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Medical education in uncertain times: Threats, challenges, and opportunities of COVID-19

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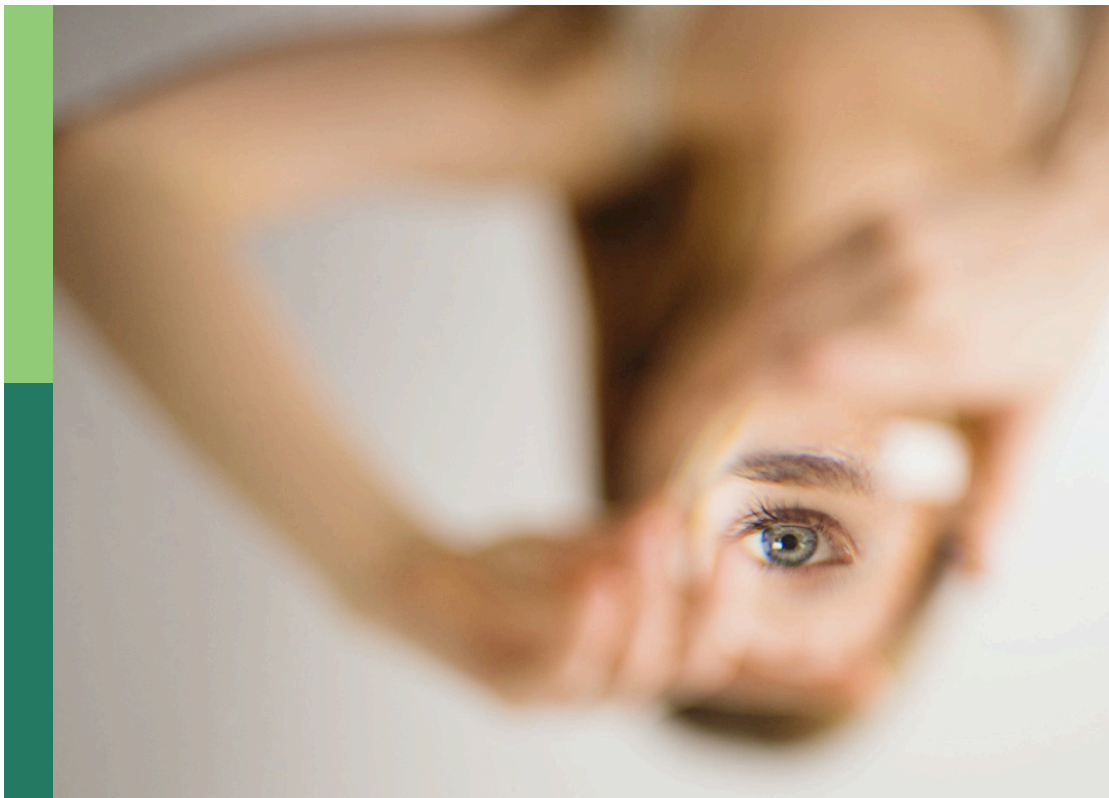

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Medical education in uncertain times: Threats, challenges, and opportunities of COVID-19

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Editorial: Medical education in uncertain times: threats, challenges, and opportunities of COVID-19

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KEYWORDS

medical education, COVID-19 pandemic, Cognitive Load Theory, extraneous load, stress, healthcare workers

Editorial on the Research Topic
Medical education in uncertain times: threats, challenges, and opportunities of COVID-19

The World Health Organization declared "coronavirus disease 2019" (COVID-19) a pandemic on March 12, 2020. As of July 2024, the total number of confirmed COVID-19 cases worldwide exceeds 774 million, and the number of deaths attributed to the virus is over 7 million (World Health Organization, 2024). In addition to the human costs, the economic impact of COVID-19 has been profound and multifaceted. As a result of widespread lockdowns, supply chain disruptions, and a significant reduction in consumer and business spending, the International Monetary Fund (2021) estimated that the global economy contracted by ∼3.5% in 2020 alone, amounting to 3.06 trillion US dollars. Additionally, the World Bank reported that the pandemic pushed an estimated 97 million people into extreme poverty in 2020, reversing decades of progress in poverty reduction (World Bank, 2021).

In addition to the human and economic consequences, both COVID-19 and the extraordinary measures to contain it have had, and continue to have, an enormous impact on higher education. Globally, the COVID-19 pandemic has forced academic institutions to adopt online education approaches, with significant and unknown implications for educators and learners. It is clear that some disciplines can smoothly adapt to online education. However, the difficulties that came with the COVID-19 pandemic, meant that medical education faced massive challenges due to its highly lab-based and hands-on structure.

Firstly, medical education had to acknowledge that most educational and psychological theories on learning and instructional design were developed for "normal circumstances." However, "Learning and instructional procedures do not occur in a situational vacuum" (Taylor et al.). Important questions included which theories could be used to understand the implications of the new psychological environment under which educators and learners had to, and still have to, perform, and how these theories needed to be revised (Pauli et al., 2008; Loftus, 2015).

Secondly, and in a related vein, medical education had to consider that "there is no learner or educator without a past" (Taylor et al.). Because of variations in their pasts, learners always come to the educational experience with different strengths and weaknesses. Hence, medical education had to consider inter- and intraindividual differences in instructing, teaching, and learning during a pandemic. Thirdly, while acknowledging the negative impacts of the COVID-19 pandemic, medical educators had to look for and capitalize on opportunities that the pandemic offered to enhance the educational experience of students. Therefore, the aim of the Research Topic on "*Medical education in uncertain times: threats, challenges, and opportunities of COVID-19*" was to provide a platform for researchers to deliver sound theoretical approaches and empirical evidence to inform medical education, public education policies, to support and advise governments and policymakers in introducing sustainable, feasible, and cost-effective guidelines for medical education. In addition, moving from a deficit-oriented approach toward a positive psychology of trauma and loss, it aimed to encourage studies that address COVID-19 as a "chance" not only to improve medical education, health care systems, and fight health disparities, but also to reconceptualize what education for any professional practice, such as healthcare, should involve (Higgs et al., 2010).

Taylor et al. expanded on Cognitive Load Theory (CLT) by incorporating the psychological impact of COVID-19 on learning environments. The study adapted CLT principles to reduce extraneous load, facilitating students' educational activities in a virtual environment. This adaptation is crucial for medical education, where reducing extraneous load can help maintain productive learning despite the pandemic's constraints. There are lessons here for reducing extraneous load under normal circumstances that can improve the learning experience.

De Micheli et al.'s examination of psychological distress among Italian healthcare students highlights that the mental health challenges of students were aggravated by the pandemic. Their findings reveal that perceived control and concern for patients positively influenced students' readiness to combat the COVID-19 pandemic. This underscores the need for universities to implement robust mental health support systems that integrate both enhancing protective factors and mitigating debilitating conditions to help students navigate crises.

Hassan et al. assessed Egyptian clinical dental students' perceptions of online education during COVID-19. Their results show that that the academic performance of over 97% of students was negatively impacted by the pandemic. However, while theoretical education was rated neutrally, practical education was rated less effective. Reduced interaction with educators and poor internet connectivity were identified as significant barriers impeding students' learning. However, despite these challenges, students favored a hybrid approach, combining online and in-person education, suggesting a need for flexible learning models that can adapt to varying circumstances.

Mohiyeddini explored the multifaceted challenges and opportunities presented by the increasingly diverse cultural landscape in healthcare. He emphasizes the necessity for medical education to adapt and equip healthcare professionals with the skills to provide equitable care. Highlighting the growing impact of globalization, migration, and multicultural societies, he argues for comprehensive Cross-Cultural Medical Education to improve health outcomes, reduce disparities, and ensure that both patient and provider cultural backgrounds are effectively acknowledged and integrated into medical practice.

Soll et al. investigated the efficacy of an asynchronous blended learning model for teaching Cognitive Behavioral Therapy (CBT) to postgraduate health professionals in Germany during COVID-19. Their study compared online training with traditional in-person methods and found that online training was non-inferior regarding content delivery and didactic quality. Although there were minor benefits to in-person training in terms of professional development, the results support the integration of online elements in CBT education beyond the pandemic.

Klasen et al. conducted a qualitative investigation into the experiences of medical students working on the COVID-19 frontline. The study revealed a mix of relief, stress, and gratitude among students, who found a sense of purpose in their contributions despite the challenges. The findings emphasize the necessity for robust support systems to ensure students' mental health during crises.

Vallone et al. explored the impact of "technostress" on academic motivation and psychological health among European university students. The study identified that techno-overload, work-home conflict, and amotivation, had a direct negative impact on some students. For some students, however, techno-ease, techno-reliability, and intrinsic and extrinsic motivation had a direct protective role on their psychological health. These findings highlight the need for tailored interventions to balance technology use and enhance student wellbeing.

He and Li investigated death attitudes and anxiety among Chinese medical interns post-COVID-19. Their study found varying levels of death anxiety and acceptance influenced by personal and professional experiences with the pandemic. These findings underscore the importance of addressing death-related attitudes and providing psychological support to medical interns.

Taken together, these studies collectively demonstrate the profound and diverse impacts of the COVID-19 pandemic on health professions, education and mental health. They emphasize the necessity for innovative educational approaches, enhanced support systems, and targeted psychological interventions to ensure the continued effectiveness and wellbeing of (medical) students. Hence, it is imperative that medical education evolves to meet these new challenges, integrating lessons learned to improve future resilience and adaptability. It is widely accepted that societal adaptations to help the disabled end up benefiting everyone. The lessons learned from providing medical education in a pandemic can be used to improve medical education during normal times.

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Teaching Cognitive Behavior Therapy to Postgraduate Health Care Professionals in Times of COVID 19 – An Asynchronous Blended Learning Environment Proved to Be Non-inferior to In-Person Training

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Training of postgraduate health professionals on their way to becoming licensed therapists for Cognitive Behavior Therapy (CBT) came to a halt in Germany in March 2020 when social distancing regulations came into effect. Since the German healthcare system almost exclusively relies on this profession when it comes to the implementation of CBT and 80% of those therapists active in 2010 will have retired at the end of 2030, it is critical to assess whether online CBT training is as satisfactory as classroom on-site CBT training. An asynchronous, blended, inverted-classroom online learning environment for CBT training (CBT for psychosis) was developed as an emergency solution. It consisted of pre-recorded CBT video lectures, exercises to train interventions in online role-plays, and regular web conferences. Training was provided at five different training institutes in Germany (duration 8–16 h). Postgraduate health care professionals (psychiatrists and psychologists) (n = 43) who received the online CBT training filled out standard self-report evaluations that assessed satisfaction and didactic quality. These evaluations were compared to those evaluations of students (n = 142) who had received in-person CBT training with identical content offered by the same CBT trainer at the same training institutes before the COVID-19 crisis. Both groups were comparable with respect to *interest in the subject* and *prior knowledge*. We tested non-inferiority hypotheses using Wilcoxon-Mann-Whitney ROC-curve analyses with an equivalence margin corresponding to a small-to-medium effect size (d = 0.35). The online training evaluations were non-inferior concerning *information content, conception of content, didactic presentation, assessment of the trainer as a suitable role-model, working atmosphere, own commitment,* and *practical relevance*. In contrast, we could not exclude a small effect in favor of in-person training in *professional benefit* and *room for active participation*. Our results suggest that delivering substantial CBT

knowledge online to postgraduate health-professionals is sufficient, and at most incurs minimal loss to the learning experience. These encouraging findings indicate that integrating online elements in CBT teaching is an acceptable option even beyond social distancing requirements.

Keywords: cognitive behavior therapy (CBT), therapist training, inverted classroom, online training, blended learning, non-inferiority

INTRODUCTION

Cognitive Behavior Therapy (CBT) is effective across a wide range of mental disorders, e.g., depression (Cuijpers et al., 2013), psychotic disorders (Bighelli et al., 2018), and anxiety disorders (Cuijpers et al., 2016). With regard to psychosis, CBT has been recommended by several national guidelines [Germany: (German Association for Psychiatry, Psychotherapy and Psychosomatics (DGPPN), 2019); United Kingdom: (National Institute for Health and Clinical Excellence (NICE), 2019)]. However, in most countries, there are still implementation problems [e.g., in Germany (Schlier and Lincoln, 2016)], often due to a lack of therapists' training (Heibach et al., 2014).

Best practice elements of CBT training have been identified in a review based on 35 randomized-controlled CBT trials (Rakovshik and McManus, 2010). Based on this review, a combination of theoretical instructions with experiential and interactive training elements (reflection on practice cases and role-play) with ongoing regular supervision is considered the "gold standard." The inclusion of experiential and interactive training elements has been proven effective for delivering theoretical knowledge and improvement of therapeutic attitudes and behavior, which in turn leads to improved CBT outcomes (Beidas and Kendall, 2010).

Postgraduate CBT training in Germany does meet this gold standard and is provided by more than 230 institutes (Psychotherapeutenvereinigung, 2020). Students are both medical and psychological graduates. The mandatory requirement of 600 h of theoretical training courses is delivered by licensed and experienced CBT therapists in small groups ($\leq$18 students) and usually includes lectures and experiential and interactive elements. CBT training is completed with a state examination and is regulated by state law (PsychTHG, 1998).

The German health care system relies heavily on regular enrollment of trained CBT therapists, as every patient diagnosed with a mental disorder according to the International Classification of Diseases (ICD-10; Dilling and Mombour, 2015) qualifies for therapy free of charge (25–80 sessions based on individual need). The ongoing demographic change makes this an even more pressing matter as 80% of the present CBT therapists will have been retired at the end of 2030 (Nübling et al., 2010).

At the beginning of the COVID-19 crisis in March 2020, Germany's theoretical training courses came to a sudden halt as state laws prohibited gathering in groups. In response, most CBT training institutes and trainers broke new ground by switching to online teaching.

Concerning online learning/e-learning, there is a tremendous variety of different approaches, one distinctive feature of these approaches being the synchronicity of presentation and reception. Synchronous online courses are often virtual classrooms modeled similar to in-person-classrooms: lectures are directly held in web conferences, and training sessions are performed in the virtual classroom. Synchronous courses have some advantages, e.g., they are more familiar for learners, but also disadvantages, e.g., all participants have identical schedules, which might be especially hindering whenever different time-zones are involved. Besides, long web conferences may be somewhat stressful, as they make it harder for participants to perceive additional information such as non-verbal cues. This stress often leads to the currently discussed "Zoom fatigue" (Wiederhold, 2020).

In the purest form of asynchronous training, participants view video-lectures or read texts and train skills independently. Sometimes additional written tasks and quizzes are added to solidify knowledge gain. Participants can learn at an individual learning pace. Still, asynchronous online training often relies too heavily on self-learning and self-monitoring abilities that participants might not always have. Also, participants sometimes feel less connected with their classes and miss the sense of community (Anderson, 2008).

An exciting combination of online and in-person learning is "blended" learning that combines "face-to-face instructions with computer-mediated instructions" (Graham, 2006). One variation of blended learning that includes asynchronous and synchronous elements is the inverted-classroom method (Lage et al., 2000; Handke, 2012): a self-directed learning phase is performed prior to the regular classroom appointment. Students read a lecture or view an instructional screencast. The subsequent classroom appointment is used to answer questions on the content, to reflect on the gained knowledge, to transfer it to practice cases, or to train the newly acquired skills. The most crucial aim of the inverted-classroom method is to enhance the acquisition of more complex skills (analysis, synthesis, and evaluation) during classroom time. In contrast, the self-learning phase is used for lower cognitive processes (acquisition of knowledge) (Tolks et al., 2016).

Thus, this method seems to be a good fit for CBT training, as it involves both synchronous and asynchronous elements. In a recent meta-analysis on studies comparing in-person instructions and inverted-classroom methods in medical education, the inverted-classroom method was superior to traditional methods and associated with more significant academic achievement (examination scores) (Chen et al., 2018). Similar results were obtained in a meta-analysis assessing inverted-classroom methods vs. in-person methods in general academic education (van Alten et al., 2019). Interestingly, while courses presented in inverted-classroom arrangements are superior regarding

performance of the enrolled students, students do not rate these courses as more satisfying and acceptable in comparison to courses held in traditional classroom formats (Roehling et al., 2017; van Alten et al., 2019).

With regard to CBT training, there is a consensus that online formats could improve the dissemination of CBT (Shafran et al., 2009; Fairburn and Cooper, 2011) and are an adequate alternative to in-person courses with regard to enhancing participants' knowledge of the interventions as well as their skills as therapists (Sholomskas et al., 2005; Martino et al., 2011).

Nevertheless, only a small number of studies compared CBT online training courses and in-person courses directly. Stein et al. (2015) compared health care professionals who received an asynchronous self-learning online training (12 h) and an in-person-training (24 h) with respect to the regular application of strategies the professionals learned in both courses (and additional regular supervision). Results revealed that both courses were comparable with regard to the implementation of CBT strategies (notably as rated by therapists' patients). Similar results were obtained in a direct comparison of synchronous CBT online training that was offered via an avatar on the platform Second Life and in-person training (Mallonee et al., 2018). Though differences between in-person and avatar training with respect to participants' satisfaction were statistically significant, a vast majority (>90%) of participants were "satisfied "or "very satisfied" in both courses (Mallonee et al., 2018).

In summary, studies suggest that CBT online training courses might be as acceptable and satisfying as in-person trainings. Hence, online-training might not only be a safer alternative in times of a pandemic, but also an effective means of dissemination of CBT techniques whenever there is a scarcity of experts and long distances to overcome.

Still, there is a lack of studies that directly compare similarly designed in-person and asynchronous concepts of online CBT training courses regarding their acceptability and participants' satisfaction. In addition to this, the trainer's effects are often not controlled, despite the possibility that they could heavily influence satisfaction ratings (Ghosh et al., 2012).

Thus, the present study aimed to investigate in a quasi-experimental design whether satisfaction with online CBT training courses is non-inferior in comparison to in-person CBT training courses with the same content (CBT for psychosis), duration of training, comparable audiences, and an identical trainer at five CBT postgraduate training institutes.

MATERIALS AND METHODS

Participants, Recruitment, and Procedure

Participants of the online training courses were enrolled at five different training institutes in Germany (Bielefeld, Bochum, Giessen, Marburg, and Göttingen) between March and April 2020. The training was held by one of the authors of this paper (S. M.). Students were psychologists (M.Sc.) and psychiatrists (second state exam) in the first year of CBT postgraduate training currently employed at inpatient units. The course duration varied between 8 h (Bochum, Giessen, Marburg) and 16 h (Bielefeld, Göttingen). Participants were asked to fill out anonymous paper questionnaires (Göttingen) or to provide their ratings via an online link (all other institutes) after the courses. An additional reminder was sent one week after the course via Email. Items were identical to those questions usually presented at the end of the in-person courses. Depending on the training institute, questions and scales differed slightly in numbers and topics.

In order to obtain data for in-person courses, all training institutes were asked via Email to provide anonymized individual participant data on the trainer's previous courses, which were held between 2013 and 2019. The duration of courses was identical. Participants were asked to fill out paper questionnaires at the end of the workshop. Participation was not mandatory, and as the data was anonymous, the ethics committee's approval was not necessary.

