication

Thirty-three of the included studies mentioned the reasons for self-medication. In relation to the pandemic, we found that the most common reasons for self-medication included fear of infecting with the virus, difficulty in accessing health services during the pandemic, and poor health system services. Several studies reported that individuals self-medicated in order to treat or prevent COVID-19 disease, boost immunity, and lessen anxiety associated with the pandemic. Affected by the policies of COVID-19 pandemic, a number of people also indicated that they self-medicated often based on lockdown, fear of isolation, and fear of stigma.

Of the general causes, the financial factor was the most prevalent, and was reported by half of the studies that described the

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TABLE 3 Categories of medicinal agents used for self-medication.

Drug class	Names of specified medications in the studies
Prescription medicines and over-the-counter products	
Antibiotics ($n = 35$)	Amoxicillin, azithromycin, metronidazole, penicillin, cefixime, doxycycline, clindamycin, ciprofloxacin, and erythromycin
Analgesics and Antipyretics ($n = 21$)	Diclofenac, acetaminophen/paracetamol, aspirin, ibuprofen, mefenamic acid, and ketoprofen
Antimalarial ($n = 16$)	Chloroquine, hydroxychloroquine, and artemisinin
Antihistamines ($n = 12$)	Piriton, cetirizine, fexofenadine, desloratadine, chlorpheniramine, and famotidine
Anthelmintics ($n = 12$)	Ivermectin
Cough syrup/suppressants ($n = 9$)	
Antacids ($n = 6$)	
Corticosteroids ($n = 5$)	Dexamethasone
Sedative ($n = 4$)	
Antivirus ($n = 2$)	Remdisivir
Antithrombotic ($n = 2$)	Aspirin and enoxaparin
Antiemetic ($n = 2$)	
Laxatives ($n = 2$)	
Traditional and complementary medicine	
Herbs and natural products ($n = 25$)	Lingzhi, Yinqiao Jiedu Pian, Radix Isatidis, Glycyrrhizae Radix Et Rhizoma, Chrysanthemi Flos, ginseng, red yeast rice, milk thistle, black cohosh, ginkgo biloba, oregano, aloe vera, rhodiola rosea, echinacea, curcumin, ashwagandha, ginger, honey, eucalyptus, cranberry, propolis, green tea, lemon, and garlic
Vitamins ($n = 23$)	Vitamin C, vitamin B, vitamin D, vitamin E, and multivitamins
Dietary supplements ($n = 19$)	Omega 3, 6 or 9 including cod liver oil, probiotics, glucosamine, melatonin, co-enzyme Q10, and protein drink/shake
Minerals ($n = 17$)	Zinc, selenium, iron, magnesium, and calcium
Homeopathic remedies ($n = 5$)	
Bach flowers remedies ($n = 2$)	
Other	
Chlorine dioxide ($n = 3$)	

reasons for self-medication. The remaining usual reasons involved time saving, previous relevant experience, minor illness, distance to health facilities, the suggestion of others, and emergencies. A portion of the research also addressed reasons related to the doctor-patient relationship. In eight studies, participants exhibited distrust of government health institutions or experienced negative experiences with doctors or were unwilling to go to health institutions. In terms of medication knowledge, a few studies indicated that people preferred to self-medicate due to sufficient knowledge of medications, while another study on the other hand revealed that people decided to self-medicate as they were unaware of the adverse effects of the drugs.

Table 4 shows the reasons that drove people to practice self-medication as reported in each study.

3.3.5. Factors associated with practice of self-medication

Factors associated with self-medication practices were characterized in 39 studies in terms of sociodemographic, anthropological, and pandemic-based data. Table 5 shows how factors like age, gender, education, marital status, occupational status, field of occupation, family income, geography, insurance, socioeconomic status, health status, anxiety, prior self-medication experience, knowledge and attitude toward self-medication, drug use habits, and perception regarding the COVID-19 pandemic correspond with different levels of self-medication habits among research participants.

Gender, age, and education were the most frequently reported factors, which all show contradictory results. Two studies observed that younger age was positively associated with self-medication behavior (39, 72) in contrast to six other studies showing that older age was a favorable correlate for engaging in self-medication (31, 34, 69, 75, 79, 80). Six studies reported that female gender was actively involved in self-medication (10, 31, 34, 69, 70, 74) while three studies observed a higher propensity for male gender (65, 66, 72). With respect to education level, four studies yielded a higher likelihood of self-medication at lower education levels (32, 69, 70, 79), whereas three studies produced results that higher education levels were more likely to self-medicate (31, 72, 74). Working in

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TABLE 4 Major reasons for the practice of self-medication.