CBT for Psychosis Online Training

The present asynchronous inverted-classroom online course was run on the Moodle platform. Participants received a fixed time table for the day and met at fixed appointments in six to seven web conferences using Zoom software. They were asked to watch pre-recorded video-lectures presenting theoretical information, patient videos, or audios of interventions between the web conferences. They were also asked to perform exercises by themselves (written reflection on content or questions) or group exercises (training interventions in role-plays via telephone or in web conferences).

The content of the pre-recorded theoretical video lectures was as follows: introduction into CBT; building a positive therapeutic relationship with patients with psychosis; psychopathological symptoms of psychosis and diagnostic criteria; setting motivating therapy goals; psychoeducation and interventions to improve patients' general mood; interventions to provide psychoeducation on emotions and to train functional and to reduce dysfunctional emotion regulation strategies; interventions to reduce worrying and rumination; interventions to cope with negative emotions such as anger, guilt or anxiety; interventions to reduce negative self-schemata and improve self-esteem; interventions for voices; interventions to challenge delusional beliefs; interventions to reduce risk of relapse. Finally, lectures were provided on prodromal symptoms of psychosis and group interventions for psychosis. Participants also viewed videos of patients with typical positive symptoms of psychosis and listened to an audio recording of a therapeutic intervention. Interventions were selected based on a German manual on CBT for psychosis (Mehl and Lincoln, 2014).

Several exercises supported the training of the intervention: participants had to reflect on previous experiences of psychotic patients to find ways to build a functional therapeutic relationship, to read texts on psychopathology and diagnostic criteria and select correct criteria or a diagnosis, and they were asked to test a mindfulness exercise with another participant. Also, several exercises required training of therapeutic skills: building a positive relationship with patients with psychosis, defining patients' most important and motivating goals for

CBT, implementing and training mindfulness, challenging dysfunctional beliefs on voices, and discussing and challenging delusional beliefs. During web conferences at fixed times (every 2–3 h), all video lectures and exercises were explained in detail, and participants could ask questions. The trainer also asked the group to reflect on typical problems with patients with psychosis and how to solve them, and performed a model role-play (on challenging delusional beliefs) with one participant who played a patient with delusions.

Duration of the online training varied between the CBT institutes between 8 and 16 h; in shorter CBT training, not all pre-recorded video lectures and exercises were provided, but participants had the opportunity to watch video lectures or to practice skills in the 4 weeks following training, as they still had access to the Moodle platform.

CBT for Psychosis: In-Person Training

The workshop consisted of the same theoretical lectures as the online workshop. The trainer presented lectures in the classroom, and participants could ask questions. The trainer used the same exercises as in the online workshop; group exercises were performed in separate training rooms.

Measures

Satisfaction and Acceptance Questionnaire

Almost all institutes used the same or a similar questionnaire that included up to eleven items answered on a 6-point-Likert scale (range 1–6) or a 5-point-Likert scale (range 1–5), depending on the institute. Lower scores indicated greater satisfaction. Two items assessed participants' self-description regarding (1) their *interest in the subject* and (2) whether they had *prior knowledge* of the subject. Nine items measured acceptance and satisfaction with the course: participants were asked whether they were satisfied with (3) the *information content*, (4) the *conception of content*, (5) *didactic presentation*, (6) *room for active participation*, (7) *practical relevance*, (8) *trainer as a suitable role-model*, (9) whether the *working atmosphere* was positive, (10) with their *own commitment,* and (11) *professional relevance* of the workshop (items are presented in **Appendix 1**). There is some variation of item use and scales, as some institutes did not use all items, but the same items were used in both the on-site and online workshops at the same CBT institutes.

Statistical Analyses

All items were carefully analyzed, and answers from different training institutes were aggregated only when identical meaning could be ascertained by two independent raters, resulting in changing numbers of ratings for each item. Since some institutes preferred a 5-point Likert scale and no "6" had been awarded for any item, we interpreted all data along a 5-point Likert scale, as the test statistics we used to assess non-inferiority (explained below) is not influenced by rescaling of Likert-scales (see Kraemer, 2014 for more information).

Usually, mean values and standard deviations for each item are forwarded by the institutes to the trainers for evaluation. This is not considered here as an adequate aggregation method for Likert-like data, as they are in rank-order only (see Jamieson, 2004). Also, with respect to the distribution of the data, Linse states that "most student ratings distributions are skewed, i.e., not normally distributed, with the peak of the distribution above the midpoint of the scale" (Linse, 2017). Our data were expected to take this to the extreme: for each item, the median and modal of the courses' ratings in the last years held by S. M. had been in the best (i.e., lowest) category almost without exception, rendering a comparative analysis along these aggregation-statistics futile. We also refrained from using a log-transformation of the data in order to obtain a normal distribution since there was no reason to believe that our categorical data followed a log-normal distribution (see Feng et al., 2013 for more information).

Analysis of Non-inferiority

Non-inferiority of the online courses vs. in-person courses was analyzed using the averaged Wilcoxon-Mann-Whitney-*U* (WMW-*U*) statistic that was determined for all nine items that assessed participants' satisfaction with the courses. The averaged WMW-U is a measure of "dominance" of one distribution over the other and can be visualized as the proportion of the area under a ROC curve (AUC), with 0.5 being the value for a pair of mutually non-dominating distributions (see Divine et al., 2018 for more information). AUC can be transformed into the effect size *d*, as explained by Salgado (2018).

Previous studies or meta-analyses that compared online vs. in-person courses used heterogeneous approaches to decide whether courses differed meaningfully regarding their satisfaction and efficacy.

For example, in their meta-analysis comparing effects of inverted-classrooms vs. normal classroom settings on satisfaction, van Alten and colleagues (van Alten et al., 2019) set the *smallest effect size of interest* (SESOI, see Lakens et al., 2018) to $g = 0.2$, but could not provide a definitive answer due to a lack of power ($g = 0.05$; 95% confidence interval (CI): −0.23, 0.32). Nevertheless, they concluded that "students are equally satisfied with the learning environments," though they could not exclude an effect size of up to $g = 0.32$.

Krogh et al. set $d = 0.36$ as SESOI in their study comparing an online course vs. an in-person course in pediatric basic life support (Krogh et al., 2015). Montassier et al. (2016) even adopted a SESOI of $d = 0.5$ for learning outcomes in online vs. in-person classrooms for the interpretation of ECG data (see Kraemer, 2006 for methods of transformation of effect sizes). The effect size seems large, but on a wide variety of clinical outcomes empirical and theoretical evidence for a SESOI of half a standard deviation ($d = 0.5$) has been provided (Norman et al., 2003).

In their study, Mallonee et al. (2018) reported a significant effect of $d = 0.35$ in satisfaction ratings for online CBT courses in comparison to in-person CBT courses and found the moderators of this difference well worth exploring. They reported that the difference could be largely explained by a shift in participants' ratings from "very satisfied" to "mostly satisfied." Experts in student feedback might possibly ignore such a shift in opinion when providing advice for administrator's evaluation of teaching staff: Linse and colleagues propose a look at the distribution of ratings "as a whole" to check whether "a large percentage of the

ratings are clustered at the higher end of the scale" (Linse, 2017), while ignoring "sporadic" ratings at the low end of the scale (Berk, 2013).

Concluding, for our question whether integrating online elements in CBT teaching is an acceptable option even beyond the pandemic crisis, the effect size $d = 0.35$ seems a suitable point of reference. In our context, an effect of this size might be established by a decline of one scale point in ratings of three to four participants of the 18 participants of a typical course that has been transformed from in-person to an online course.

Therefore, we tested whether an effect size larger than $d = 0.35$ between in-person and online course ratings can be rejected. This is the case, whenever the one-sided 95% CI around AUC = 0.5977 does not contain the point-estimator for AUC.

There are several alternative procedures to compute the CI (see Kottas et al., 2014). Among those, the Wald-procedure without continuity correction seems an overall reasonable choice that takes our sample sizes ($87 < n < 185$), highly skewed distributions, a supposedly rather small value of actual AUC and unequal group sizes between 1:2 and 1:3 into account.

RESULTS

Enrollment of Participants

At five different CBT institutes, 85 students participated at the online training courses (Bielefeld: $n = 21$; Bochum: $n = 12$; Giessen $n = 19$; Göttingen: $n = 14$; Marburg: $n = 19$). Of this group, a total of 43 participants provided online ($n = 31$; Bielefeld: $n = 7$; Bochum: $n = 7$; Giessen: $n = 11$; Marburg; $n = 6$) or pen-and-paper (Göttingen: $n = 12$) feedback (50.59%).

With regard to in-person courses, we received data of $n = 142$ participants of ten courses at three different training institutes in Germany [two courses in Bielefeld (2018–2019, $n = 14$; $n = 16$), six courses in Göttingen (2013–2018, $n = 18$; $n = 14$; $n = 11$; $n = 20$; $n = 12$ and $n = 11$) and two courses in Giessen (2018; $n = 13$, $n = 13$)].

Sociodemographic data was not assessed in both groups to ensure anonymity. Since all participants were regular aspirants of board certification in CBT at the respective training institutes, a minimum age of 26 and a Master's degree in psychology or second state exam in medicine was necessary for course enrollment. In a comparable German online study on students in CBT training, the mean age was 30.5 (SD = 5.8: Nübling et al., 2019), and women outnumbered men by a factor of five (86.2% female).

On a descriptive level (see **Figure 1** and **Table 1**), with respect to their self-reported *interest in the subject* of the courses, participants in the online courses were comparable with participants in the in-person courses, though more heterogeneous. Participants in the in-person courses rated their *prior knowledge* more positively in comparison to participants in the online courses.

Distributions of satisfaction ratings in both groups are depicted in **Figure 2** and **Table 1**. As expected, all ratings were skewed to the left (with the exception of *own commitment*): a vast majority of participants in both groups rated the courses as satisfying or very satisfying in all items. **Table 2** depicts the number and percentage of positive ratings [satisfying (2) or very satisfying (1)] vs. negative ratings (3–5) in both groups. A visual inspection of the data yields similar shapes of the distributions for online and in-person courses.

Results of the non-inferiority test using averaged U-values (AUC; see **Table 1**) revealed that the assumption of inferiority of the online courses could be rejected with regard to the items assessing satisfaction with the *information content, conception of content, didactic presentation, satisfaction with the trainer as a suitable role-model, working atmosphere, own commitment,* and *practical relevance*.

The assumption of inferiority of the online courses could not be rejected with regard to the items assessing satisfaction with *room for active participation* and *professional benefit* of the workshop.

DISCUSSION

An asynchronous, blended, inverted-classroom online learning environment for CBT training (CBT for psychosis) was developed as an emergency solution to training provision during the COVID-19 pandemic. Our study investigated the hypothesis that participants' ratings regarding acceptance and satisfaction of online CBT courses were non-inferior in comparison to the former in-person courses. For this purpose, we compared ratings of online courses and in-person courses with similar content, length, and trainer with regard to the participants' satisfaction ratings, using a non-inferiority test (Lakens et al., 2018). Results revealed that participants' satisfaction with the online courses was not relevantly lower in the categories *information content, conception of content, didactic presentation, satisfaction with the trainer as a suitable role-model, working atmosphere, own commitment,* and *practical relevance* than satisfaction with the in-person training courses. Concerning *room for active participation* and the course's *professional benefit,* we could not exclude relevantly lower satisfaction ratings in the online courses. Nevertheless, a vast majority of online-participants rated these items as very satisfying or satisfying (81.4%, 83.9%).

With regard to satisfaction with online training courses for CBT therapists, to the best of our knowledge, this is the first study that directly assessed whether an asynchronous online training of identical length, trainer and topic is non-inferior to in-person training.

Our results are built on a study that compared various training courses of some evidence-based CBT techniques (e.g., Prolonged Exposure, CBT for depression) as synchronous online and in-person courses (Mallonee et al., 2018) in a large group of various mental health workers (e.g., therapists, social workers, and pastors). They used a more general measure of satisfaction (one item) and found a statistically significant difference ($d = 0.35$) between the groups. Though being a small-to-moderate effect in the Cohen classification (Cohen, 1992), this difference was not seen as an obstacle for the future use of synchronous online courses by the authors as participants' ratings were still "satisfied" or "very satisfied" in more than 90% of the cases in both groups.

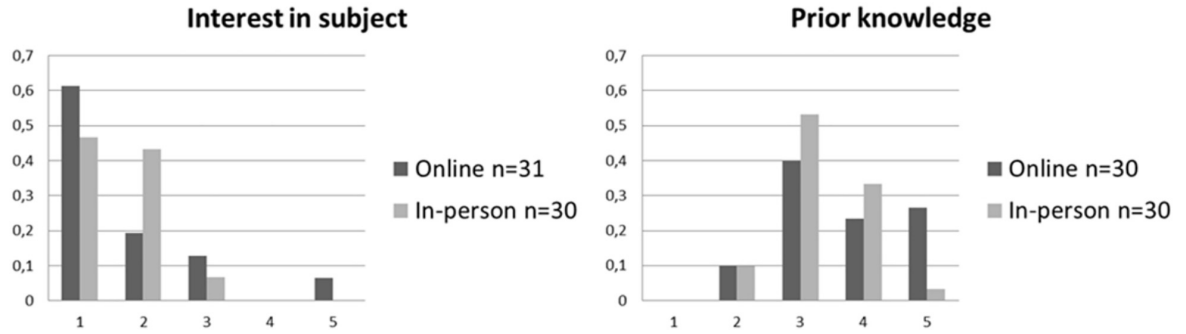

FIGURE 1 | Relative frequ encies of self-reported items of the Satisfaction and acceptance questionnaire for online and in-person courses. 1 = "very much," 5 = "none."

While synchronous online training cuts geographic connections between trainer and participants, times of learning and teaching remain similar in amount and schedule, posing obstacles to upscaling and dissemination of training e.g., into regions with differing time zones and a lack of suitable experts. Going one step further, we aimed to investigate whether loosening the time-bonds by adding asynchronous elements could still establish equal satisfaction.

Our positive answer for most of the items is in line with a meta-analysis that found no differences in satisfaction rates between in-person teaching in inverted and traditional classrooms (van Alten et al., 2019) in higher education and medical training (Chen et al., 2018).

However, we could not exclude the online training's inferiority regarding the items *room for active participation* and *professional benefit* even though the number and content of exercises were equal in both online and in-person courses. With respect to the active participation of the audience, we assume that the differences are related to the reception of the pre-recorded lectures: participants could not pose their questions spontaneously during the lecture but were required to write them down. Posed later, the context of the question might not have been at the center of attention for the other participants. This might have framed the question as a special issue of the inquirer, leading to less engagement of the rest of the group in spontaneously emerging discussions of practical cases.

In addition, emerging discussions in web conferences are hindered by the fact that social cues such as eye gaze and body gestures cannot be used in an online setting to determine the audience's degree of interest and adapt speech content towards it. The lack of these implicit gestures also leads to difficulties in signaling turn-taking in conversations (see Rossano, 2012 for more information). Furthermore, joining into the discussion is often hindered by the need to activate microphones. The resulting toll on participants' concentration has been named "Zoom fatigue" (Wiederhold, 2020). From the trainer's point of view, this might have impeded her from telling stories from everyday practice, which might explain the reduced professional benefit.

Summing up, the asynchronous, online blended learning solution had some practical advantages at relatively small costs in certain dimensions of satisfaction. Whenever there is a scarcity of shared room, shared time or specialized trainers on the spot, online CBT courses seem to be a feasible and acceptable solution.

Limitations

First, we are not able to report demographic data of the participants, due to the fact that our study was part of the regular CBT training in Germany in small groups ($\leq$18): usually demographic data are not gained to prevent de-anonymization.

In addition, we collected the data via both an online form and pen-and-pencil questionnaires. Several studies suggest that online assessments are as representative as paper-and-pencil evaluations and yield similar results (Spooren et al., 2013). Nevertheless, in the online courses, drop-out rate was more pronounced (41%) in comparison to the in-person courses where we had data from all participants. Although drop-out rates are typically higher in online satisfaction assessments (Ardalan et al., 2007), it is possible that we only included participants who were more satisfied with the online courses. This also led to an unequal sample size in our analysis, however, we remedied this problem by using a robust computation of the confidence intervals, as recommended by Kottas et al. (2014).

Participants were not randomized to the CBT training conditions; thus, we are not able to exclude a cohort effect. Furthermore, both 6-point-Likert scales and 5-point-Likert scales were used and then combined for our analysis, which is not ideal, but did not affect the non-parametric analyses (also, ratings of 6 were not awarded on the 6-point Likert scales).

As our study was part of the regular CBT training for therapists in Germany, no objective measures of the degree of gained knowledge was included. Nevertheless, student's satisfaction ratings are known to be reliable and valid (Linse, 2017), although the correlation between students' satisfaction ratings and their learning outcome is small (Abrami, 2001; Eizler, 2002). However, in contrast to students in general, our participants had at least 6 years of previous experience in higher education and can thus be considered experienced in the evaluation of didactic presentations. Since the workshops prepared our participants for an important exam, it is plausible that the amount of gained knowledge influenced their acceptance ratings. Furthermore, no objective evaluation of the skills learned

TABLE 1 | Ratings for online vs. In-person workshops and results of the non-inferiority analysis.

Items	In-person group							Online group							Confidence Interval $d = 0.35$ AUC = 0.5977 *95% CI*	Point estimator $\widehat{AUC}$
	n	1	2	3	4	5	Median	*n*	1	2	3	4	5	Median		
	%							%								
Interest in subject	30	14	13	2	1	0		31	19	6	4	0	2	1		
	%	46.7	43.3	6.7	3.3	0	2	%	61.3	19.4	12.9	0	6.5			
Prior knowledge	30	0	3	16	10	1		30	0	3	12	7	8	3		
	%	0	10	53.3	33.3	3.3	3	%	0	10	40	23.3	26.7			
Information content	142	87	45	10	0	0		43	26	17	0	0	0	1	[0.5442, ∞)	0.4901*
	%	61.3	31.7	7	0	0	1	%	60.5	39.5	0	0	0			
Conception of content	56	30	20	6	0	0		31	19	11	1	0	0	1	[0.5193, ∞)	0.4482*
	%	53.6	35.7	10.7	0	0	1	%	61.3	35.5	3.2	0	0			
Didactic presentation	142	73	50	18	1	0		43	27	11	5	0	0	1	[0.5442, ∞)	0.4460*
	%	51.4	35.2	12.7	0.7	0	1	%	62.8	25.6	11.6	0	0			
Room for active participation	142	85	46	8	3	0		43	20	15	6	1	1	2	[0.5442, ∞)	0.5834
	%	59.9	32.4	5.6	2.1	0	1	%	46.5	34.9	14	2.3	2.3			
Practical relevance	142	95	38	8	1	0		43	25	15	3	0	0	1	[0.5442, ∞)	0.5418*
	%	66.9	26.8	5.6	0.7	0	1	%	58.1	34.9	7	0	0			
Trainer as role model	141	85	45	10	1	0		42	28	12	2	0	0	1	[0.5439, ∞)	0.4644*
	%	60.3	31.9	7.1	0.7	0	1	%	66.7	28.6	4.8	0	0			
Working atmosphere	142	73	54	14	1	0		43	23	12	7	1	0	1	[0.5442, ∞)	0.5108*
	%	51.4	38	9.9	0.7	0	1	%	53.5	27.9	16.3	2.3	0			
Own commitment	142	42	61	34	4	1		43	12	21	7	2	1	2	[0.5442, ∞)	0.4969*
	%	29.6	43	23.9	2.8	0.7	2	%	27.9	48.8	16.3	4.7	2.3			
Professional benefit	56	23	24	8	1	0		31	11	15	5	0	0	2	[0.5193, ∞)	0.5222
	%	41.1	42.9	14.3	1.8	0	2	%	35.5	48.4	16.1	0	0			

*H_0 : d 0.35, $\widehat{AUC}$ empirical area under the ROC-curve, CI = 95% -confidence intervals for $\widehat{AUC}$ under H_0. * H_0 is rejected if $\widehat{AUC}$ is outside CI (p = 0.05).*

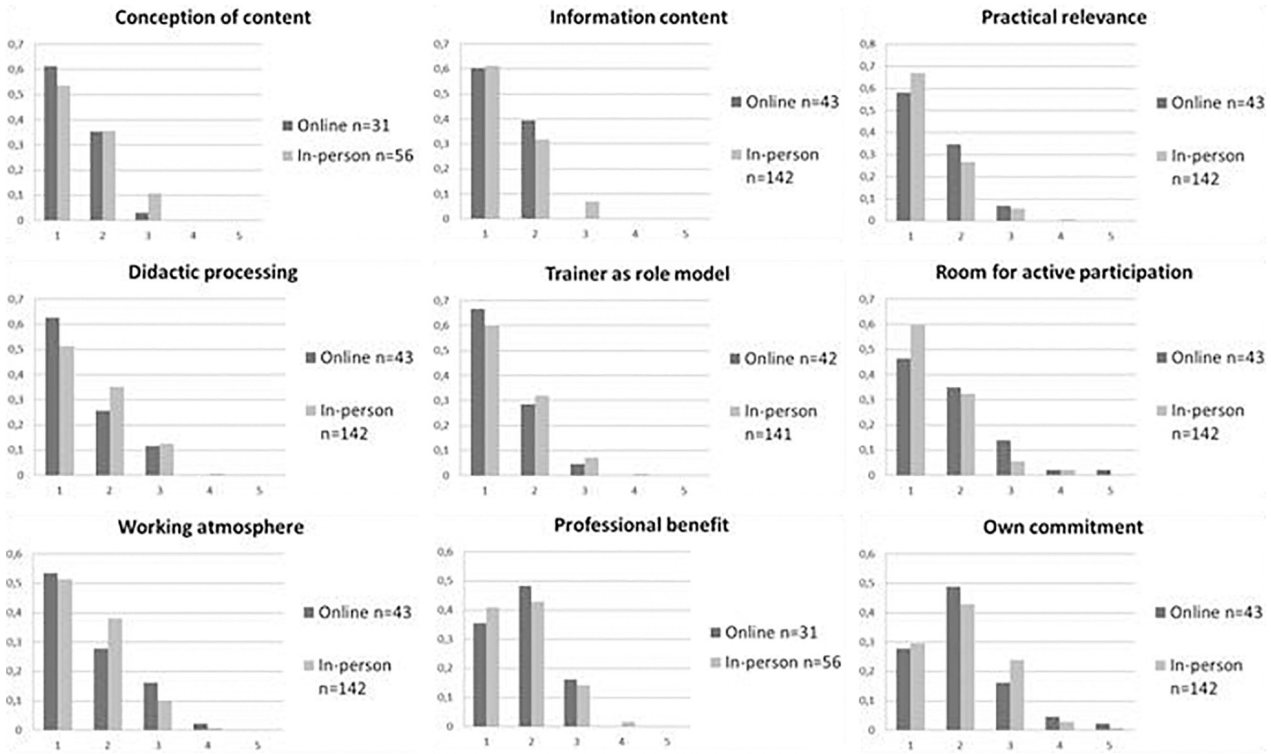

FIGURE 2 | Relative frequencies of items of the Satisfaction and acceptance questionnaire for online and in-person courses. 1 = "very satisfied," 5 = "not at all satisfied."

TABLE 2 | Descriptive data and percentage of positive vs. neutral/negative ratings in online courses vs. in-person courses.

Items	*n*	In-person courses			Online courses	
		1–2	3–5	n	1–2	3–5
Information content	142	132	10	43	43	0
	%	93	7	%	100	0
Conception of content	56	50	6	31	30	1
	%	89.3	10.7	%	96.8	3.2
Didactic presentation	142	123	19	43	38	5
	%	86.6	13.4	%	88.4	11.6
Room for active participation	142	131	11	43	35	8
	%	92.3	7.7	%	81.4	18.6
Practical relevance	142	133	9	43	40	3
	%	93.7	6.3	%	93	7
Trainer as role model	141	130	11	42	40	2
	%	92.2	7.8	%	95.2	4.8
Working atmosphere	142	127	15	43	35	8
	%	89.4	10.6	%	81.4	18.6
Own commitment	142	103	39	43	33	10
	%	72.5	27.5	%	76.7	23.3
Professional benefit	56	47	9	31	26	5
	%	83.9	16.1	%	83.9	16.1

during the training was assessed by the trainer. Also, there were no data on qualitative satisfaction ratings available that would be helpful in evaluating students' subjective experience.

Because of the satisfaction ratings' subjective nature, the emotional background of the online courses is worth considering. We delivered the asynchronous online inverted-classroom courses during the COVID-19 pandemic as an emergency solution. Thus, participants were well aware that the trainer had voluntarily increased her effort at short notice to transfer the content into online courses. Satisfaction ratings of the

participants might have been influenced by their gratitude for being able to continue their CBT training.

Furthermore, satisfaction ratings might also depend on the courses' subject (CBT for psychosis) that might be considered more interesting than other topics. Also, some CBT courses might be more easily transferred to an online format in comparison to CBT courses that focus more on training of interventions (e.g., imagination techniques, chair work). Thus, the generalizability on other topics of CBT training is unclear.

Implications for Future Studies

With regard to the special situation of the pandemic discussed above, a first step would be to replicate our study in a non-pandemic situation as a pre-registered randomized-controlled study. It is also important in future studies to assess whether asynchronous online courses are non-inferior in comparison to synchronous online courses regarding satisfaction ratings and to use additional outcome criteria, e.g., to include assessments of gained knowledge, evaluation of gained knowledge by the trainer and to test participants on their newly acquired therapeutic skills.

In order to gain realistic, less pandemic-dependent data on satisfaction ratings, perceived advantages and shortcomings of the online setting can be assessed by the so-called "willingness to pay" paradigm (WTP) in economics. In this setting, scientists or CBT institutes might offer an online-course at the same time as the regular in-person course. Students would have to place a bid for online-participation, which can be either positive (they signal their willingness to pay an additional fee for the perceived advantages), or negative (they signal the amount of reduction they expect for the perceived restricted service). The online course is then sold to the half of the group with the highest bids at the price of the lowest bid in that half of the group (see Breidert et al., 2006 for a review of WTP-assessments).

Implications for CBT Training Post the COVID-19 Pandemic

Asynchronous online courses offer several advantages with respect to convenience and costs. Since candidates are usually employed in a full-time position at different locations and often have caring duties, a more individual schedule and no need for traveling might be appreciated by participants. Without the need for traveling and staying overnight, highly qualified trainers might be easier to find. Of course, this comes at the price of a more individualized learning experience, e.g., no informal meetings at the coffee station and diminished sense of belonging to a community of learners.

There are a number of potential solutions in order to give participants more room for active participation in online courses. One solution is to start the course with short "break out" exercise sessions in smaller groups. Participants often have less problems to engage in these smaller groups, as it is less important to mute their microphone when not talking (to prevent white noise). In these smaller groups, it is also easier to help each other to get used to the software.

In order to encourage participants to ask more questions, the trainer could start each web-conference with a short visual summary of the video lectures the participants were required to watch between the web conferences and could share the slides of her presentation. Also, she could motivate participants to ask questions either verbally or by writing down the question in the group chat.

In addition, participants were often interested in the trainer performing a therapeutic intervention role-play with a student role-playing as a client. These live role-plays in large groups can be improved if all students except the participants of the role-plays deactivate their cameras in order to enhance visibility of the participants. In addition, students can write down additional questions or suggest interventions for the trainer to read during the exercise in the group chat. Obviously, it is beneficial afterward to train the interventions in small groups in break out rooms, supported by the trainer. Also, playful quizzes or tests at the end of the courses could positively influence the effectiveness and attractiveness of online courses (Spanjers et al., 2015).

CONCLUSION

The present study yields some interesting results: it provides first evidence that ratings of satisfaction of an online asynchronous CBT training are not inferior to ratings of an in-person training provided by the same training person at the same training institutes regarding various dimensions of satisfaction (information content, conception of content, didactic presentation, satisfaction with the trainer as suitable role-model, working atmosphere, own commitment, and usefulness for own practice). The results also suggest that some differences between online and in-person courses could not be excluded with regard to active participation and practical orientation.

Our results indicate that integrating online elements in CBT teaching is an acceptable option even beyond the pandemic crisis.

DATA AVAILABILITY STATEMENT

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

ETHICS STATEMENT

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

DS performed the statistical analyses. All authors conceived the study, planned the trial's design, wrote the manuscript, read, and approved the final manuscript.

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APPENDIX 1

Items of the acceptance questionnaire (translated by the authors)

Please rate how. . .

(1) strongly you were interested in the subject of the workshop?
(2) broad was your prior knowledge?

Please rate your satisfaction with. . .

(3) the information content of the workshop?
(4) the conception of content of the workshop?
(5) didactic presentation?
(6) room for active participation?
(7) practical relevance?
(8) trainer as suitable role model?
(9) working atmosphere?
(10) own commitment during the workshop?
(11) professional benefit of the workshop?

Fragebogen zur Qualitätssicherung der theoretischen Ausbildung (QS1)

Bitte geben Sie an, wie groß. . .

(1) Ihr Interesse am Thema war?
(2) Ihre Vorkenntnisse zu dem Thema waren?

Bitte stufen Sie ein, wie zufrieden Sie sind mit. . .

(3) dem Informationsgehalt?
(4) der inhaltlichen Konzeption?
(5) der didaktischen Präsentation?
(6) der Möglichkeit zur aktiven Beteiligung?
(7) dem Praxisbezug?
(8) dem Referenten/der Referentin als Rollenmodell?
(9) der Arbeitsatmosphäre?
(10) mit dem eigenen Engagement während der Veranstaltung?
(11) dem Nutzen für die eigene Tätigkeit?

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Impact of COVID-19 Related Knowledge and Precautions on Emotional and Behavioral Problems Among Children During the Post-pandemic in China: The Explanatory Value of Emotional Problems Among Caregivers

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To investigate the prevalence of emotional and behavioral problems (EBPs) among children during the COVID-19 post-pandemic in China; examine associations between COVID-19-related knowledge and precautions and problems in children, and explore the potential explanatory value of the mental health status of caregivers on any associations observed. Based on a cross-sectional design, caregivers of 6,017 children from 12 primary schools in Shanghai and Taizhou, China, were invited to complete an online survey from June 26 to July 6, 2020. EBPs of the children were assessed using the Strengths and Difficulties Questionnaire (SDQ), while the emotional problems of caregivers were assessed using the Depression Anxiety Stress Scales-21 (DASS-21). Structural equation modeling was employed to estimate the direct and indirect associations (explained by the emotional problems of caregivers) between COVID-19-related knowledge and precautions and the EBPs among children. The overall prevalence of EBPs in the sample was 12.5%, and 5.3% of them had a high or very high SDQ total difficulties score during the COVID-19 post-pandemic. After adjustment for covariates, higher COVID-19-related knowledge ($\beta = -0.83$; $P < 0.001$) and precautions ($\beta = -0.80$; $P < 0.001$) were significantly associated with lower SDQ total difficulties score among children. There was an explanatory effect of emotional problems of caregivers on the aforementioned associations, which explained 31% and 41% of the total effect, respectively. Higher levels of knowledge and precautions of COVID-19 were associated with lower EBPs among children, and the relationship was partially explained by the emotional problems in caregivers. It may be beneficial to improve pandemic-related prevention education and adopt psychological interventions toward the emotional status of caregivers for the psychological health of children.

Keywords: COVID-19, knowledge, precaution, emotional and behavioral problems, children, caregivers

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INTRODUCTION

COVID-19, the infectious disease caused by the novel coronavirus SARS-COV-2, was first identified in Wuhan, China in December 2019 (Zhu et al., 2020), and has rapidly become the worst global health pandemic in a century. In response to the outbreak, most of the countries have made unprecedented efforts to practice "social distancing" (Shen et al., 2020). As a result, mass gatherings and public events were banned; schools, public buildings, and businesses were closed; and travel was restricted (Chen et al., 2020; Van Lancker and Parolin, 2020). Global risk of depression and anxiety was caused by the detrimental effect of these measures, including home quarantine, economic recession, negative information overload, and fear of infection (Agha, 2020). The pandemic not only exacerbated existing mental health problems but also led to more clinical psychiatric cases among the general population (Golberstein et al., 2020). Children are particularly vulnerable owing to their limited understanding of the event, and may not be able to avoid physical and mental problems due to their limited coping strategies (Dalton et al., 2020). Furthermore, because of the closure of schools, children experienced a prolonged state of home isolation and lacked healthcare knowledge, in-person contact with peers and teachers, and personal space, which could hurt their mental health (Brooks et al., 2020; Van Lancker and Parolin, 2020). Although the education sector had launched online education to minimize the learning loss, there were still a substantial proportion of students who were not satisfied with online education and were not participating effectively, especially those from families or regions with lower socioeconomic status (Ma et al., 2021). The problems related to studies, such as having difficulty in studying at home and dislike of remote learning, have been reported to be prevalent among adolescents during the closure of schools, and they were associated with more severe depressive symptoms (Wang et al., 2021). Among hospitals that provide mental health services to children and adolescents in China, 9% closed their outpatient units and 25% closed inpatient wards during the COVID-19 outbreak (Cui et al., 2020). Although over 15% of these hospitals launched online services, the disruption of previous mental health services had a negative influence on children and their caregivers (Cui et al., 2020).

Previous studies have reported the prevalence of mental health problems in children during the pandemic period (Duan et al., 2020; Jiao et al., 2020; University of Oxford, 2020; Xie et al., 2020). A study in Hubei province found that 22.6 and 18.9% of 2,330 primary school students suffered from depression and anxiety, respectively (Xie et al., 2020). Similarly, another study investigated 359 children and 3,252 adolescents by online survey and revealed that the prevalence of depressive symptoms in children and adolescents was 22.28% during the COVID-19 outbreak (Duan et al., 2020). Many children aged 3–18 years in China displayed psychological problems including clinginess, inattention, irritability, and fear of asking questions about the pandemic (Jiao et al., 2020). An online survey conducted among over 1,500 parents by the CO-SPACE study in the UK suggested that children had a high level of COVID-19-related worries and fears, with the number of younger children (aged 4–10 years) being significantly higher than older children (aged 11–16 years) (University of Oxford, 2020).

At the same time, caregivers of children were also at high risk of mental health problems owing to the fear of infection in family members, economic problems in the family, and educational attainment of children (Spinelli et al., 2020; Wang et al., 2020a). It also resulted in stress for caregivers as they had to inform and explain to their children about the pandemic and manage their fears (Fegert et al., 2020). Previous studies suggest an increased risk of EBPs among children whose parents had depression (Psychogiou et al., 2017). The pressure that caregivers suffered could lessen their parenting abilities and convey anxiety to their children (Heinrich, 2014). A cross-sectional study conducted in Bangladesh, during the pandemic, reported that children of parents who needed to go to the workplace or were at risk of losing their jobs tended to have a higher level of stress and increased mental disorders (Yeasmin et al., 2020).

As COVID-19 is a new disease and has devastating effects globally, knowledge and compliance with coronavirus precautions are crucial to prevent and alleviate mental health problems during the pandemic. Studies of public health crises suggest that adequate knowledge during the epidemic largely influenced the degree of adopting preventive behaviors among the general population and ultimately protected mental health (Brug et al., 2004; Sadique et al., 2007; Yildirim et al., 2020). The importance of self-perceived knowledge has also been emphasized by existing studies. Self-perceived knowledge, which moderately correlated with actual knowledge (Flynn and Goldsmith, 1999; Krawczyk et al., 2013), increased the confidence in a person's knowledge which could translate into more information search, perceived benefits of adopting preventative behaviors, and all phases of the decision-making process (Park et al., 1988; Krawczyk et al., 2013). With the widespread use of social media, conspiracy theories about the pandemic spread rapidly, which often disturbed emotional well-being (Desta and Mulugeta, 2020). Having poor knowledge and preventive behaviors owing to erroneous media information and pandemic rumors could harm the mental health of children (Rosling and Rosling, 2003). Recent studies suggest that a lack of knowledge about the pandemic and inadequate preventive behaviors affected the overall mental health (Yildirim and Güler, 2020), and increased depression, stress, and anxiety (Du et al., 2020; Wang et al., 2020b).

Although some previous studies reported the prevalence of psychological problems among children or their caregivers during the pandemic, very little is known about the prevalence during the post-pandemic period in China when the epidemic was under control, and about the associations between knowledge of and preventive behaviors against COVID-19, the mental health status of caregivers, and psychopathology of children. Therefore, we conducted a cross-sectional study to assess the EBPs among children when the schools reopened. We also aimed to investigate the association between COVID-19-related knowledge and preventive behaviors (precautions) and the EBPs in children, and also explore whether the emotional problems in caregivers would explain the association.

MATERIALS AND METHODS

Participants and Design

A cross-sectional study was conducted among primary school children and their caregivers in Taizhou and Shanghai, China, from June 26 to July 6, 2020, when local schools had fully reopened. Cluster sampling was adopted, and six primary schools each were randomly sampled from Taizhou and Shanghai, respectively, which included public and non-public schools. Three classes were randomly sampled from each grade (first to fifth grade) in each school. All the caregivers of children in the chosen classes were invited to complete an online Chinese questionnaire through the Wenjuanxing platform (https://www.wjx.cn), with an average response time of 18.6 ± 10.7 min. Eligibility criteria were: (1) caregivers of children in first to fifth grade; (2) should be able to read, understand, and complete the survey questionnaire independently; and (3) children and their caregivers should provide online informed consent. After excluding 34 invalid questionnaires and 349 with missing data on school information, 6,017 participants were included for the current analyses. This study was approved by the Institutional Review Board of the School of Public Health, Fudan University, Shanghai, China (IRB#2020040817), and all participants provided online informed consent.

Assessment of Sociodemographic Characteristics

Demographic information included children's age, gender (male or female), type of school (key school or not), grade (first to fifth), family economic status (low, medium, and high), and educational attainment of caregivers (primary school or lower, middle school, high school, and college or higher).

Assessment of COVID-19 Pandemic Characteristics

Knowledge and precaution levels of caregivers and children regarding COVID-19 were evaluated based on four items: Q1. How much do you know about COVID-19-related knowledge? Q2. How much do you think your child knows about COVID-19-related knowledge? Q3. How many precautions do you take to prevent the spread of COVID-19? Q4. How many precautions do you think your child takes to prevent the spread of COVID-19? Each item consisted of seven options, scored from 1 (Very poor knowledge/Not at all) to 7 (Very good knowledge/Completely following the recommendations from authorities), and the items were treated as continuous variables, with a higher score indicating a better understanding and prevention of the infectious disease. The COVID-19 knowledge and precaution questionnaire showed good internal consistency (Cronbach's alpha was 0.79).