Reason for self-medication		No. of studies	References
COVID-19 related reasons			
Accessibility	Poor access to doctor	10	(29, 33, 42, 46, 48, 55, 56, 59, 64, 68)
	Poor access to health facilities service	9	(29, 53, 55, 59, 68, 73, 79, 81, 82)
	Poor access to medicine in health facilities	2	(81, 82)
	Lockdown	4	(31, 32, 54, 60)
Fear to get COVID-19	Fear of getting contact to virus	12	(29, 31, 33, 39, 42, 55, 56, 59, 67, 68, 79, 82)
	Fear of COVID-19 test	2	(73, 82)
	Fear of being stigmatized or discriminated	2	(81, 82)
	Fear of self-isolation/Quarantine	2	(81, 82)
	Strengthening the immune system	4	(31, 32, 54, 60)
Treatment	To prevent or treat COVID-19 disease	7	(10, 28, 32, 60, 67, 79, 80)
	Treating COVID-19-related anxiety and stress	2	(31, 60)
General reasons			
Affordability	High fees/save money on going to the doctor/economic/to save money	17	(28, 29, 33, 37, 41–43, 46, 48, 53, 55, 56, 68, 76, 77, 81, 82)
	The lack of insurance coverage	1	(28)
Personal mobility	Time wastage/to save time/lack of time	12	(29, 33, 39, 42, 46, 48, 53, 68, 76)
Health knowledge	Previous knowledge regarding the problem/previous experience with complaints so that you know how to treat them/previous satisfaction with the medicine	11	(28, 33, 37, 41–43, 52, 53, 55, 68, 76)
	Sufficient knowledge about drugs	2	(53, 76)
	The lack of knowledge about the adverse effects of the drug	1	(28)
Health beliefs	Due to minor problem/disease was not serious/mildness of illness	10	(28, 29, 33, 39, 42, 43, 48, 53, 76, 77)
	It is habit of yours/consume it regularly	4	(10, 56, 59, 67)
	Felt no need to consult a physician	1	(37)
Availability	Too far from the health institution/the location of the health service facility/there is no transportation	8	(28, 33, 41, 55, 68, 76, 81, 82)
	Emergency/to get quick results	6	(37, 41, 52, 53, 81, 82)
	Easy access to medicines (available at home, cheap drugs, over-the-counter sales in pharmacies)	3	(28, 76, 81)
	Lack of effectiveness of doctors' medicine	2	(56, 73)
	Not eligible for treatment	1	(55)
Advice from others	Pharmacist advice/recommended by others, pharmacy, media/Friend, social media, TV, radio program influenced your decision to self-medicate	7	(28, 43, 55, 64, 73, 79, 81)
Negative attitudes toward health services	No faith in government health facilities/I do not trust doctors	6	(28, 37, 55, 59, 68, 73)
	Bad experience with doctor	1	(56)
	Unwillingness to attend a health care facility/use time from a healthcare professional	1	(64)
Personal health management	Treatment acute or chronic illness/reduce the disease symptoms	4	(31, 32, 60, 61)
	Support respondents' activity/to increase physical performance	2	(32, 60)
	Improving general wellbeing	1	(61)
	Psychological assurance	1	(80)

TABLE 5 Factors associated with self-medication.