Assessment of Emotional and Behavioral Problems in Children

The EBPs in children were measured by the parent's version of the Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997). The SDQ is a 25-item measure that asks caregivers to rate their child's behavior over the past 6 months, using five subscales—emotional problems, conduct problems, hyperactivity, peer problems, and prosocial behavior in young people aged 4–17 years. Each scale includes five items and each item consists of four statements scored from 0 to 2 (ranging from "did not apply to me at all" = 0; "applied to me some of the time" = 1; and "applied to me very much or most of the time" = 2). Caregivers were asked to choose the best statement that described their child's feelings and thoughts. The total difficulties score was generated by summing the scores from all the scales except prosocial. The resultant score ranged from 0 to 40, with higher scores indicating more EBPs. A 4-fold classification was used to divide different groups based on the scores: 0–13 indicated close to average, 14–16 indicated slightly high, 17–19 indicated high, and 20 to 40 indicated very high. The Chinese version of the SDQ showed good reliability and validity (Cronbach's alpha for the total difficulties score = 0.86) (Liu et al., 2013).

Assessment of the Emotional Problems of Caregivers

In this study, 99.4% of caregivers of children were their parents, and 0.6% were step-parents or grandparents. The Depression Anxiety Stress Scales-21 (DASS-21) was used to measure the states of depression, anxiety, and stress in these caregivers (Henry and Crawford, 2005). The DASS-21 is a 21-item self-reported scale, which asks caregivers to respond to each item by rating the best statement applied over the past week, using a score from 0 to 3 (ranging from "did not apply to me at all" = 0; "applied to me some of the time" = 1; "applied to me a good part of the time" = 2; and "applied to me very much or most of the time" = 3). Each subscale of depression, anxiety, and stress ranged from 0 to 21, with higher scores indicating greater severity of symptoms. The Cronbach's alpha of DASS-21 for depression anxiety, and stress was 0.90, 0.82, and 0.87 in the previous study (Lee, 2019), and 0.81, 0.79, and 0.81, respectively, in this study.

Statistical Analysis

Continuous data were described as means (SD) and categorical data as frequencies and percentages. Chi-square tests and one-way ANOVA were used to compare the categorical and continuous variables among different SDQ groups. Pearson's correlation analysis tested the relation between these variables. Two structural equation models (SEMs) were used to estimate whether associations between COVID-19-related knowledge or precautions and children's total difficulties score were explained by the DASS-21 score of caregivers. COVID-19-related knowledge was represented as a latent variable based on the knowledge of caregivers and children about the disease. COVID-19 related precautions were represented as a latent variable based on the precautions of caregivers and children about the disease. The DASS-21 score of caregivers was represented as a latent variable based on the three subscales of depression, anxiety, and stress. The models were adjusted for gender, grade, school type, family income status, and educational attainment of caregivers. We first tested the SEM model built on a pre-specified theoretical assumption. Subsequently, we re-specified the model by removing non-significant associations and re-evaluating its fitness. Effect sizes of the explanatory factor were calculated

TABLE 1 | Characteristics of participants.

Characteristics	Total	Strengths & Difficulties Questionnaire (SDQ) total difficulties score level				*P*-value
		Close to average (0–13)	Slightly raised (14–16)	High (17–19)	Very high (20–40)	
n	6,017	5,267 (87.5)	431 (7.2)	201 (3.3)	118 (2.0)	
SDQ total difficulties score (range 0–40)	8.1 (4.5)	6.8 (3.2)	14.8 (0.8)	17.8 (0.8)	21.7 (2.3)	<0.001
Sociodemographic variables						
Gender, *n* (%)						<0.001
Male	3,287 (54.6)	2,810 (53.4)	267 (61.9)	130 (64.7)	80 (67.8)	
Female	2,730 (45.4)	2,457 (46.6)	164 (38.1)	71 (35.3)	38 (32.2)	
School, *n* (%)						0.506
Key school	1,092 (18.2)	971 (18.4)	68 (15.8)	33 (16.4)	21 (17.8)	
Non-key school	4,924 (81.8)	42,96 (81.6)	363 (84.2)	168 (83.6)	97 (82.2)	
Grade, *n* (%)						0.265
First grade	1,269 (21.1)	1,127 (21.4)	91 (21.1)	35 (17.4)	16 (13.6)	
Second grade	1,200 (19.9)	1,045 (19.8)	87 (20.2)	37 (18.4)	31 (26.3)	
Third grade	1,262 (21.0)	1,086 (20.6)	104 (24.1)	44 (21.9)	28 (23.7)	
Fourth grade	1,233 (20.5)	1,077 (20.4)	85 (19.7)	50 (24.9)	21 (17.8)	
Fifth grade	1,053 (17.5)	932 (17.7)	64 (14.8)	35 (17.4)	22 (18.6)	
Caregivers' Education, *n* (%)						<0.001
Primary school or lower	415 (6.9)	331 (6.3)	51 (11.8)	15 (7.5)	18 (15.3)	
Middle school	1,750 (29.1)	1,506 (28.6)	150 (34.8)	56 (27.9)	38 (32.2)	
High school	1,500 (24.9)	1,302 (24.7)	110 (25.5)	64 (31.8)	24 (20.3)	
College or higher	2,352 (39.1)	2,128 (40.4)	120 (27.8)	66 (32.8)	38 (32.2)	
Economic status, *n* (%)						<0.001
High	620 (10.3)	569 (10.8)	31 (7.2)	12 (6.0)	8 (6.8)	
Middle	4,927 (81.9)	4,346 (82.5)	344 (79.8)	152 (75.6)	85 (72.0)	
Low	470 (7.8)	352 (6.7)	56 (13.0)	37 (18.4)	25 (21.2)	
COVID-19 related knowledge						
Caregivers (range 1–7)	5.3 (1.7)	5.4 (1.7)	4.7 (1.8)	4.6 (1.9)	4.6 (1.9)	<0.001
Children (range 1–7)	4.5 (1.8)	4.6 (1.8)	3.9 (1.9)	3.8 (1.8)	3.8 (1.9)	<0.001
COVID-19 related precautions						
Caregivers (range 1–7)	6.5 (1.1)	6.5 (1.1)	6.3 (1.3)	6.0 (1.6)	6.0 (1.6)	<0.001
Children (range 1–7)	6.5 (1.1)	6.5 (1.1)	6.2 (1.4)	6.0 (1.6)	5.9 (1.6)	<0.001
Caregivers' DASS-21 score						
Depression (range 0–21)	2.0 (2.0)	1.7 (1.6)	3.2 (2.6)	4.4 (3.4)	5.6 (4.1)	<0.001
Anxiety (range 0–21)	1.9 (1.7)	1.6 (1.3)	2.9 (2.3)	4.1 (3.1)	4.9 (3.8)	<0.001
Stress (range 0–21)	2.9 (2.5)	2.5 (2.1)	4.7 (3.1)	6.0 (3.7)	6.8 (4.3)	<0.001

Data are mean (SD) for continuous variables or n (%) for categorical variables. Chi-square test and one-way ANOVA were used to compare the categorical and continuous variables among different SDQ groups. SDQ, Strengths and Difficulties Questionnaire; DASS-21, Depression Anxiety Stress Scales-21.

as the indirect effect divided by the total effect, according to MacKinnon's formula (Mackinnon, 2008). Chi-square test, root means square error of approximation (RMSEA), the comparative fit index (CFI), Tucker Lewis index (TLI), and standardized root mean square residual (SRMR) were used to test how well the models fitted the observed data, where an RMSEA and SRMR value <0.05 and CFI and TLI value more than 0.95 indicated an adequate model fit. The regression coefficient was used to quantify the strength of the relationship between pairs of variables in the SEM model, and bootstrapping for 10,000 times was used to estimate the SE. A sensitivity analysis was performed in which COVID-19-related knowledge and precautions of caregivers and children were treated as independent variables. This was done to examine whether the latent variable models were misspecified and to determine the robustness of the primary analyses. All analyses were performed by *Mplus* (Muthén and Muthén, 1998) and *R* (version 4.0.1; R Foundation for Statistical Computing, Vienna, Austria). All statistical tests were two-sided and the level of significance was set at a $P < 0.05$.

RESULTS

Characteristics of the Study Population

Table 1 presents descriptive information on the study population. Of the 6,017 participants, 54.6% were boys. The mean (SD) SDQ total difficulties score of children was 8.1

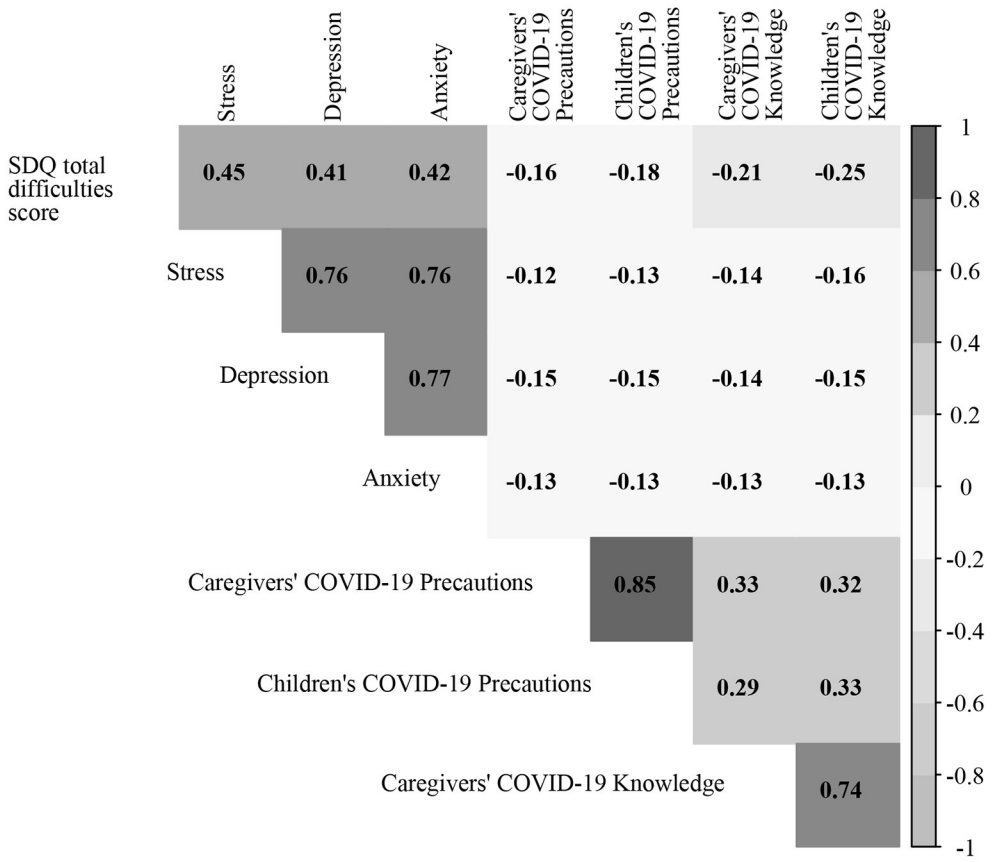

FIGURE 1 | Plot of the correlation coefficient. All $P < 0.05$. SDQ, Strengths and Difficulties Questionnaire.

(4.5) in this study. The prevalence of slightly high, high, and very high EBPs was 7.2, 3.3, and 2.0%, respectively. Boys and children of caregivers with lower educational attainment and family economic status had a higher prevalence of EBPs. The mean COVID-19-related knowledge scores of caregivers and children were 5.3 ± 1.7 (min: 1.0, max: 7.0) and 4.5 ± 1.8 (min: 1.0, max: 7.0), respectively, and the mean COVID-19-related precautions scores were 6.5 ± 1.1 (min: 1.0, max: 7.0) for both. Compared to children without EBPs, children with those problems and their caregivers rated lower for COVID-19-related knowledge and precautions. Caregivers of children with EBPs had higher depression, anxiety, and stress scores. The distributions of school type and grade were not different across the levels of SDQ score.

COVID-19-Related Knowledge and Precautions, DASS-21 Score of Caregivers, and SDQ Total Difficulties Score of Children

The correlation matrix for the indicator variables used in the models is presented in **Figure 1**. The total difficulties score of children was positively correlated with depression ($r = 0.45$, $P < 0.001$), anxiety ($r = 0.41$, $P < 0.001$), and stress of caregivers ($r = 0.42$, $P < 0.001$), while the score was negatively correlated with COVID-19-related knowledge ($r = -0.25$, $P < 0.001$) and precautions ($r = -0.18$, $P < 0.001$) of children as well as the COVID-19-related knowledge ($r = -0.21$, $P < 0.001$) and precautions ($r = -0.16$, $P < 0.001$) of their caregivers. Stress, depression, and anxiety of caregivers were positively intercorrelated and were negatively correlated, respectively, with the COVID-19-related knowledge and precautions of themselves and their children. COVID-19-related precautions among caregivers had a strong positive correlation with those of their children, while COVID-19-related knowledge among caregivers had a strong positive correlation with that of their children.

Figure 2 displays model 1 of the relationship between COVID-19-related knowledge and total difficulties score of children, which was explained by the depression, anxiety, and stress in caregivers. Model 1 adjusted for gender, grade, school type, family economic status, and educational attainment of caregivers. The model fit indices were acceptable with χ^2 927.198 ($df = 71$, $P < 0.001$), CFI 0.956, TLI 0.950, RMSEA 0.045, and SRMR 0.035. COVID-19-related knowledge was treated as a latent variable with two indicators, including the knowledge of caregivers and children ($\beta = 1.22$, $P < 0.001$). The DASS-21 score of caregivers was treated as a latent variable with three indicators, including depression, anxiety ($\beta = 0.88$, $P < 0.001$), and stress scales ($\beta = 1.26$, $P < 0.001$). The three path coefficients were all significant: path a from COVID-19-related knowledge to

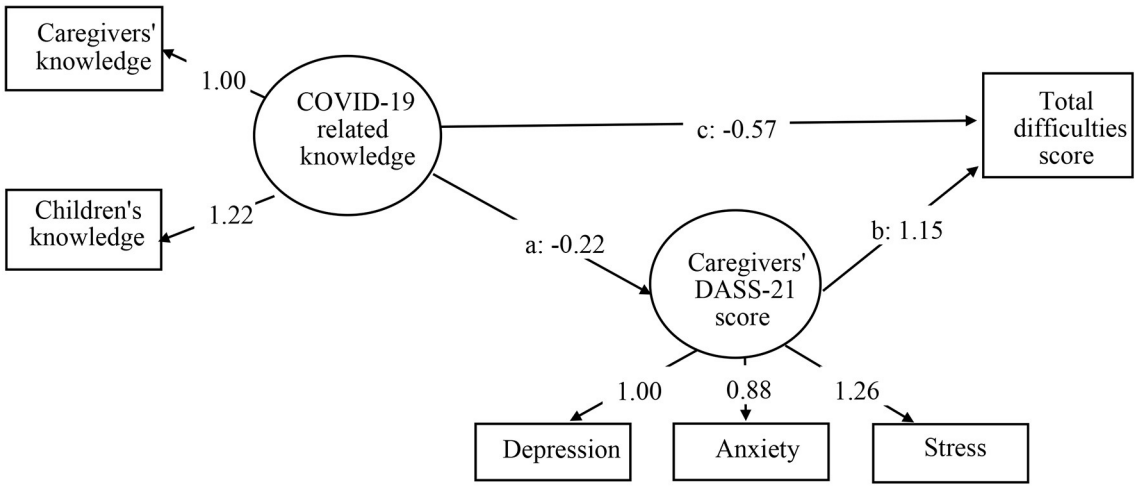

FIGURE 2 | Model 1 of associations between COVID-19-related knowledge, DASS-21 score of caregivers, and total difficulties score. Data shown are unstandardized coefficients and all the associated $P < 0.001$. Model 1 adjusted for gender, grade, school, family economic status, and education level of caregivers. DASS-21, Depression Anxiety Stress Scales-21.

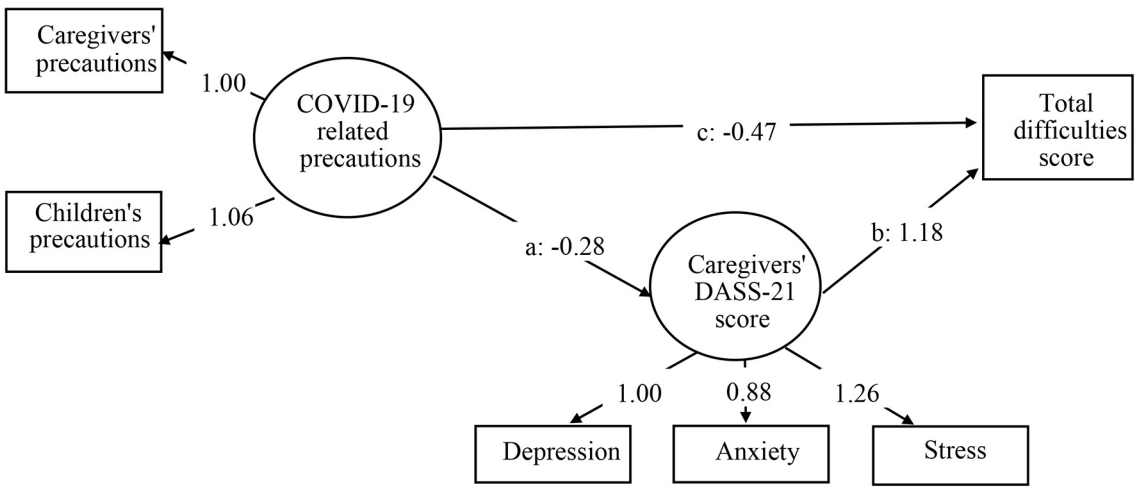

FIGURE 3 | Model 2 of associations between COVID-19-related precautions, DASS-21 score of caregivers, and total difficulties score. Data shown are unstandardized coefficients and all the associated $P < 0.001$. Model 2 adjusted for gender, grade, school, family economic status, and education level of caregivers. DASS-21, Depression Anxiety Stress Scales-21.

DASS-21 score of caregivers ($\beta = -0.22$, $P < 0.001$), path b from DASS-21 score of caregivers to total difficulties score of children ($\beta = 1.15$, $P < 0.001$), and the direct path c from COVID-19-related knowledge to total difficulties score of children ($\beta = -0.57$, $P < 0.001$). The bootstrapping index for an indirect effect (a * b: $\beta = -0.26$, $P < 0.001$) was also statistically significant with effect size 0.31, suggesting that the DASS-21 score of caregivers partially explained the relationship between COVID-19-related knowledge and total difficulties score of children.

Figure 3 displays model 2 of the relationship between COVID-19-related precautions and total difficulties score, which was explained by depression, anxiety, and stress in caregivers. Model 2 adjusted for the same covariates as model 1. The model fit indices were acceptable with χ^2 591.726 ($df = 71$, $P < 0.001$), CFI 0.976, TLI 0.973, RMSEA 0.035, and SRMR 0.034. COVID-19-related precautions were treated as a latent variable with two indicators, including precautions of caregivers and children ($\beta = 1.06$, $P < 0.001$). The three path coefficients were all significant: path a from COVID-19-related precautions to DASS-21 score of caregivers ($\beta = -0.28$, $P < 0.001$), path b from DASS-21 score of caregivers to total difficulties score of children ($\beta = 1.18$, $P < 0.001$), and the direct path c from COVID-19-related precautions to total difficulties score of children ($\beta = -0.47$, $P < 0.001$). The bootstrapping index for an indirect effect (a * b: $\beta = -0.33$, $P < 0.001$) was also statistically significant with effect size 0.41, suggesting that the DASS-21 score of

TABLE 2 | Statistical results of the multivariable models.

	β	*SE*	*b*	*P*-value	Effect size
Model 1					
COVID-19 related knowledge → Caregivers' DASS-21 score (path a)	−0.22	0.02	−0.18	<0.001	
Caregivers' DASS-21 score → Total difficulties score (path b)	1.15	0.05	0.45	<0.001	
COVID-19 related knowledge → Total difficulties score (path c)	−0.57	0.04	−0.18	<0.001	
Indirect effect *via* Caregivers' DASS-21 score (a * b)	−0.26	0.02	–	<0.001	
Total effect of COVID-19 related knowledge on total difficulties score (a * b + c)	−0.83	0.07	–	<0.001	0.31
DASS-21					
Anxiety	0.88	0.02	0.88	<0.001	
Stress	1.26	0.03	0.87	<0.001	
COVID-19 related knowledge					
Children' knowledge	1.22	0.05	0.91	<0.001	
Model 2					
COVID-19 related precautions → Caregivers' DASS-21 score (path a)	−0.28	0.03	−0.16	<0.001	
Caregivers' DASS-21 score → Total difficulties score (path b)	1.18	0.05	0.46	<0.001	
COVID-19 related precautions → Total difficulties score (path c)	−0.47	0.06	−0.10	<0.001	
Indirect effect *via* Caregivers' DASS-21 score (a * b)	−0.33	0.04	–	<0.001	
Total effect of COVID-19 related precautions on total difficulties score (a * b + c)	−0.80	0.07	–	<0.001	0.41
DASS-21					
Anxiety	0.88	0.02	0.88	<0.001	
Stress	1.26	0.03	0.87	<0.001	
COVID-19 related precautions					
Children' precautions	1.06	0.06	0.94	<0.001	

β = unstandardized estimate; b = standardized estimate. Effect size is the proportion mediated, which is calculated by dividing the indirect effect by the total effect. Models adjusted for gender, grade, school, family economic status, and education level of caregivers. DASS-21, Anxiety Stress Scales-21.

caregivers partially explained the relationship between COVID-19-related precautions and total difficulties score of children. The bootstrapping results of the two models are summarized in **Table 2**.

Sensitivity Analysis

A sensitivity analysis was performed in which COVID-19-related knowledge and precautions of caregivers and children were treated as independent variables. All the model fit indices were acceptable, and the bootstrapping results of the four models are summarized in **Table 3**. The results also revealed that COVID-19-related knowledge and precautions of caregivers and children were negatively associated with the total difficulties score, partially explained by the DASS-21 score of caregivers.

DISCUSSION

In this cross-sectional study, the prevalence of EBPs in primary school children of Shanghai and Taizhou was 12.5%, with 3.3 and 2.0% children having high and very high SDQ total difficulties scores, respectively, during the post-pandemic period in China. Additionally, higher COVID-19-related knowledge and precautions were significantly associated with lower total EBPs among children after adjusting for covariates. Emotional problems in caregivers were associated with greater EBPs in children. The SEM suggested that emotional problems in caregivers partially explained the relationship between COVID-19-related knowledge and precautions and EBPs in children.

Based on this study, the prevalence of EBPs in children during the COVID-19 post-pandemic period was 12.5% in China. It was similar to a cross-sectional study conducted in Guangdong, between March 8 and March 30, 2020, which showed that the self-reported psychological disorder was 10.5% among students with an average age of 12 years (Qin et al., 2021). However, the prevalence in this study was lower than that reported in the previous studies during the COVID-19 period. In April 2020, Xie et al. reported that 22.6% of 2,330 primary school students had depressive symptoms in Hubei province during the pandemic (Xie et al., 2020). Another study, which included 3,613 students aged between 7 and 18 years from 20 provinces in mainland China, reported that 22.3% of the respondents suffered from depressive symptoms (Duan et al., 2020). The main reason for the difference was that the two studies covered Hubei province, the epicenter of the COVID-19 outbreak in China. We speculated that the survey period could be another reason. In this study, we collected the data between June 26 and July 6, 2020, when the pandemic was under control and most of the primary schools had reopened normally in China.

The results of this study provide substantial support for the association between COVID-19-related knowledge and precautions and lower psychopathology among children. This is in line with the previous findings that students who had more knowledge about COVID-19 and higher face mask-wearing

TABLE 3 | Statistical results of the multivariable models for sensitivity analysis.

	β	*SE*	*b*	*P*-value	Effect size
Model 1					
Caregivers' COVID-19 related knowledge → Caregivers' DASS-21 score (path a)	−0.15	0.02	−0.15	<0.001	
Caregivers' DASS-21 score → Total difficulties score (path b)	1.17	0.05	0.45	<0.001	
Caregivers' COVID-19 related knowledge → Total difficulties score (path c)	−0.36	0.03	−0.13	<0.001	
Indirect effect *via* caregivers' DASS-21 score (a * b)	−0.18	0.02	–	<0.001	
Total effect of caregivers' COVID-19 related knowledge on total difficulties score (a * b + c)	−0.54	0.07	–	<0.001	0.33
DASS-21					
Anxiety	0.88	0.02	0.88	<0.001	
Stress	1.26	0.03	0.87	<0.001	
Model 2					
Children' COVID-19 related knowledge → Caregivers' DASS-21 score (path a)	−0.15	0.01	−0.16	<0.001	
Caregivers' DASS-21 score → Total difficulties score (path b)	1.16	0.05	0.45	<0.001	
Children' COVID-19 related knowledge → Total difficulties score (path c)	−0.39	0.03	−0.16	<0.001	
Indirect effect *via* caregivers' DASS-21 score (a * b)	−0.17	0.02	–	<0.001	
Total effect of children' COVID-19 related knowledge on total difficulties score (a * b + c)	−0.57	0.03	–	<0.001	0.30
DASS-21					
Anxiety	0.88	0.02	0.88	<0.001	
Stress	1.26	0.03	0.87	<0.001	
Model 3					
Caregivers' COVID-19 related precautions → Caregivers' DASS-21 score (path a)	−0.24	0.03	−0.15	<0.001	
Caregivers' DASS-21 score → Total difficulties score (path b)	1.19	0.05	0.46	<0.001	
Caregivers' COVID-19 related precautions → Total difficulties score (path c)	−0.36	0.05	−0.09	<0.001	
Indirect effect *via* caregivers' DASS-21 score (a * b)	−0.28	0.03	–	<0.001	
Total effect of caregivers' COVID-19 related precautions on total difficulties score (a * b + c)	−0.64	0.06	–	<0.001	0.44
DASS-21					
Anxiety	0.88	0.02	0.88	<0.001	
Stress	1.26	0.03	0.87	<0.001	
Model 4					
Children' COVID-19 related precautions → Caregivers' DASS-21 score (path a)	−0.23	0.03	−0.15	<0.001	
Caregivers' DASS-21 score → Total difficulties score (path b)	1.18	0.05	0.46	<0.001	
Children' COVID-19 related precautions → Total difficulties score (path c)	−0.40	0.05	−0.10	<0.001	
Indirect effect *via* caregivers' DASS-21 score (a * b)	−0.27	0.03	–	<0.001	
Total effect of children' COVID-19 related precautions on total difficulties score (a * b + c)	−0.67	0.05	–	<0.001	0.40
DASS-21					
Anxiety	0.88	0.02	0.88	<0.001	
Stress	1.26	0.03	0.87	<0.001	

β = unstandardized estimate; b = standardized estimate. Effect size is the proportion mediated, which is calculated by dividing the indirect effect by the total effect. Models adjusted for gender, grade, school, family economic status, and education level of caregivers. DASS-21, Depression Anxiety Stress Scales-21.

frequency were less likely to experience psychological distress (Qin et al., 2021). Therefore, concerning COVID-19-related precautions, the significant inverse relationship with EBPs among children suggested that individuals who followed the recommended guidelines also had better mental health. One of the possible explanations for the protective association between pandemic-related knowledge and preventive behaviors with EBPs is that lower COVID-19-related knowledge or precautions may reflect lower intelligence of the children or family economic status, which may, in turn, be associated with poor mental health. However, the causal effects of COVID-19-related knowledge and precautions need to be verified in future prospective studies.

Our results indicate that emotional problems among caregivers, including depression, anxiety, and stress, explained 31% and 41% of the total effect of COVID-19-related knowledge and precautions, respectively, on EBPs among children during the post-pandemic period. The findings provide support for the positive relationship between emotional problems among caregivers and EBPs in children, which is consistent with previous studies (Psychogiou et al., 2017; Spinelli et al., 2020; Liang et al., 2021). A previous study indicated that as fear can be contagious, children are exceedingly sensitive to the emotional status of adults around them, who are an indispensable source of security and emotional well-being (Imran et al., 2020).

Emotional problems in caregivers, such as depression, might significantly influence parent-child relations (Riley et al., 2008) and increase the risk of marital conflict and unhappiness (Cummings et al., 2005), which in turn predispose children to EBPs (Rasic et al., 2014). The pandemic caused caregivers to worry about the health of their family members and the inability to meet the demanding economic needs, especially in developing countries like China where the pandemic had badly disrupted the financial and economic activities. The consequent family economic hardship during the pandemic resulted in an increased risk of childhood psychiatric disorder (Solantaus et al., 2004). Moreover, emotional problems among caregivers are often associated with rude behaviors and difficulties in explaining the pandemic situation. Thus, children in these families may have lower personal resources to prevent negative psychological consequences (Pinquart, 2017). A steady and supportive parent-child relationship is a benefit to the positive development of the psychological well-being of young children (Schofield et al., 2013).

These findings suggest many efficient implications that should be applied to promote the well-being of children during the post-pandemic period in China. During and after the pandemic, education regarding prevention should be emphasized, and parents or caregivers should be encouraged to pay attention to what children see or hear on television or online, communicate to their children truthful and appropriate information, and teach the correct precautions including hand-washing and mask-wearing, which are important to lessen the negative effects of COVID-19 (Centers for Disease Contol and Prevention, 2020). Schools and communities have to inform children and their caregivers about the potential risk of COVID-19 and help to increase their knowledge and preventive awareness of the pandemic. Individual preventive behaviors may alleviate mental health problems in caregivers and children, and mental health intervention can improve resilience in the face of adversity among caregivers and children. It is imperative for schools and communities to not only provide the necessary health and pandemic-related information but also provide mental support to caregivers and children. The kids whose caregivers experienced psychological problems and whose families were faced with economic hardship may return to school with more intensive needs. School psychologists need to increase their level of service and consider psychoeducation to support the transition of children back into the school building and address emotional and behavioral problems. Besides, mental health providers also can assist the NGOs to organize interactive webinars with experts to help children and their caregivers cope with mental health (OECD, 2020). A previous study presented that mental disorders in children had significant consequences throughout a child's life and affected the child's development, including poor educational outcomes and a higher rate of unemployment (OECD, 2018). Thus, for children living with mental disorders, timely psychological interventions such as online counseling and cognitive behavioral therapy by trained psychologists are also critical.

Several limitations should be considered while interpreting the findings. First, causality between COVID-19-related knowledge and precautions and EBPs in children cannot be inferred from a cross-sectional study, and a longitudinal study is needed to clarify these relationships. Second, compared with a face-to-face interview, a self-report online survey was not representative of individuals who had limited access to the internet. Third, a single-item scale was used to assess COVID-19-related knowledge and precautions. Future studies could adopt a more comprehensive scale, such as a 16-item questionnaire of knowledge, attitudes, and practice toward COVID-19 used in the study of Zhong et al. (2020). Future studies could also consider measuring both self-perceived and actual knowledge to obtain a more in-depth understanding of the impact of knowledge on emotional and behavioral problems in people. Fourth, we only measured knowledge and practices toward COVID-19. It would have been better if we could also assess the attitudes of participants, such as the perceived risk of the pandemic, and evaluate their impact on the mental health of caregivers and children. Despite these limitations, this study with a large sample size offers sufficient statistical power to assess the association between COVID-19-related knowledge and precautions and EBPs in children and detect the small but plausible explanatory effect of emotional problems among caregivers on the relationship.

In conclusion, the prevalence of EBPs in primary school children was 12.5% during the post-pandemic period in China. Findings from this study suggest that levels of knowledge and preventive behaviors of COVID-19 were associated with EBPs in children, and the relationships were partially explained by the emotional problems among caregivers. Policymakers and mental health professionals should ensure that psychological interventions such as outpatient or online psychological counseling by trained psychologists are available to help children and their caregivers deal with public health crises such as the COVID-19 pandemic.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, upon a reasonable request.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional Review Board of School of Public Health, Fudan University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

JW and YC: conceptualization, methodology, formal analysis, validation, writing-original draft, and visualization. XG and HL: conceptualization, methodology, data curation, writing review, and editing. MR: conceptualization, methodology, supervision, writing review, and editing. HW: methodology, data curation, writing review, and editing. XC: conceptualization,

methodology, data curation, supervision, writing review, and editing. CF: conceptualization, methodology, supervision, funding acquisition, resources, writing review, and editing. All authors contributed to the article and approved the submitted version.

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After the Pandemic: The Future of Italian Medicine. The Psychological Impact of COVID-19 on Medical and Other Healthcare-Related Degrees Students

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Objective: The study aimed to explore the psychological symptoms and the readiness to fight the pandemic of the new generation of healthcare professionals: medical and other healthcare degree students.

Methods: We enrolled 509 medical and healthcare-related degree students during the second outbreak of COVID-19 in Italy. We have examined their psychological symptoms using the 12-item General Health Questionnaire (GHQ-12) and their readiness to fight the pandemic together with their academic career status, their relationship with the university, and their emotional reactions to the pandemic with Visual Analog Scales.

Results: We retrieved a GHQ mean of 21.65 (SD = 40.63) and readiness to fight the pandemic mean of 53.58 (SD = 31.49). Perceived control affects variables: a negative effect on psychological symptoms and a positive effect on the willingness to fight the pandemic. The other variables with an impact were stress, loneliness, and anger that had a significant and positive impact on psychological symptoms. Age and concern for patients had a significant positive impact on readiness to fight for the pandemic, while years of attendance had a significant but negative impact.

Conclusion: Universities and Institutions should consider the impact of the pandemic on students, in particular, for its effect on their mental health.

Keywords: students, health-care professionals, COVID-19, psychological symptoms, pandemic, emotional reactions

INTRODUCTION

The COVID-19 pandemic has been affecting the lives of people significantly for the past year. Italy, in particular, has been one of the most affected countries, with a substantial number of cases that, despite numerous restrictions, stopped increasing for a while (Distante et al., 2020; Remuzzi and Remuzzi, 2020).

During this tough time, we have experienced an apocalyptic-like scenario where the streets were empty and the hospitals were full. People were forced into their homes starting from March 9, 2020, to May 18, 2020, with this affecting significantly their quality of life and mental health status (Masiero et al., 2020; Pizzoli et al., 2020; Prete et al., 2020; Serafini et al., 2020; Monzani et al., 2021).

Initially, the Italian Government tried to loosen the containment measures, since the cases seemed to decrease, but unfortunately, the situation resumed quickly, after a few months from the end of the first phase (Bontempi, 2020; Wise, 2020).

Hospitalization, infections, and deaths linked to COVID-19 returned and rose exponentially, leaving people facing new restrictions and several hard consequences: freedom of movement was severely constrained in most of the Italian regions, the majority of workers started to operate from home again, shops were closed, and restaurants were forced to limited opening, with this having a major impact on the economy.

In hospitals, the situation became critical, leading to the suspension of non-urgent procedures and wards converted for COVID-19, therefore, affecting the quality of life of those who needed treatment and putting even more stress on healthcare workers.

Starting from March 5, face-to-face educational activities of the academic year 2019–2020 were suspended in both schools and universities throughout the country to limit the spread of the virus. To deal with this situation, distance learning through various online platforms was initiated (Favale et al., 2020). Undoubtedly, this modality had several advantages. There is no need to share a room for hours, reducing the risks of infection (Saddik et al., 2020). On the other hand, there was a significant reduction of interaction between students and professors, with a loss of practical training opportunities. The mental health of the students was also brought into question.

In this regard, some studies were conducted with college students worldwide, demonstrating a strong emotional impact of the COVID-19 pandemic (Nurunnabi et al., 2020; Sundarasen et al., 2020; Batais et al., 2021; Pedraz-Petrozzi et al., 2021). For example, in a study conducted on Malaysian college students, the levels of anxiety during the peak of the COVID-19 crisis were high, and the major causes of stress were financial restrictions, distance learning, and uncertainty about the future, in particular, related to academic performance (Sundarasen et al., 2020). In China, students showed clinically relevant symptoms of anxiety, depression, and post-traumatic stress disorder (PTSD), with various factors making a contribution: for example, older age was linked with PTSD symptoms (Chi et al., 2020). In a recent study with Italian college students, depressive symptoms worsened during lockdown compared with 6 months before isolation (Meda et al., 2021). Multiple stressors were identified that contributed to the increased levels of stress, anxiety, and depressive thoughts, such as both factors related to university life and other emotional reactions to the situation (Son et al., 2020).

Among the college students, the worries of students in health professions were particularly enhanced by the situation, and this was true both because of the impact of the pandemic on their education and because of their possible commitment to fight the pandemic (Biavardi, 2020; Chandratre, 2020; Ferrel and Ryan, 2020).

Students in health professions are usually and generally more prone to stress, as demonstrated by some studies: they suffer from stress and burnout, and even higher rates of depression than the general population, with rates of women higher than rates of men (Dahlin et al., 2005; Watson et al., 2008). During the pandemic, studies conducted in different countries highlighted that medical students showed symptoms of depression, stress, or anxiety (Saddik et al., 2020; Batais et al., 2021; Nishimura et al., 2021; Pedraz-Petrozzi et al., 2021; Seetan et al., 2021). Among the factors associated with higher stress levels, studies identified female gender, worries about family, or personal health, and also, online learning (O'Byrne et al., 2020a). Nursing students were found to suffer from anxiety, stress, and fear (Temiz, 2020; Aslan and Pekince, 2021; Medina Fernández et al., 2021). In the healthcare students sample, smoking, using medications, and having lower family income are factors associated with higher anxiety during the COVID-19 pandemic (Basheti et al., 2021).

Consistent with these results, a recent study showed that the mental health of Italian healthcare workers was affected by the COVID-19 pandemic (Marton et al., 2020), suggesting that perceived control, concern for patients and family, feeling alone, and anger were significant predicting factors.