Factor	No. of studies	References
Demographics		
Gender	20	Female (10, 31, 34, 69, 70, 74) Male (65, 66, 72) Gender (30, 38, 41, 43, 47, 50, 55, 57, 60, 61, 81)
Age	18	18–24 (76); younger (72); adult age (66); 23–28 (39); adult and older adult (>29 years) (65); 25–34 (76); >40 years (69, 79); >35 to 55 (31); >55 (31); more than 60 years old (75); older age (34, 80); The younger and older working mothers (32); Age (41, 44, 47, 50, 57, 67)
Education	18	None/primary (79) Low educational level (elementary and middle school) (69, 70) High school (32) Secondary level (74, 79) Higher diploma, degree or above (31) University level (74) More educated (72) Education (28, 29, 40, 43, 45, 47, 50, 55, 61, 81, 82)
Marital status	10	Single (69, 76) Marital status (30, 38, 47, 48, 50, 57, 80) Widowed/separated (79)
Work/study sector	8	Working in the health sector (74) Occupation (Government employee) (76) Work in the medical field (57) Being pharmacist (80) Health profession (72) Status designation (61) Place of practice (82) Faculty (60) Field of study (43)
Income and expenses	7	Higher income (32, 80) Fewer family expenses (32) Income (43, 47, 52, 75, 82)
Employment	6	Unemployment (69, 75) Profession (44) Currently have a job (67) Occupation (52, 82)
Region	5	(30, 43, 52, 61, 75)
Anxiety	5	Anxiety (34, 38, 60) Psychological distress (72) Being diagnosed with mental illness (69) The use of psychiatric medication (69)
Symptoms	5	The experience of COVID-19 symptoms (60, 78) Cough and flu symptoms (44, 66) Anosmia (66) Dyspnea (66) Dysgeusia (66) Nausea/vomiting (66) Gastroesophageal reflux (66) Dental complaint: Pain (12) Pus and abscess (12)
Grade level (for the student population)	4	(10, 41, 43, 60)
Health status	4	Healthy (9) Self-reported health as good (10) Number of times you fell ill during COVID-19 (44) Number of medications used every day (48) Use of canes/crutches (48)
Family factor	4	Household size: 6 and more (75) Having a health sciences student within the family (65) Having children under 18 in a household (8) Having children (30)

(Continued)

TABLE 5 (Continued)

Factor	No. of studies	References
Comorbidity	3	The presence of a comorbidity (44, 65) Diabetes mellitus (80)
Life habits	3	Undertook physical activity (9) Diet (60) Smoking (66)
Insurance	2	Insurance coverage (28) Having private health insurance program (69)
Socioeconomic status	2	Low socioeconomic status (45, 70)
Religion	2	Have a religious affiliation (8, 31)
Work time	1	Worked on day shift (9)
Ethnicity	1	(76)
Self-medication behavioral aspects		
History of use	4	History of use TCIM (31, 47) Have previous history of self-medication (52) Number of times taking antibiotics in the past year (72)
Knowledge	4	Poor knowledge about SM (76) Knowledge about SM (60, 72, 81)
Attitude	3	Thinking that chlorine dioxide is not effective (65) Not being informed of the efficacy of chlorine dioxide (65) Your opinion for opting for self-medication during COVID-19 (44) Likelihood of self-medication within next 6 month (29)
Irrational drug use habits	3	Storing medications at home (48, 68) Forget drug use (48) Confuse medication time (48) Having recommended medications to other people (48, 68) Addicted to drugs (30)
Information source	3	Trusted information (ref: Thai govt.) (34): friends/family, doctors online, and foreign countries Having medical information as a source of information about COVID-19 (65) Friends as a source of information (30)
Use of other substances (for self-medication for specific drugs)	3	Medications (65) Plants (65) Use prescription medication (83) Consumption of drugs (69)
Access	1	Took leftover antibiotics (72) Easily acquire antibiotics from friends/family (72) Easily acquire from doctor (72) Asked doctor for antibiotics (72)
Price	1	The perception of self-medication as cheap (79)
COVID-19 context		
Consideration of COVID-19	10	COVID-19 pandemic (12) Worries getting infected with COVID-19 (61, 63) Being infected with coronavirus (57), Having any close family member infected with coronavirus (57) Previous COVID-19 testing (30, 80) Those previously infected with COVID-19 (10) Avoid going to the clinic/hospital due to COVID-19 (44, 73) Afraid of the pandemic (50)
Perceived susceptibility	2	Strongly considering COVID-19 to be a dangerous and deadly disease (65) Personal sensitivity (83)
Face masks	1	Taking off face masks in enclosed public places (83) Frequent face-mask use (83)

the medical/health field was revealed to be a favorable predictor of self-medication in 4 studies (57, 72, 74, 80). Two studies reveal a significant relationship between self-medication and insurance coverage (28, 69). Additionally, individuals in two studies with lower socioeconomic position showed a greater propensity for self-medication (45, 70).

There are 10 studies identifying relationships between COVID-19 and self-medication (10, 12, 30, 44, 50, 57, 61, 63, 73, 80). Afraid of the pandemic, fear of being infected, being previously infected, previous COVID-19 testing, and avoiding going to the hospital due to COVID-19 were all factors affecting self-medication. Sources of pharmacological information (30, 34, 65), drug use habits (30, 48, 68), and drug accessibility (72) all have an impact on self-medication.

3.3.6. Sources of medication products and information/recommendation

Twenty-four studies observed sources of information regarding self-medication. Medication information regarding self-treatment came from a diverse range of sources, of which friends/relatives ($n = 22$) and social platforms/networks ($n = 21$) were the most dominant. Healthcare professionals were also a key component of the sources of information about self-medication ($n = 15$), including physicians, pharmacists, nurses and herbalists. Other sources of information included old prescriptions, academic knowledge available from scientific websites/books/research articles, news/TV/radio/advertising, product's brochures, as well as own judgment. In several of the individual research, government agency such as ministry of health help center, cultural influences, and illegal prescribing were also mentioned.

Eighteen researches provided data on the primary sources of products used to treat self-medication. Pharmacies were listed as a purchase channel in all of the publications. Sources of medication acquisition in public setting also included hospitals ($n = 3$), primary health facilities ($n = 3$), private clinics ($n = 1$), stores/shops ($n = 2$), and herbalists ($n = 2$). From the perspective of one's medication habits, numerous investigations discovered that access to medications included relatives and friends ($n = 7$), leftovers at home ($n = 8$), and homemade ($n = 1$). Five research cited online resources, including telemedicine and online pharmacies. Meanwhile, a few studies also identified irregular channels for people to obtain medications such as patent medicine vendor ($n = 3$), hawkers ($n = 1$), and faith-based outlets ($n = 2$).

3.3.7. Knowledge and attitude about self-medication

The majority of the articles that discussed respondents' knowledge of self-medication revealed a moderate or high level of good knowledge. According to a research from Kenya, during the outbreak, knowledge of the dosage, mode of administration, and adverse effects of purchased medicines climbed to 75% (9). The report from Iran shows that only 20% of patients with poor knowledge level about antibiotics (27). In terms of knowledge about adverse effects of self-medication, <½ of the parents (42.7%) reported limited knowledge about side effects in Turkey (46). Of these parents, 103 (62%) believed that the medication caused negative consequences on the gastrointestinal system. In a group of students, Merwid-Lad et al. observed that their knowledge of dietary supplements was rated as moderate or high (60). In four studies assessing self-medication knowledge, the proportion of participants with good awareness was 47.6, 57.4, 58.6, and 96.7%, respectively (52, 68, 76, 81). Amuzie et al. reported that virtually all respondents (97.7%) were aware of self-medication and more than three-quarters (88.4%) correctly defined it (79).

People's attitudes toward self-medication were mixed in the included studies. On the one hand, participants in several research reported that self-medication is unsafe and ineffective as well as not changing symptoms, while having negative long-term impacts on the body, like drug dependence, drug resistance, efficacy reversal and damage to body organs. On the other hand, respondents in some studies maintained a positive attitude toward self-medication. They claimed that they felt better physically or psychologically after self-medication and considered self-medication to be effective, beneficial and safe. Two articles also discussed the relationship between attitudes toward self-medication and COVID-19 pandemic. Onchonga et al. (9) reported that more than half (64.3%) felt that the COVID-19 pandemic necessitated self-medication and would continue self-medication post-COVID-19 pandemic (55.9%). 84.1% felt there was an increased desire for self-medication in the general population as a result of the pandemic. However, others (91.5%) thought that test for side effects should be performed before using Traditional Chinese Medicine in COVID-19 therapy (47).

3.3.8. Adverse drug reactions

A total of 14 articles have described the situation of adverse reactions to self-medication. The proportion of adverse drug reactions associated with self-medication ranged from 4.7 to 36%. Adverse reactions have been reported mainly involving the central nervous system (anxiety, irritability, insomnia, poor concentration, headache, dizziness, fatigue, and sleepiness) and the gastrointestinal system (nausea, vomiting, loss of appetite, diarrhea, bloating, constipation, and stomach pain or heartburn). Other symptoms included drug dependence, dry mouth, allergic reactions, and fungal infections.

3.4. Role of healthcare professionals at the community level

3.4.1. Pharmacist

A total of 12 articles mentioned pharmacists in various contexts. The content primarily covers sources of information about self-medication, suggestions for self-medication, and measures to take after adverse reactions due to self-medication, with one article exploring the role of pharmacist. When investigating the pharmacist's role in self-medication, it was found that respondents asked more frequently about three areas of medication advice, dose use and medication interval, and other areas included combination medication and side effects in self-medication in detail.