In this context, it was particularly interesting to study the perceptions of students of being able to fight the pandemic (O'Byrne et al., 2020b). This idea is compatible with studies of resilience and self-efficacy (Bandura, 1994) and with the more recent studies on perceived work readiness (Caballero and Walker, 2010). Much of the literature that has investigated the transition experiences of graduate healthcare workers have mostly focused on the stressors associated with the first years of work (e.g., Daly and Willcock, 2002; Willcock, 2005; Kelly and Ahern, 2009; Watson et al., 2009). However, less is known about the perceived efficacy to work in the context of the pandemic. In past pandemics, other studies had highlighted the willingness of medical students to be directly involved (Mortelmans et al., 2009; Waight et al., 2011), but little is known about factors associated with this desire: we may suppose that older students attending the last years of their university health professional education programs are more experienced, have more perceived efficacy, and therefore, are more ready to fight the pandemic. However, as noted, mental stress and other emotional reactions are common for students during this situation and may affect their readiness to fight the pandemic and the relationship they have with the university.

The aim of this study was to explore the mental health and readiness to fight the pandemic during the second wave of the COVID-19 pandemic. Based on previous studies conducted during similar events on college students and healthcare professionals (Chi et al., 2020; Marton et al., 2020; Son et al., 2020), we hypothesized increased psychological symptoms in students and different degrees of readiness to fight the pandemic on the basis of their current academic career and their emotional reactions to the COVID-19 pandemic. More specifically, we hypothesized that psychological symptoms of students and readiness to fight the pandemic were dependent on a number of factors, such as the academic career status (age and years of attendance), relationship with the university (feeling abandoned by the university, possible regret for the chosen program), and other emotional reactions to the pandemic (stress, feeling alone, anger, fear for patients, and perceived control).

MATERIALS AND METHODS

We performed an observational study with a sample of 509 students enrolled in healthcare programs during the second wave of COVID-19 in Italy. Recruitment started on November 23, 2020, and ended on December 5, 2020; it occurred through social media, mailing lists of universities, and snowball recruitment. The research was approved by the European Institute of Oncology Ethics Committee. Written informed consent was provided by the participants before they started to complete an online survey, which aimed to measure their mental health status and their response to the second wave of COVID-19 in Italy. In the introduction to the questionnaire, we explained that we wanted to assess how the emergency affected the lives of the students in terms of psychological symptoms, readiness to fight the pandemic, and their academic career status, relationship with the university, and other emotional reactions to the pandemic.

The online questionnaire was designed following the 12-item General Health Questionnaire (GHQ) Italian Translation (Piccinelli et al., 1993; Goldberg et al., 1997) and used Visual Analog Scales (VAS).

Specifically, the GHQ-12 assessed psychological symptoms. Examples of items were "have you felt unhappy or depressed?" and "have you lost confidence in yourself?" Four-point Likert scale answers were used in each question. Scores above the threshold of 13/14 are an indicator of the presence of psychological symptoms (Piccinelli et al., 1993; Goldberg et al., 1997).

Fourteen VAS were designed by authors to explore the readiness of students to fight the pandemic, their academic career status, their relationship with the university, and their emotional reactions to the pandemic. Examples of items were "You are feeling stressed," "You are feeling in control of the situation in everyday life," "You are feeling lonely," and "If you chose a career in healthcare, how ready would you feel to face the current pandemic situation." The VAS had a range from 0 (not at all) to 100 (completely), with high values indicating the worse condition except for questions concerning the compliance with the rules, the perceived control on the situation, and readiness to respond to it. The full VAS are reported as **Supplementary Material**.

Using SPSS 26, we performed descriptive statistics (mean and SD), bivariate correlation, and multivariate regression analysis, considering $p < 0.05$ as a statistical significance.

RESULTS

The sample was composed of 362 (71.1%) medical students, 132 (25.9%) nursing students, and 15 (2.9%) students of other healthcare professions. Among the participants, 374 (73.5%) were female and 133 (26.1%) male; two (0.4%) persons preferred not to specify their gender.

Regarding the year of attendance, 166 (32.6%) participants were attending the first year, 213 (41.8%) the second, 66 (13.0%) the third, 27 (5.3%) the fourth, one student (0.2%) attending the fifth, and 36 (7.1%) students the sixth. In the sample, 418 (82.1%) students were not doing clinical internships whereas 91 of them (17.9%) were doing.

Since restrictions varied from region to region, we decided to consider the areas from which the participants came: 33 participants (6.5%) were located in "yellow areas," (low risk), 248 (48.7%) in "orange areas" (moderate risk), and 228 (44.8%) in "red areas" (high risk) according to the regions risk scenarios established by the Italian Government (Decree by the President of the Council of Ministers on November 3, 2020, published in the Italian official journal no. 275).

Descriptive Statistics

Descriptive statistics of our study variables can be found in **Table 1**.

In particular, regarding the key variables, the mean of psychological symptoms was 21.65 (SD = 4.63) above the threshold of 13/14, therefore, indicating a high level of distress. The VAS investigating the readiness to fight the pandemic had a mean of 53.58 (SD = 31.49). Regarding academic career status, we retrieved a mean age of 21.28 (SD = 3.08) and a mean year of attendance of 2.19 (SD = 1.33). VAS investigating the relationship with the university—feeling abandoned by the university and possible regret for the chosen degree—had respectively, a mean of 40.35 (SD = 33.92) and 6.17 (SD = 16.86). VAS related to emotional reactions to the pandemic included stress (mean = 65.22; SD = 24.92), loneliness (mean = 51.43; SD = 34.25), anger (mean = 45.61; SD = 33.24), fear for patients (mean = 27.09; SD = 36.85), and perceived control (mean = 48.16; SD = 27.52).

TABLE 1 | Descriptive statistics of study variables.

	Minimum	Maximum	Mean	SD
Psychological symptoms	5	33	21.65	4.63
Readiness to fight the pandemic	0	100	53.58	31.49
Age	18	46	21.28	3.08
Year of attendance	1	6	2.19	1.33
Feeling abandoned by university	0	100	40.35	33.92
Regret for the chosen degree	0	100	6.17	16.86
Stress	0	100	65.22	24.92
Loneliness	0	100	51.43	34.25
Anger	0	100	45.61	33.24
Fear for their patients	0	100	27.09	36.85
Perceived control	0	100	48.16	27.52
Fear for themselves	0	100	33.65	27.07
Fear for family member/cohabitant	0	100	71.35	28.39
Feeling worried about the effect of the pandemic on the timing of their degree	0	100	30.89	35.12
Respect for the rules imposed by the government	0	100	90.50	17.26
Undertaken preventative behavior	0	100	87.86	16.62
Stress related to the region	0	100	60.40	31.33

Correlations and Regression Analyses

Results of the correlational analysis between the key variables are reported in **Table 2**.

We then performed a multivariate regression analysis, considering psychological symptoms and readiness to fight the pandemic as dependent variables whereas academic career status variables (i.e., age and years of attendance), relationship with the university variables (i.e., feeling abandoned by the University, possible regret for the chosen degree), and emotional reactions to the pandemic variables (i.e., stress, loneliness, anger, fear for patients, and perceived control) were regarded as independent.

We considered partial η^2 as an effect size measure, following the classification of Cohen (1988): 0.01, as small effects, 0.06 as medium effects, and 0.14 as large effects.

Variance inflation factor (VIF) indicators were considered to verify that multicollinearity did not represent a problem.

Detailed results and coefficient values of the multivariate regression analysis are reported in **Table 3**.

We retrieved satisfactory R^2 values for both psychological symptoms and readiness to fight the pandemic (respectively: R^2 = 0.38 and adjusted R^2 = 0.36; R^2 = 0.19 and adjusted R^2 = 0.16).

Perceived control was the only variable having a significant effect on both the two dependent variables: a negative effect on psychological symptoms and a positive effect on the readiness to fight the pandemic. Stress, loneliness, and anger had a significant and positive effect on psychological symptoms. Age and concern for patients had a significant positive effect on readiness to fight the pandemic, while years of attendance had a significant but negative effect.

TABLE 2 | Correlations between the key variables.

	Variables	1	2	3	4	5	6	7	8	9	10	11
1	Psychological symptoms		−0.09*	−0.07	−0.07	0.21**	0.15**	0.53**	0.43**	0.36**	−0.04	−0.38**
2	Readiness to fight the pandemic			0.15**	−0.19**	−0.08	−0.05	−0.06	−0.06	0.00	0.23**	0.18**
3	Age				0.37**	0.2*	0.05	−0.09*	−0.12**	−0.1*	0.16**	0.16**
4	Years of attendance					0.32**	0.09*	−0.11*	−0.08	−0.16**	0.08	0.07
5	Abandoned by university						0.2**	0.21**	0.20**	0.21**	0.02	−0.07
6	Regret for the chosen degree							0.05	0.05	0.07	0.06	−0.15**
7	Stress								0.37**	0.43**	0.03	−0.28**
8	Loneliness									0.38**	0.06	−0.24**
9	Anger										0.02	−0.2**
10	Fear for their patients											−0.03
11	Perceived control											

*Significant correlations 0.05 two-tailed; **significant correlations 0.01 two-tailed.*

TABLE 3 | Results and coefficients of multivariate regression analysis.

Dependent variable		B	*p*	95% C.I.		Partial η^2
Psychological symptoms	Age	0.085	0.307	−0.078	0.247	0.004
	Year of attendance	−0.036	0.841	−0.388	0.316	0.000
	Abandoned by university	0.009	0.208	−0.005	0.024	0.006
	Regret for the chosen degree	0.023	0.077	−0.002	0.048	0.011
	Stress	0.062	0.000	0.042	0.082	0.116
	Loneliness	0.026	0.000	0.012	0.040	0.044
	Anger	0.017	0.031	0.002	0.033	0.016
	Fear for their patients	−0.011	0.068	−0.023	0.001	0.012
	Perceived control	−0.031	0.000	−0.048	−0.015	0.046
Readiness to fight the pandemic	Age	2.335	0.000	1.114	3.557	0.048
	Year of attendance	−5.878	0.000	−8.519	−3.237	0.063
	Abandoned by university	−0.010	0.861	−0.119	0.100	0.000
	Regret for the chosen degree	−0.006	0.953	−0.194	0.183	0.000
	Stress	−0.059	0.441	−0.208	0.091	0.002
	Loneliness	−0.041	0.444	−0.147	0.064	0.002
	Anger	0.062	0.299	−0.055	0.179	0.004
	Fear for their patients	0.188	0.000	0.097	0.279	0.055
	Perceived control	0.211	0.001	0.087	0.335	0.038

DISCUSSION

Even though some opinion articles and editorials are circulating (e.g., Biavardi, 2020), to the best of our knowledge, this is the first study aiming to investigate psychological symptoms and readiness to fight the pandemic of a sample of students in health professions in Italy during the COVID-19 emergency, in particular, during the second wave.

In a world that is changing unexpectedly, in which healthcare professionals are pushed to fight the virus at the cost of their safety and lives (Marton et al., 2020), some students are looking at the healthcare crisis and at the difficulties of healthcare providers imagining their future and projecting themselves into it.

Overall, we found that students in health professions in our sample respected the rules imposed by the government to restrict the pandemic, and they think that their behavior is protective, but fear for their family members and cohabitants is high. We can only assume that following our previous results found in a healthcare professional sample fighting against COVID-19 in phase 1 of the Italian pandemic, once they start their jobs face to face with COVID-19-affected patients, the fear could grow together with their psychological distress (Marton et al., 2020). Their psychological symptom level was above the threshold of the GHQ-12 indicating a high level of distress. All of these factors contribute to making the condition of the students in health professions a difficult one, but they do not regret their choice in studying in a healthcare profession degree—the mean of the VAS investigating the feeling of regret for the chosen degree is low. This last result is in line with the findings of Bai et al. (2021) in a group of Chinese nursing students. The commitment of students to nursing as a profession increased after the beginning of the pandemic; the authors highlighted as possible reasons the positive image of nurses provided by media and the implementation of policies to improve the welfare of nurses during the pandemic.

The mean of the VAS investigating the readiness to fight the pandemic is moderately high, but it could be comparable to other similar results retrieved in different pandemic contexts. In the past H5N1 pandemic, 88.0% of medical students interviewed in Michigan expressed their desire to be part of the healthcare staff (Waight et al., 2011). Moreover, during the same pandemic, the vast majority of Belgian senior medical students were willing to "being involved in implementing primary care" and "would care for pandemic patients if necessary" (Mortelmans et al., 2009, 438). Despite their fears, for themselves and their families, their anger, and their high level of psychological symptoms, our sample of students would like to "take the field," exposing themselves directly to the challenges of managing the COVID pandemic.

Psychological Symptoms

The psychological symptoms of students in health professions are explained by four variables, all pertaining to their emotional reactions to the pandemic: stress, loneliness, anger, and perceived control. Distress is defined as "a state of emotional suffering associated with stressors and demands that are difficult to cope with in daily life" (Arvidsdotter et al., 2016, 687) and is associated with many negative emotions: distress could impact the emotional status by changing it (Ridner, 2004; Carmassi et al., 2020).

Previous literature indicates that psychological distress could be related to different variables. In a sample of Chinese health professional students, psychological distress experienced during the pandemic and symptoms of acute stress reaction have been linked to adverse childhood events, life stressors, and internet addiction (Li et al., 2021a). The pandemic of COVID-19 increases stress, loneliness, and anger in students in health professions (Wang et al., 2020). These negative emotions could play a major role in the first year of training (Pitkälä and Mäntyranta, 2004; Kremer et al., 2016).

Another factor that contributed to explaining psychological symptoms is perceived control of the situation. The data are in line with the results of other previous studies (e.g., Zheng et al., 2020), which found that life satisfaction and perceived general health during the COVID-19 pandemic are affected by perceived control of the situation, and they concluded that they could be considered as protective factors against the negative effects of the pandemic. Our results add some interesting nuances—perceived control also affects the distress of students in health professions.

These data, indicating the high level of distress of this population in this particular situation, could be useful to Institutions and Universities. Distress in college students is often linked to costly consequences—such as worsening academic achievement or risky behaviors (Sharp and Theiler, 2018). For these reasons, it could be useful to implement appropriate and tailored interventions to identify vulnerable subjects, support students, and prevent negative effects. These interventions could be focused on implementing coping strategies helpful to overcome this particular situation and future ones.

Readiness to Fight the Pandemic

In our study, students reported that they were quite ready to fight the pandemic. This appears consistent with other studies in other national contexts, in which students indicated their willingness to join the healthcare response to the COVID-19 pandemic (Hong et al., 2021).

Moreover, we found that four variables participated in explaining the readiness to fight the pandemic. The variables, regarding academic career status, age, and year of attendance had the strongest effect.

In particular, the older students seemed to be more ready to fight the pandemic compared to younger students. To explain these results, we could borrow from Petersen (2020) the concept of "optimistic anxiety": in order to face the pandemic optimally, individuals should be both anxious and optimistic, anxious that they follow the rules and optimistic enough to believe that what they do could make a difference. This concept addresses the general population, but we think that it could be translated into the situation of students in health professions. It may be that, older students are more experienced and they acknowledge that fear is a natural reaction when facing a pandemic, but they also know that fear should be addressed and that it becomes more manageable when acknowledged (Finset et al., 2020); they are "optimistically afraid" and they feel ready to fight the pandemic admitting their fears.

This result needs to be contrasted with the finding that years of attendance (differently from age) had a significant but negative effect on readiness to fight the pandemic: so, students with less academic experience feel more ready to fight the pandemic. Age and year of attendance are different variables: in particular, year of attendance refers to the academic year that students are enrolled in. For example, a 33-year-old student can be currently enrolled in the first year, along with a 21-year-old student. At the end of the 20th century, Kruger and Dunning (1999, 30) discovered that "people tend to hold overly favorable views of their abilities in many social and intellectual domains." In fact, "inexperienced people often have a falsely elevated sense of confidence about their performance" (Rahmani, 2020, 532). Various studies have been conducted, especially with young physicians, highlighting this effect also in the medical field. We may cautiously hypothesize that this effect could account also for our results: students in health professions in their very first years of attendance, with limited knowledge and experience, may falsely feel more confident, and more ready to directly face the healthcare crisis.

None of the relationships with the university variables had a significant effect on the readiness to fight the pandemic.

Two of the emotional variables, instead, participated in explaining the feelings of the students on being ready to fight. Fear for patients had a significant and positive effect, while in most cases, students had to interrupt internships and clinical activities. Some students in health professions may continue their activities or may be involved in some volunteering services, having direct contact with patients. The fear for the survival of patients and their condition is one of the most important elements that push healthcare students in their willingness to be involved in the fight against COVID-19. Healthcare professions, indeed, are often characterized by "empathy, compassion, engagement, and a wish to be of use" (González, 2012, 52). The readiness to fight the pandemic is influenced also by other emotional reaction variables: the more perceived control, the more students are willing to directly face the health crisis. We think that this result is complementary to the previously explained effect that perceived control has on psychological symptoms. As already pointed out, perceived control could be considered as a sort of protective factor against the psychological and mental effects of the pandemic.

Limitations

Our study is not exempt from some limitations. First of all, our sample is not perfectly representative of all the population of students in health professions in the Italian context: the vast majority, more than 70%, was composed of medical students, while only 30% students came from other healthcare-related degrees. The percentage of women in our sample (about 70%) reflects the real situation in the health professions in the Italian context (Comitato Unico di Garanzia dell'Università degli Studi di Milano, 2017), but we have to point out that women usually have a greater probability of meeting criteria for Post-Traumatic Stress Disorder (Tolin and Foa, 2006; Carpita et al., 2019): this could have had an impact on our results. In addition, the percentage of students collocating themselves in red, orange, or yellow areas reflects the real national situation at the time of our recruitment; it is not the same for the year of attendance: the vast majority of the students attended the first, second, or third year, while only about 13% of our samples came from more senior years. In fact, all the health profession curricula, except for medical and dental health ones, last 3 years, but we have to point out the fact that our sample is composed of a majority of medical students, so we may conclude that our sample is not well balanced. These limitations are due to the convenience method we used for the recruitment, considering the restrictions imposed by the COVID-19 situation. Second, as the pandemic evolves, it is possible that at different times and places, the impact on students could be different from the one that we found. For example, the emotional impact of the pandemic could be different over the different waves (Li et al., 2021b) and in different contexts. Due to the pandemic constant evolution and differences across contexts, the generalizability of our results should be approached carefully.

Third, our survey entirely relies on self-report items and questions. Among the advantages of these psychological instruments, it is necessary to consider also their well-known limitations (Demetriou et al., 2015); moreover, due to setting characteristics and to avoid the cognitive burden, we chose to investigate some constructs with a single-item question and to focus only on the mentioned variables, avoiding collecting other data (as data about the location of Institutions and Universities in which students are enrolled).

Fourth, our study has a cross-sectional design. We could not compare our data collected during the pandemic with psychological symptoms and distress before the pandemic. Also, we did not collect any information about other risk factors, previous psychiatric history, or psychological vulnerabilities that could have influenced the emotional response and distress during the pandemic period.

For these and the abovementioned reasons, we think that further research is needed to understand more in depth and more precisely psychological distress and emotional conditions of students in health professions in the pandemic context.

CONCLUSION

Despite these limitations, to the best of our knowledge, our study is the first investigating psychological health and readiness to fight the pandemic in Italian students in health professions during the second wave of the pandemic.

We found that students in health professions had high levels of psychological symptoms, predicted by stress, loneliness, anger, and perceived control. The readiness to fight the pandemic, instead, was predicted by age, year of attendance, fear for their patients, and perceived control.