There are seven articles that discuss the role of pharmacists in advising on self-medication. The proportion of people who practiced self-medication on the advice of the pharmacist was similar across the three studies, ranging from 17 to 18% (46, 50, 60). In the study by Tobaiqi et al. (55), advice from pharmacists accounted for the third highest reason for self-medication, standing at 27%. In addition, about 19% of the respondents consulted

pharmacists about the use of the antibiotics such as dosage, duration, etc. However, the survey by Jiri et al. had a different finding in that pharmacists were infrequent (4.5%) among the sources of advice for self-medication as well as when asked where they obtained their knowledge regarding the hazards of self-medication, just 1.1% obtained it from pharmacists (29). The mean score for the question "it is sufficient for medicines to be prescribed by pharmacists" was moderate (about 4 on a scale of 1–7) as reported by Coman et al. (59). A study carried out on a group of university students in Pakistan found that the advice of the pharmacist was the most popular factor influencing their self-medication. When investigating the pharmacist's role in self-medication, it was found that respondents focused more on three areas of medication advice, dose use and medication interval, and other areas included combination medication and side effects. Furthermore, a subset of the participants received guidance from pharmacists on the side effects of medicines (43).

The function of pharmacists as a provider of self-medication information is inconsistent. For two studies (11, 57), in nearly half, pharmacists were used as a source of information about self-medication, while in the other three studies (31, 53, 73), only a minority of participants did so. Pharmacists can also perform a supporting role following self-medication practices. In a Kenyan study (9), 10.8% of participants decided to consult a pharmacist after experiencing an adverse medication event.

3.4.2. Other healthcare professionals

The role of other healthcare professionals was also described in different studies. Apart from pharmacists, the more commonly mentioned healthcare professionals were physicians including general practitioners and private doctors. Others included psychologist, psychiatrist, chiropractor, massage therapist, dietitian, nurse, and herbalist.

Six articles addressed the role of healthcare professionals in providing advice to individuals on their own use of medication. Participants in two of the studies approached their physicians for advice at similar rates [25% (50); 28.59% (51)]. In the Dehghan et al. study, a higher proportion consulted a physician before using dietary supplements (55%) than before using herbal medicines (33.3%) (30). Two more roles, similar to the previous subsection, were to provide a source of drug information and to deal with adverse events. The study by Mutua et al. said that only 4% received drug information from health practitioners or quacks (73). In the other article, 11.8% of participants indicated that they would take measures to seek a private doctor after an adverse reaction (9).

4. Discussion

4.1. Major contribution

This review provides a detailed overview of the practice of self-medication in different populations during the pandemic. A large volume of self-medication-related literature was yielded by our search, demonstrating a trend for researchers to spotlight self-medication in medical resource-limited settings like COVID-19 pandemic. To the best of our knowledge, it is the most thorough systematic review of self-medication during a COVID-19 pandemic to date. Self-medication behaviors performed in response to this as yet incompletely clarified COVID-19 disease require a great deal of attention, as do several self-medication situations occurring as a result of changes in the health care resource, environment and services associated with the pandemic. However, previous related systematic reviews limited their scope only to medication use in COVID-19 disease (21, 24, 25). Findings from our results show variations in the prevalence of self-medication reported across different country regions, with differences in the structure of health systems, access to over-the-counter medications, epidemiological policies between countries, as well as the population and purpose of each study influencing trends in self-medication. Moreover, approximately only a quarter of the studies we found addressed the role of health care professionals in guiding self-medication. In light of the potential risks associated with unregulated self-medication, the value of a comprehensive understanding of self-medication practice is even more pronounced.

4.2. Self-medication is a common practice during COVID-19 pandemic

The results of this review found that the behavior of higher self-medication during COVID-19 pandemic is of concern. Given the circumstances and structure of health systems, self-medication was a widespread practice in low- and middle-income countries and regions. Meanwhile, it was also observed that there was a higher proportion of self-medication behavior among groups that need more attention in society including general public, older adult and patients. Similar high prevalence rates have been reported in previous studies including pre-pandemic and pandemic periods (2, 3, 19, 21, 25, 84, 85). The heterogeneity caused by separate studies precludes straightforward comparisons. There were, however, a few articles in the available literature that compared self-medication before and after the pandemic. The studies conducted in Iran (12), Kenya (9), and Nigeria (77) all identified a trend of rising self-medication usage during the pandemic relative to the pre-pandemic period. This may relate to the accessibility of health services and the risk of infection in health care settings during the pandemic (12).

4.3. Concerns and benefits associated with self-medication during COVID-19 pandemic

Antibiotics, analgesics, vitamins and dietary supplements, herbal medicines were examples of the types of pharmaceuticals that are widely utilized for self-medication during the pandemic. The type of drugs used for self-medication is not without safety concerns. If used improperly, adverse and potentially harmful effects can occur. Paracetamol is primarily used to relieve pain and cold-related symptoms, while vitamin C is commonly utilized to boost the body's immune system (86). This review discovered that paracetamol/acetaminophen, as well as vitamin C, were frequently cited as the medications with the highest percentage of use in

the investigations. However, these two drugs will interact in the body, competing for the body's sulfate pool thereby lengthening the paracetamol residence time in the body, which potentially contributes to enhanced toxicity (87). Meanwhile, the review revealed that many research done tend to investigate only the class of pharmaceuticals used for self-medication without mentioning the specific drug ingredients. That may be because for the general public, as non-medical professionals, often rely on the brand name or the indication type of the drug to purchase. However, it is worth noting that antipyretics, cold or flu medications, and compounded medications may carry the same main ingredients which should not be taken together to avoid overdose resulting in hepatotoxicity (88). Excessive intake of vitamin C may cause side effects, which most specifically increase the risk of kidney stones (74).

Among the included studies, antibiotics were the most widely referred to medication ($n = 35$). The inappropriate utilization of antibiotics, encompassing self-medication with residual medications or acquiring them from unreliable sources, represents a significant healthcare concern (89). Individuals may turn to using leftover antibiotics from earlier treatment plans, which creates a hazardous scenario because antibiotics should only be used as directed and for the full period of the specified treatment (90). On the other hand, in many cases, antibiotics are not considered necessary in the treatment of certain symptoms or diseases (91). In the review, symptoms most commonly self-treated by respondents were found to be those related to the common cold and other upper respiratory tract infections (URTIs). Since viruses are primarily to blame for these symptoms, antibiotics shouldn't be used to treat them. Yet the current study showed that the use of antibiotics in such viral illnesses is widespread. This may contribute to the development of antibiotic resistance, thus posing a threat to global health.

The majority of individuals rely on family and friends as sources of drug information, followed by social media and Internet. With the advent of digitalization, people now have a simple access to the internet where they easily research their symptoms and discover what they believe to be the best course of action. However, there are evidence that healthcare misinformation linked to COVID-19 pandemic diffused at alarming rates on social media (92, 93). In addition, researchers have noticed that erroneous information regarding COVID-19 on social media is much more popular and challenging to block from spreading (94). The way that people interpret and respond to false information might vary depending on their environment and culture (95). These practices were risky and may have clinical consequences such as adverse reactions, drug-drug or drug-herb interactions, and antimicrobial resistance.

In this review, it should be emphasized that, other from the fear of infecting the virus, the reasons why people self-medicate for COVID-19 during the pandemic period included inaccessibility and unacceptability. Inaccessibility referred to difficulties in accessing services due to physicians' busy schedules; in terms of acceptability, the health system was perceived to be poorly served during COVID-19. Owing to the immense patient burden during the pandemic, most physicians lack sufficient time to interact well with patients. They tended to concentrate primarily on biomedical elements of body health while ignoring psychological aspects of care. When these conditions are combined with the other bottlenecks experienced throughout the health care delivery process in resource-limited settings, most patients leave the facility dissatisfied, reducing trust and acceptability of health care services (96), which negatively impact health care seeking behavior and lead to more self-medication behavior (97). Hence the government need to be aware of the problems in this area and make timely response solutions in future pandemics.

Before or during the pandemic, financial considerations, time considerations, and minor illnesses were discovered to be common causes of self-medication. Self-medication is a great option to get a more convenient and cheaper treatment for minor illnesses (15). Likewise, this is true for pandemics, where responsible self-medication practices can both prevent the crowding of medical resources and quicker control of the disease's progression. Therefore, more education and awareness measures will be needed to enable the public to better utilize the benefits and reduce the risks of self-medication.