We think that our data could be useful to Universities and Institutions now and in similar future situations when making decisions about the academic, clinical, and distance learning

activities of students, always considering their impact and the impact of the situation itself on their mental health. The point of view of students about the current situation and the new learning technologies should be carefully considered (Hossain et al., 2019). The majority of the literature focused on the involvement of patients in care (Monzani et al., 2020); in our point of view, it may be useful to explore also the readiness of health professional students to be involved in the care process during these situations. Moreover, the readiness of students to fight the pandemic should be considered, together with other numerous factors, in the complex and delicate decision making (Miller et al., 2020; Riva et al., 2020) about the appropriate role that students in health professions should have in pandemic contexts.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, upon reasonable requests.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the European Institute of Oncology Ethics Committee – (IEO 1248 – RE 2872). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

GDM, LV, and GM planned and conducted the study. GDM, LV, GM, and DM drafted the manuscript. All authors contributed to the article and approved the submitted version.

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SUPPLEMENTARY MATERIAL

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ORIGINAL RESEARCH
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Perceptions of Clinical Dental Students Toward Online Education During the COVID-19 Crisis: An Egyptian Multicenter Cross-Sectional Survey

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Objectives: To evaluate the perceptions of clinical dental students on the role of online education in providing dental education during the COVID-19 crisis.

Materials and Methods: A cross-sectional online survey was sent to four Egyptian dental schools from the 20th of January 2021 to the 3rd of February 2021. Survey questions included the demographics, uses, experiences, perceived benefits, and barriers of distance learning in dentistry during the COVID-19 pandemic. Responses were collected from the clinical dental school students. Categorical data were presented as frequencies (*n*) and percentages (%) and were analyzed using Fisher's exact test.

Results: Three hundred thirty-seven clinical dental students across four Egyptian dental schools responded. Most students used either Google Classroom or Microsoft Teams to access the online content. The data showed that the COVID-19 pandemic affected the academic performance of most participants (97.4%) with varying degrees. On average, students were neutral when asked to rate the online lectures, but did not find online practical education as effective (81.3%) as online theoretical teaching. The commonly described barriers to online teaching included loss of interaction with educators, inappropriateness in gaining clinical skills, and the instability of the internet connection.

Conclusion: Despite the reported benefits, clinical dental students in Egypt preferred the hybrid approach in dental education as distance learning represented a prime challenge to gain adequate clinical dental skills.

Keywords: COVID-19, dental education, clinical education, dental students, online education, coronavirus

INTRODUCTION

In December 2019, COVID-19 was first identified in Wuhan, China (Li et al., 2020). The COVID-19 outbreak rapidly spread worldwide and on the 15th of March 2020, the WHO announced COVID-19 as a pandemic (WHO/Europe, 2020). The overall number of confirmed cases and mortalities are 141,754,944 and 3,025,835, respectively, in 216 countries as of the 20th of April 2021 (WHO Coronavirus Disease (COVID-19) Dashboard, 2020).

COVID-19 has affected the educational process at all levels. The majority of the educational institutions during the first and the second waves closed campuses and transitioned from physical attendance to virtual learning (Hassan and Amer, 2021). Early in this pandemic, many countries, including Egypt, began to implement precautionary measures, such as social distancing and lockdowns of educational institutions in order to control and mitigate the pandemic (Social Distancing, 2020). Medical institutions quickly adapted to the COVID-19 pandemic. Dental and oral health education services became greatly affected due to the dental team's proximity to the patient and aerosols during routine dental therapeutic procedures (Shehata et al., 2020). Dental institutions recognized the challenges this pandemic presented to dental students (Barabari and Moharamzadeh, 2020; Hung et al., 2021). Specifically, the pandemic affected clinical training for dental students, which could delay them from taking regional dental board exams or completing other graduation requirements (Hassan and Amer, 2021; Hung et al., 2021). In Egypt, the Ministry of Higher Education and Scientific Research authorized the replacement of ongoing classroom teaching with e-learning for both undergraduate and postgraduate education using various software and interactive online platforms (Hassan and Amer, 2021). Dental institutions in Egypt encountered many challenges making this transition to online education. One of these challenges includes accessibility by the low-income population of the developing countries (World Economic Outlook Databases, 2021), which does not always have compatible electronic devices nor stable access to an Internet connection (Egypt: number of internet users, 2019; Online Education, 2021). Furthermore, the resumption of in-person practical dental courses (laboratory, pre-clinical, and clinical), which are important for the development of skills of dentist training, are fundamentally important to assure educational and therapeutic services in a safe environment for students, faculty, and patients.

As dental schools adapt to the sudden transition in dental education, little is known about how this shift has affected students, and whether e-learning can be considered as effective as the usual face-to-face tutorials and should continue to exist post-pandemic. The media and the UNESCO have raised concerns regarding the impact of these changes to university teaching on student education in the COVID-19 and post-COVID-19 world (Lewin, 2020). During the year 2020, mounting research has examined the application of e-learning styles in medical and dental academic institutions in response to the COVID-19 crisis (Al-Balas et al., 2020; Bennardo et al., 2020; Brar et al., 2021; Herr et al., 2021). In Italy, dental schools moved classes and examinations into virtual platforms (Bennardo et al., 2020). This shift was followed by delaying the beginning of the new semester to allow professors and educators time to prepare digital content according to the curriculum changes. The number of online courses offered from 21 Chinese academic dental institutions moved from 33 online courses before the pandemic into 119 online courses within 3 weeks (Liu et al., 2020). Other studies have focused on students' feedback about online dental classes (Van Doren et al., 2020; Cheng et al., 2021). However, we believe that the field still needs to understand the different variables that could affect the students' feedback toward online classes. Moreover, dental educators should be willing to receive students' perspectives toward this massive change in dental education and how they can handle these serious challenges. Considering the "students' perspective" and integrating their views is fundamental for administrators, faculty, and other policymakers as they re-envision dental education in a new "virtual reality."

The purpose of this study was to determine the effects of the COVID-19 pandemic on the perceptions of Egyptian clinical dental students. We conducted an online survey on senior dental students in both public and private Egyptian dental academic institutions. The survey addressed the online education strategies and suggestions for better dental educational approaches. Challenges related to clinical dental education were also analyzed. We believe that dental schools need to consider sharing and documenting their experiences, and the challenges they faced during this pandemic in both published research. Internationally, this combined evidence will help dental educators to improve educational systems in both pre-clinical and clinical dental education.

MATERIALS AND METHODS

Setting and Participants

The project was conducted with the participation of senior dental students in four universities [two public (South Valley University, Ain Shams University) and two private (Egyptian Russian University, October 6 University) universities]. All the participating universities are accredited by the Egyptian Supreme Council of Universities and apply the same educational modalities. Students were asked to answer the survey questionnaire for research purposes. A power analysis was performed to ensure adequate power for our statistical testing on the prevalence of the perceptions of clinical dental students on the role of online education in providing dental education during the COVID-19 pandemic. Power analysis parameters were obtained from the results of Varvara et al. (2021). Using a confidence interval of 95% and a margin of error of 5% with finite population correction, the predicted sample size (n) was a total of 235 responses. Sample size calculation was performed using Epi info for Windows version 7.2 (Dean et al., 2011).

Survey Questionnaire

This descriptive cross-sectional study was conducted online at the national level. A 20 item survey was devised following

a literature search on current online education methods and the effects of COVID-19 on dental and medical education (Dost et al., 2020; Mahdy, 2020). The questionnaire was drafted and informally discussed with an interdisciplinary team[1] to confirm that the survey questions were aligned with study aims. The questions explored the following three sections: the demographic characteristics of participants, the perceived effect of the COVID-19 pandemic on the academic performance of the students and the online education experience during the lockdown, and the perceived effect of the pandemic on the student's clinical performance. The questionnaire was created using Google Forms, and an initial trial was given to 30 participants to ensure that the draft questionnaire was understandable. The questionnaire was then distributed by the authors *via* each school's online platform and social media feeds. The questionnaire was accessible *via* an anonymous link and open for a two-week period.[2]

Participant Consent and Ethical Considerations

The current study was approved by the Research Ethics Committee of Ain Shams University, Cairo, Egypt (Approval # 08092020). Participants were informed that participation was voluntary and clarification was presented that all data would be non-identifiable and would only be used for research purposes.

Data Analysis

The survey responses were exported from Google Form to Microsoft Excel (Office 365). Descriptive statistics were calculated for the survey responses to explore patterns in responses. Categorical data were presented as frequencies (n) and percentages (%) and were analyzed using Fisher's exact test. Quantitative data were presented as mean and standard deviation values. Values of p were adjusted for multiple comparisons utilizing Bonferroni correction. The significance level was set at $p \leq 0.05$ for all tests. Statistical analysis was performed with R statistical analysis software version 4.0.3 for Windows (RStudio Team, 2015).

RESULTS

Cohort Demographics

A total of 345 responses were retrieved. Eight responses were excluded due to missing or invalid data. The remaining 337 responses were from four different public and private Egyptian dental institutions (two each; **Table 1**; **Figure 1**). Of the 337 responses collected, there were more male participants (57%, $n = 192$) than female participants (43%, $n = 145$). There were more private dental school students (70%, $n = 236$) than public dental school students (30%, $n = 101$). About 50% ($n = 166$, 49.3%) of the participants were 5th year students while 49.3% ($n = 166$) were 4th year dental students (**Table 1**; **Figure 1**).

The Effect of the COVID-19 Pandemic on the Academic Dental Performance

The majority of the participants (65.3%) believed that COVID-19 pandemic affected their academic performance. Given the current COVID-19 practices, 67.4% of the participants had their on-site classes canceled. Most students expressed overall satisfaction (73.5%) with online lectures. The online practical sessions had an opposite trend with 70.3% overall dissatisfaction. Most participants used personal laptops or tablet computers (57%) to participate in online classes, spending 3 h on average (61.7%) every day (**Table 2**; **Figure 2**).

Nearly 50% of the participants (73.6%) used online classes. Google Classroom was the most used platform for online classes (74.5%), followed by Microsoft Teams (18.7%). The classes were pre-recorded and uploaded on the platform for most of the participants (80.1%; **Table 2**; **Figure 2**). Although more than 70% of the participants had their exams remotely online, some of the students (39.8%) expressed their preference of attending the exams in person.

Assessing the Impact of COVID-19 Pandemic on the Clinical Training of Students

Most students (81.3%) reported more negative responses related to the effect of the pandemic on their clinical performance (**Table 3**; **Figure 3**). Students expressed that the COVID-19 pandemic affected them negatively with a smaller number of patients available for clinical training (33.9%), in addition to the fear of the re-lockdown (25.2%). Most of the dental students (93%) participating in the survey expressed the need to have additional clinical training after graduation to compensate for the time lost during the lockdown (**Table 3**; **Figure 4**).

TABLE 1 | Frequency and percentage (%) for answers to demographic characteristics.

Question	Answers	*n*	%	Value of *p*
Gender	Male	192	57.0%	0.011*
	Female	145	43.0%	
Nationality	Egyptian	328	97.3%	<0.001*
	Other	9	2.7%	
Type of institution	Public	101	30.0%	<0.001*
	Private	236	70.0%	
Academic year	3rd year	5	1.5%	<0.001*
	4th year	166	49.3%	
	5th year	166	49.3%	

*Significant ($p \leq 0.05$). ns, non-significant ($p > 0.05$).

[1]https://docs.google.com/forms/d/e/1FAIpQLScJ291UIjEcFV3UvtEeWgbxZnt_1TRXsgz9FRw8qWMvCeJ8zA/viewform?usp=sf_link

[2]https://docs.google.com/forms/d/e/1FAIpQLSdOyiEnR543YvHKdm2fMSrxX0oV3lJN_rSumUsSpOd56z-uag/viewform?usp=sf_link

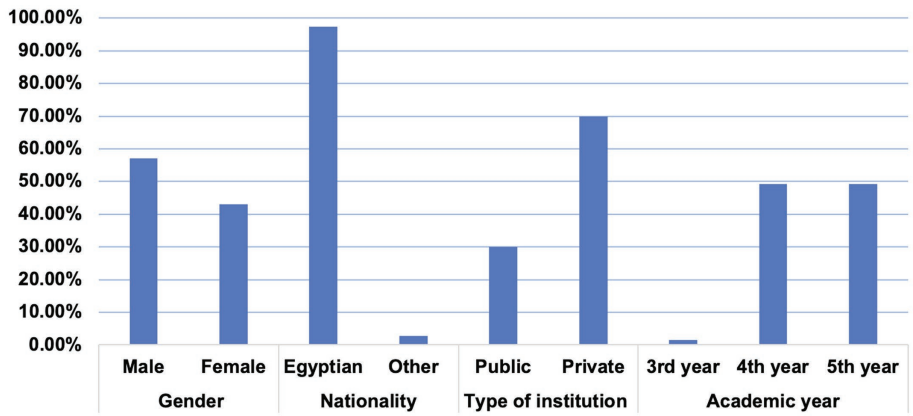

FIGURE 1 | Bar chart showing percentage values for demographic characteristics.

The Participants' Responses Regarding the Common Problems With Online Education Could Be Summarized as Follow:

- The speed and cost of the Internet in Egypt prevented the delivery of study materials to students, and the Internet connection was insufficient to download and view the lectures.
- The quality of the recorded videos was not great (e.g., presence of noise and/or low resolution).
- The interactive component was missing The absence of discussions made online learning less interactive due to insufficient interactions between students and professors, which made the lectures boring for them, and easy to lose concentration.
- There was a miscommunication between the administration and academic departments, there were problems with the lectures schedule.
- The timing and the organization of the online exams were problematic. Moreover, the online educational platforms did not allow the students to resume the exams when Internet connection was lost.
- It is difficult to teach clinical subjects using online platforms.

The Students' Recommendations Regarding Improvements of the Online Education Were Summarized as Follows:

- Provide training for lecturers on e-learning tools and computer skills.
- Improve the voice recording for lectures by using a separate microphone and compress recorded lectures before uploading them.
- Enhance the interaction between students and teachers, provide real-time online meetings to discuss the subject rather than a recorded video.
- Provide 10–15 min at the end of each lecture for students' questions.
- Provide a well-organized timetable that suits both lecturers and students.
- Weekly online assessment to follow students after each lecture.
- Provide virtual resources to mimic the laboratory work or live streaming directly from the laboratory.
- Provide practical learning through interactive tools, such as videos and 3D animation.
- More time is required to develop clinical skills to compensate for the lost time during the lockdown.

DISCUSSION

With the escalation of the COVID-19 pandemic, it is foreseeable that many dental academic institutions have shifted to online education platforms instead of in-person education (Hassan and Amer, 2021; Herr et al., 2021). In this survey, we explored the major challenges during the transition into distance learning, overall satisfaction as well as a future vision toward online education in dental education among clinical dental students in public and private Egyptian dental schools.

Our data showed that 337 participants from four Egyptian dental schools answered the survey. Survey responders were 57% male and 43% female. Although these levels are similar to the demographics of the Egyptian population (45.5% women and 55.5% men; Egypt Data Portal, 2021) they are different than the population of dental students in the United States, which comprises 38% women and 62% men (Scarbecz and Ross, 2002). The current data showed that COVID-19 pandemic lockdown affected the academic performance of most participants to varying degrees and only a small percentage of participants reported that the pandemic had no effect on their academic performance. This is in agreement with previous studies, which reported that COVID-19 pandemic has had a profound impact on medical, dental, and veterinary students (Iyer et al., 2020; Mahdy, 2020; Rose, 2020).

Unlike recently published studies, the most used online platform among the participants in our survey was Google Classroom, followed by Microsoft Teams. This finding contrasts with previous work where ZOOM was reported to be the most commonly used online platform (Al-Balas et al., 2020; Ahmed et al., 2021; Brar et al., 2021; Herr et al., 2021; Temash et al., 2021). Herr et al. (2021) found that ZOOM was the most used platform among

TABLE 2 | Frequency and percentage (%) for answers for assessing the impact of COVID-19 pandemic on the academic performance.

S. No.	Question	Answers	*n*	%	Value of *p*
1.	How did covid 19 pandemic affect your study?	1	9C	2.7%	<0.001*
		2	18C	5.3%	
		3	90B	26.7%	
		4	98AB	29.1%	
		5	122A	36.2%	
2.	Were your on-site lectures on campus canceled due to the COVID-19 pandemic?	Yes, my on-site classes have been canceled	227A	67.4%	<0.001*
		No, my on-site classes have not been canceled	110B	32.6%	
3.	How are you accessing online course content during the covid 19 pandemic?	I have my own personal computer, laptop or tablet	192A	57.0%	<0.001*
		I share a home computer, laptop or tablet	24C	7.1%	
		I borrowed a computer, laptop or tablet from someone outside of my home	1D	0.3%	
		I am only able to use my cellphone to access content	117B	34.7%	
		I have not been able to access online course content	3D	0.9%	
4.	How many hours do you spend in online learning during the pandemic?	1 h/day	63AB	18.7%	<0.001*
		2 h/day	55B	16.3%	
		3 h/day	90A	26.7%	
		4 h/day	51B	15.1%	
		5 h/day	20C	5.9%	
		6 h/day	29C	8.6%	
		Other	29C	8.6%	
5.	How do you rate online lectures during covid 19 pandemic? 1 is the lowest evaluation	1	30C	8.9%	<0.001*
		2	59B	17.5%	
		3	109A	32.3%	
		4	88A	26.1%	
		5	51B	15.1%	
6.	How do you rate online practical lessons during covid 19 pandemic? 1 is the lowest evaluation	1	172A	51.0%	<0.001*
		2	65B	19.3%	
		3	57B	16.9%	
		4	25C	7.4%	
		5	18C	5.3%	
7.	Which virtual learning tools did you use during the covid 19 pandemic?	University Platform	106B	31.5%	<0.001*
		Online Classes	170A	50.4%	
		Educational Websites	5D	1.5%	
		Youtube videos	25C	7.4%	
		E-books	12CD	3.6%	
		Educational applications	14CD	4.2%	
		Other	5D	1.5%	
8.	Which online learning tool do you use during the covid 19 pandemic?	Zoom	9CD	2.7%	<0.001*
		Microsoft Teams	63B	18.7%	
		moodle	12C	3.6%	
		Google classroom	251A	74.5%	
		Social Media Networks (ex: Facebook)	2D	0.6%	
9.	Which of these forms of online lectures has been the most dominant please select only one?	Online in real time video conference	56B	16.6%	<0.001*
		Online with a video recording not in real time	208A	61.7%	
		Online with an audio recording not in real time	62B	18.4%	
		Online by sending presentations to students with no video or audio recording	11C	3.3%	
10.	What is the evaluation method used during the covid 19 pandemic?	Online exams remotely	243A	72.1%	<0.001*
		Online exams at the college's testing center	14C	4.2%	
		Assignments only	36B	10.7%	
		Written exam at college	44B	13.1%	
11.	Which method of evaluation do you find most accurate and convenient?	Assignments only	15B	4.5%	<0.001*
		Online exams at the college's testing center	25B	7.4%	
		Online exams remotely	163A	48.4%	
		Written exam at college	134A	39.8%	
12.	Would you prefer to get back to onsite lectures or continue to use online learning after the end of the pandemic?	Get back to onsite lectures	165A	49.0%	<0.001*
		Continue to use online learning	172A	51.0%	

*Significant ($p \leq 0.05$). Different letters indicate a statistically significant difference within the same question; ns, non-significant ($p > 0.05$).