4.4. Support is needed for safe practice of self-medication

The high prevalence of self-medication during the COVID-19 pandemic significantly highlighted the importance of maintaining counseling efforts and guidance on medication use, even in situations where health care services are disrupted and/or resources are limited. The WHO suggested that achieving "successful" self-medication in many countries would need increasing people's awareness and education in order to minimize the possible harm that could result from this practice (1). Similarly, the International Pharmaceutical Federation, in tandem with the World Self-Medication Industry (98), and the World Medical Association (99), emphasizes the responsible use of non-prescription medications. Also, self-medication as a key component of self-care. The FIP document (20) indicates that policies should more prominently reflect the benefits of self-care, especially demonstrating how self-care can improve health and wellbeing in complement with formal healthcare systems. Transforming passive patients into proactive participants interested in their own health management, leading to a revolution of the health care system from a disease system to a prevention system, is critical to the advancement of health care. A comprehensive understanding of this global concern will offer clues to the formulation of sound, effective, and efficient public health policies and guidelines to facilitate responsible self-medication and minimize the risks associated with self-medication. This study suggests that supporting responsible self-medication practices necessitates the participation of all key stakeholders and the long-term viability of strategic health promotion and education programs.

Considering the diverse information available to public, authorities need to strengthen pharmaceutical information dissemination as well as safety medication education. Akyol Onder and Ertan (100) suggested that dissemination of

factual information would facilitate sensible solutions to the worst public health catastrophe of the century. Receiving trustworthy information from healthcare professionals would be a potent strategy to prevent misinformation and promote responsible self-medication (101). Furthermore, countermeasures can be implemented to prevent the escalation of disinformation by comprehending the patterns of misinformation. Collaboration among fact-checkers, news media, platform companies, and public authorities is necessary to sustain a coordinated effort to address the spread of misinformation about COVID-19 and to assist the general public in understanding and responding to the pandemic (102).

Governmental health departments can facilitate self-care by providing effective, efficient, and inclusive primary care services to the general public, specifically through community pharmacies, high quality health care information, and convenient access to preventive care and complementary care services. Systems will gain over time from the effective distribution of resources among primary and specialized care services. For special populations that require regular monitoring, counseling and medication administration such as those with chronic diseases, and pregnant women, establishing counseling facilities or streamlining the prescription refill process for them would be beneficial and alleviate general anxiety as well as promote community health (36).

4.5. Role of the pharmacist

Pharmacists should be positioned as key roles in the public health measures to address self-medication behavior during the pandemic. This is especially the case when concurrent use of prescription medicines and traditional and complementary medicines are involved which gave rise to additional risks to drug safety (103, 104). Our results show that pharmacists were the professionals more frequently mentioned by the public for offering medication information or advice during self-medication. First, public in fact encounter pharmacists more frequently than other healthcare professionals (105). The finding showed that pharmacies were the stakeholders responsible for providing drugs to the self-medicating public in a time of pandemic, which reflects the favorable conditions for pharmacists to make a difference in self-medication. Second, pharmacists are trusted sources of health information in communities, and they promote to generating positive health outcomes by empowering individuals to better care for their own health (20). Furthermore, pharmacists are well-trained to effectively educate patients and provide evidence-based advice on a broad range of topics, including self-care interventions and the use of non-prescription medicines in the treatment of minor ailments (106, 107). Community pharmacists can support curbing the dangers of self-medication by repeatedly communicating (108), monitoring medication-related risks, and identifying populations at risk for substance abuse (109–111). As such, their role in facilitating the provision of safe and effective self-medication practices should be more effectively implemented. From another perspective, the fact that participants in the included studies use old prescriptions and leftover medications at home also points to deficient aspects of prescribing and dispensing which require effective health education and promotion strategies. Strengthening the regulation of dispensing practices while encouraging pharmacists to educate patients about medication use during the consultation process.

For future pandemics, we recommend that pharmacists actively involve their patients in early conversations pertaining to the medications they may use for the prevention and treatment of infectious diseases and instruct them appropriately. The findings of this study may assist them in reflecting on and evaluating the burden of self-medication in society and benefit them in developing strategies to curb the problem. However, barriers to the uptake of pharmacists' engagement in self-medication are multiple (112, 113). In particular, it would need to take into account the recognition of pharmacists in society. Compared to doctors, pharmacists are frequently regarded with less trust (114). To some people, the role of pharmacists remain predominantly traditional, often limited to solely dispensers of medications based on prescriptions (115). Simultaneously, the management patterns and remuneration mechanisms in pharmacies have resulted in a predominant emphasis on the retail activities, rather than prioritizing pharmacist's professional role in providing comprehensive advice and guidance (116). Significant efforts are required if pharmacy is to transform from a "dispenser and seller alone" mentality to a more clinical, patient-centered entity. Insufficient professional self-perception and inadequate training (20) are also among the challenges pharmacists face in supporting self-medication guidance services. Facilitating the ability of pharmacists to effectively support patient self-medication necessitates the cultivation of an enhanced sense of social responsibility and the provision of higher-quality education and training.

Further to this, the responsibility of healthcare providers, including physicians, nurses, dentists, and other healthcare professionals, to increase awareness of the appropriate medication use, both in the context of the pandemic and traditional healthcare settings, needs to be emphasized. Appropriate medication utilization is essential to ensure patient safety, optimize treatment outcomes, and prevent medication errors and adverse reactions (117–119). Healthcare professionals are encouraged to offer patient education using concise and comprehensible language to elucidate the potential advantages and risks linked to medications, while also addressing any concerns or inquiries that patients may present (120). Meanwhile, healthcare providers should emphasize the importance of medication adherence and provide strategies to promote patient compliance (121).

4.6. Way forward

Wide disparities in results among studies were discovered in the review's findings, indicating that each setting (region,

country), has its own patterns and implications for self-medication, and therefore urged different local health authorities to support research and interventions to lessen the likelihood of unfavorable self-medication outcomes. Further analysis of self-medication trends is also necessary given the quickly shifting COVID-19 situation and the results of widespread immunization. Most studies related to self-medication of COVID-19 disease focused their research scope on the prevention and treatment of COVID-19, while research on self-medication behaviors of people recovering from COVID-19 is also necessary. The prevalence, types of medication, contributing factors, and adverse effects of self-medication during the pandemic have been the subject of several research; nevertheless, little is known about poor medication habits or medication misconceptions like drug combination, overdose, or repetitive medication usage. Consequently, more qualitative, comprehensive, and comparative studies will provide a richer and deeper comprehension of the phenomenon of self-medication and thus better guide future practice. Meanwhile, during the pandemic, self-medication has become an essential health policy, yet current studies have mostly concentrated on the adverse effects of self-medication, so there is a call for more research to explore the beneficial aspects of self-medication and the implementation of self-medication health policies.

The results of our review found that only one in five studies mentioned pharmacists as a source of information or advice on self-medication. Considering the importance of enhancing responsible self-medication practices through the mentorship of health practitioners, particularly pharmacists, and the research gaps in this area, the findings of this study will drive future contextual and insightful research. Greater research is warranted to explore the potential value of pharmacists in guiding people to self-medicate and how government can support pharmacists in developing such role to meet the needs.

4.7. Strengths and limitations

The results of this review should be viewed with caution, as the key messages of each study have been carefully reviewed and provide important guidance for contemporary medical practice. The main limitation of this systematic review was the heterogeneity of definitions for self-medication in the examined studies, which made it impossible to do meta-analyses for all of the studies. Also of note, there have been variations in the quality of the included studies, the operational definitions of medicine use, study design, data collection tools, sample selection, sample size, and measurement time frame. We realize that the studies were not randomly distributed across regions, most of which were from Asia and Africa, and that more studies may have been conducted in regions where high self-medication was suspected. Other limitations of this review pertain to cross-sectional research design, variable recall period, and inherent constraints of self-reporting methodology.

5. Conclusion

During the COVID-19 pandemic, self-medication practices were widespread and varied across countries and populations. Self-medication has emerged as an important component of health care, but also as a huge global challenge. Self-medication practices may reduce the burden on health care resources especially in COVID-19 scenarios, but may also have potentially harmful and dangerous effects. Therefore, the engagement of healthcare administrators and policy makers and the implementation of health education programs are essential to regulate and monitor appropriate self-medication practices. The expertise and favorable conditions of pharmacists make them positioned as key roles in public health interventions for self-medication. As the fight against COVID-19 continued, more research is needed in the future to explore aspects of self-medication policy implementation and the potential value of pharmacists in self-medication behaviors.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

YZ and JL conceived of the design, methodology for this review, developed the review protocol, searched the literature with input, analyzed and interpreted the results, prepared the tables and figures, and drafted the manuscript. PT assisted in data analysis, interpreted the results, and reviewed the manuscript. HH supported data analysis, interpreted the results, and critically reviewed the manuscript. CU conceptualized and organized the study, confirmed and interpreted results, and critically reviewed and revised the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2023.1184882/full#supplementary-material

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