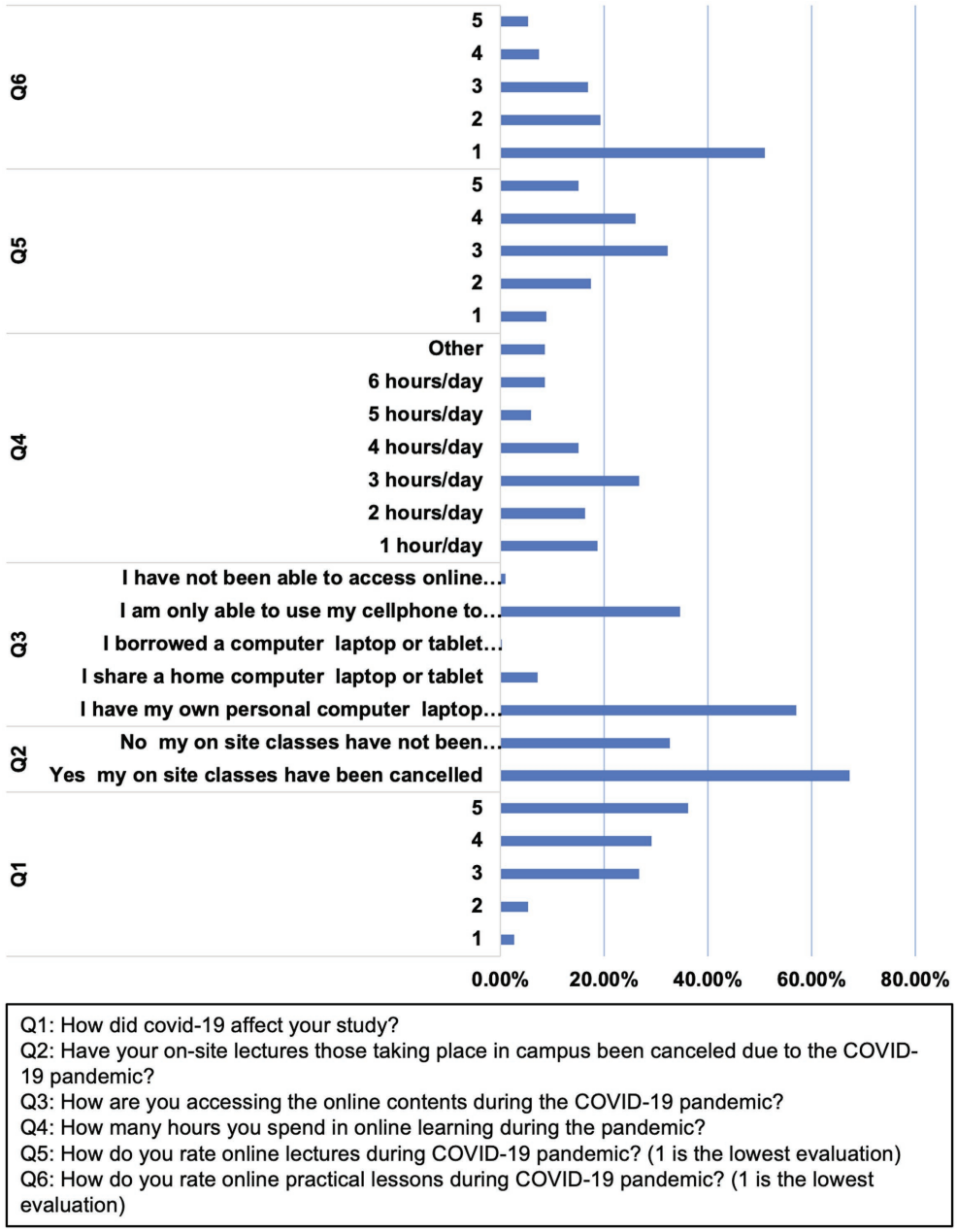

FIGURE 2 | Students' responses to the survey on the impact of COVID-19 pandemic on the academic performance. The corresponding questions are as follows: Q1: How did COVID-19 affect your study? Q2: Were your on-site lectures on campus canceled due to the COVID-19 pandemic? Q3: How are you accessing the online content during the COVID-19 pandemic? Q4: How many hours do you spend in online education during the pandemic? Q5: How do you rate online lectures during COVID-19 pandemic? (1 is the lowest evaluation) Q6: How do you rate online practical lessons during COVID-19 pandemic? (1 is the lowest evaluation).

South Korean dental students (Herr et al., 2021). We hypothesize two reasons for the differences. First, Google Classroom is a freely accessible platform, whereas ZOOM requires a subscription to extend meetings longer than the 40-min time limit. This lower barrier of Google Classroom may have helped the transition to readily available online educational content in the absence of a well-established educational platform in the majority of the Egyptian institutions. Secondly, there was a high level of cooperation between the Egyptian Ministry of Higher Education and Scientific Research and Microsoft Corporation to provide Teams educational package for the public universities which helped contribute to the high level of usage of Microsoft Teams that we observed in our survey (Ministry of Higher Education and Scientific Research and Microsoft Egypt joined forces to empower fresh graduates with digital skills through "Bina'a Insaan" initiative – Middle East and Africa News Center, 2021).

TABLE 3 | Frequency and percentage (%) for answers for assessing the impact of COVID-19 pandemic on the Clinical training of students.

S. No.	Question	Answers	*n*	%	Value of *p*
1.	Do you feel that the covid 19 outbreak is negatively affecting your clinical performance?	Yes	274A	81.3%	<0.001*
		No	32B	9.5%	
		Unsure	31B	9.2%	
2.	Do you feel that the covid 19 outbreak is negatively affecting your clinical performance?	Extra time to perform infection control measures	158BC	20.9%	
		Financial burden of the required PPE personal protective equipment	151C	19.9%	<0.001*
		Less number of patients than previous years	257A	33.9%	
		Fear of re lockdown	191B	25.2%	
3.	Do you feel you need extra clinical training time to compensate for the lost time during the lockdown period?	Yes	314A	93.2%	<0.001*
		No	23B	6.8%	

*Significant ($p \leq 0.05$). Different letters indicate a statistically significant difference within the same question; ns, non-significant ($p > 0.05$).

Regarding the accessibility to the online content, most of the students used their own laptops or tablets. It is worth mentioning that most of the students (91.5%) owned an electronic device to access the online content. These results are in agreement with the results from different surveys among German, South Korean, and Brazilian dental students (Schlenz et al., 2020; Herr et al., 2021; Silva et al., 2021). However, when the students were given the opportunity to elaborate their views of the common problems associated with online education, the speed and cost of the Internet in Egypt were one of the main reasons that prevented the proper delivery of study materials to students (Online Education, 2021). Economic distress may be one explanation for the survey results as studies have shown that students in economic distress are more likely to have poor or no Internet access because they cannot afford the cost of a laptop/computer, the Internet connection, or because they live in regions or neighborhoods with low connectivity (Universities tackle the impact of COVID-19 on disadvantaged students, 2021).

Although the integration of online education in Egyptian dental programs is still new, most of the participants were neutral when asked to rate the online lectures. Online education is known to have many advantages such as the accessibility of the educational materials, the flexibility of studying with the possibility of repeating content, and ultimately enabling the students to customize different study plans. In a survey published in 2021, dental students in the United States rated their online curriculum positively, with 87.6% reporting a high degree of comfort adapting to technology and only 12.4% feeling neutral. No students reported being uncomfortable with the online technology, as 72.0% of students had completed at least one online course prior to dental school and 34.8% had reported completing at least four online classes prior to the COVID-19 pandemic (Hung et al., 2021). A systematic review of 59 studies suggested that online education is equivalent to traditional teaching in terms of knowledge gained, skills gained, and student satisfaction (George et al., 2014).

In contrast to the traditional classroom courses, many students considered their clinical performance to be negatively affected by the transition to online platforms due to the COVID-19 pandemic, with the reduced exposure to patients hindering their development of clinical skills and professionalism. Students lost almost 4 months of clinical practice with the cancelation of the final practical hands-on assessment. Survey participants perceived that they missed important learning experiences, particularly the clinical sessions. The effect of the COVID-19 pandemic on the clinical skills of final year students who did not have enough time to compensate for lost educational time is difficult to assess and consequences may only become evident in the subsequent years. Even after schools re-opened, students observed a negative impact on patient attendance at appointments during the beginning of the COVID-19 pandemic. A recent study reported a significant reduction in the use of emergency dental services by 38% at the start of the COVID-19 outbreak in China, suggesting COVID-19 influenced people's dental care-seeking behavior (Van Doremalen et al., 2020). This might be because people were reluctant to go outside and leave the house, and were less willing to seek dental care. It is important to mention that the prolonged suspension of clinical training is likely to impact the clinical confidence and competence of dental students.

While there is still no substitute for clinical training, which is the core curriculum of dental schools, survey participants suggested that online case-based discussions, treatment planning exercises, and extra clinical sessions at the end of the year may be helpful to make up for the lost learning due to the pandemic disruptions. Virtual clinical learning innovations are currently being proposed to complement standard clinical practice as a safe way to acquire practical clinical skills through simulation exercises, without direct contact with patients to minimize COVID-19 transmission risks. Such systems provided the tutor and students with continuous and integrated feedback (Hollis et al., 2011). Virtual reality (VR) simulators have the capability of tactile feedback, which allows students to touch and feel the dental tissue virtually. Studies have shown that the use of VR has

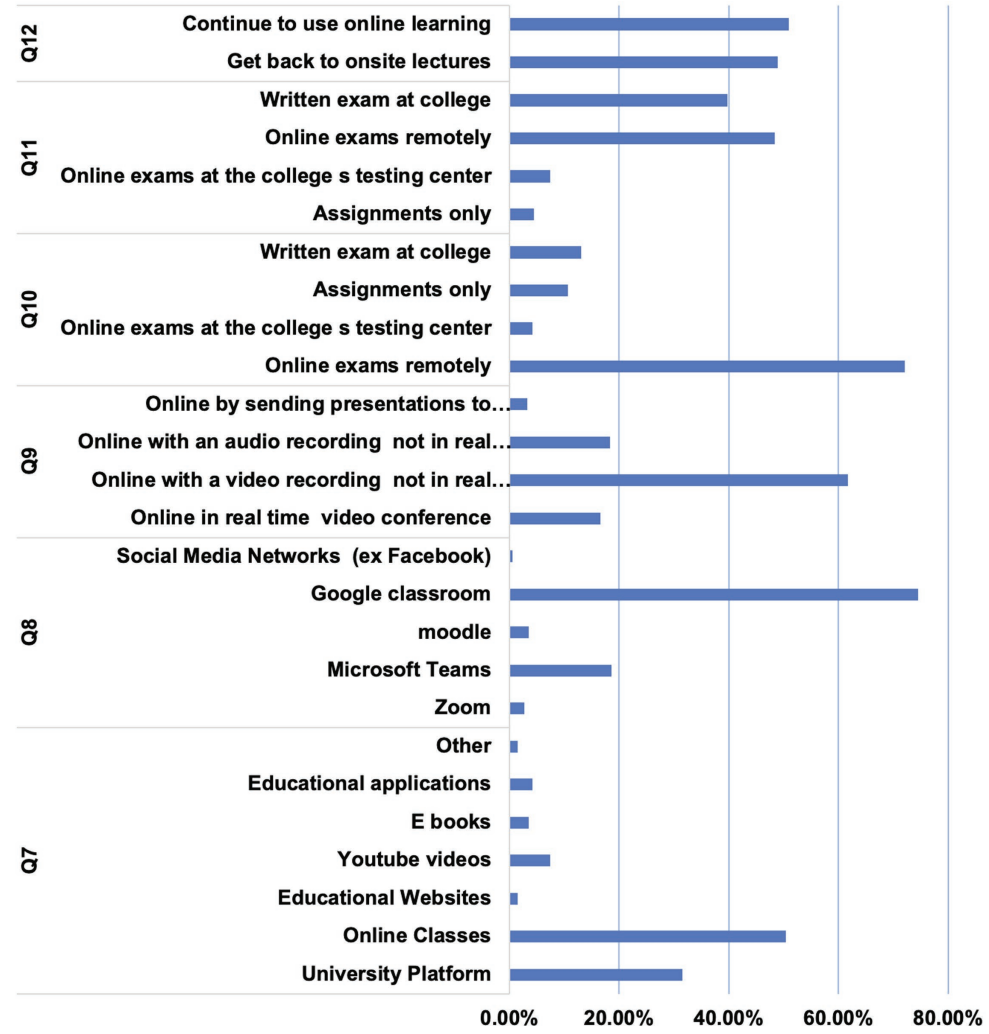

FIGURE 3 | Students' responses to the survey on the impact of COVID-19 pandemic on the academic performance. The corresponding questions are as follows: Q7: Which virtual learning tools do you use during the COVID-19 pandemic? Q8: Which online learning do you use during the COVID-19 pandemic? Q9: Which of these forms of online lectures has been the most dominant? (Please select one) Q10: What is the evaluation method used during the COVID-19 pandemic? Q11: Which method of evaluation do you find most accurate and convenient? Q12: Would you prefer to get back to on-site lectures or continue to use online education after the end of the pandemic?

improved the acquisition of manual dexterity in dentistry courses in the operative area (Miyazono et al., 2019; Morales-Vadillo et al., 2019). However, a large investment from colleges is required to offer this type of teaching methodology.

Future Improvements of Online Education in Egypt

Based on the students' feedback, dental schools are required to provide faculties not only with intense training on the technical aspects of the virtual platform itself but also on basic principles of instructional design for effective online delivery to promote student engagement and appropriate assessment methodology. Additional infrastructure and resources are required to support the complete transition.

Limitations and Future Work

As far as we know, this study is the first to investigate the impact of COVID-19 on clinical dental education across

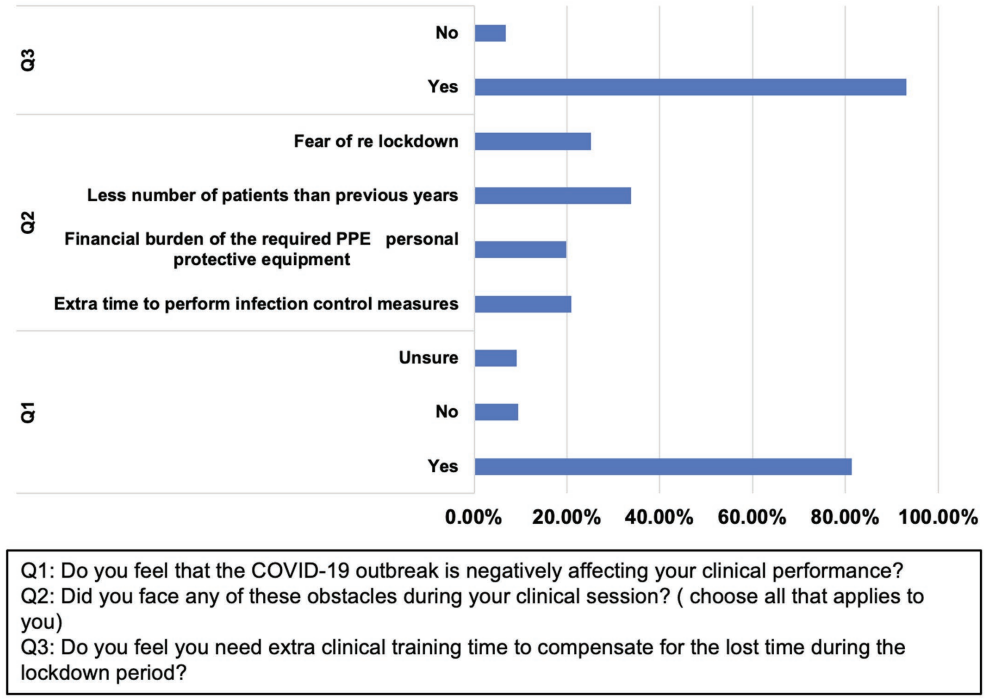

FIGURE 4 | Student's responses to the survey on the impact of COVID-19 pandemic on the clinical dental performance. The corresponding questions are as follows: Q1: Do you feel that the COVID-19 outbreak is negatively affecting your clinical performance? Q2: Did you face any of these obstacles during your clinical session? (Choose all that applies to you) Q3: Do you feel you need extra clinical training time to compensate for the lost time during the lockdown period?

Egypt, with responses from four dental schools. One of the strengths of this survey is its diversity of senior dental students across private and public Egyptian dental academics. Furthermore, the recruitment of the clinical dental students for this survey distribution *via* a range of methods minimized potential response bias. However, this study also had some limitations. Some dental schools may have been disproportionately represented with larger numbers of responses from some schools, for example, Egyptian Russian University. For this reason, the results should be interpreted cautiously before being generalized to the dental education community. Finally, answering some questions of this questionnaire depended on students' memory which may be subjected to reporting and recall bias.

CONCLUSION

This cross-sectional survey highlighted the perception of clinical dental students toward online education during the COVID-19 crisis in Egypt. The participants in the current study agreed that the COVID-19 pandemic significantly affected dental education with varying degrees. According to the students' answers, e-learning can act as a valuable tool that could help clinical dental students to follow-up lectures and journal clubs. Despite the reported benefits, dental students preferred the hybrid approach in dental education as distance learning represented a prime challenge to gain adequate clinical dental skills. Since the majority of the final years' courses are clinical, students highlighted the difficulty to fulfill the requirements for clinical competencies only using online platforms.

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 Research Ethics Committee, Faculty of Dentistry, Ain Shams University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

All authors have read and approved the final article. MGH and RH conceived and designed the study. MGH, RH, TE, and AK collected the data and wrote and revised the manuscript. MGH analyzed the data.

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Death Attitudes and Death Anxiety Among Medical Interns After the 2020 Outbreak of the Novel Coronavirus

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This study investigates the *status quo* and influencing factors of death attitudes and death anxiety among medical interns in China as measured by the *Death Attitude Scale* and *Death Anxiety Scale* following the outbreak of "Novel Coronavirus Pneumonia" in China in early 2020. Results of this study show that under the influence of COVID-19, in terms of death attitude, medical interns scored the highest in neutral acceptance and the lowest in escape acceptance. There were significant differences in death attitude and anxiety among the groups with different backgrounds, including their families' approaches to discussions of death, the number of funeral experiences, and other factors. There were two additional factors affecting attitudes that were related to the epidemic situation: whether the individual had participated in work to treat COVID-19 and whether their close friends or relatives ("cherished persons") had been diagnosed with COVID-19. The study reveals the ways that the epidemic had an impact on death attitude and death anxiety.

Keywords: medical students, death attitude, death anxiety, COVID-19, death education

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INTRODUCTION

A "death attitude" is an individual's feelings relating to the death of the self or others. It is an evaluative and relatively stable internal psychological tendency held by an individual in response to death (Dezutter et al., 2009; Du et al., 2020). Early studies on the concept while influenced by a public aversion to death and as such tended to focus on negative attitudes toward death such as fear, anxiety, avoidance, or denial. Holcomb et al. (1993), by contrast, determined that an individual's death attitude was complex, combining various positive and negative emotions. Wong et al. (1994) further elaborated and delineated a model of death attitudes consisting of five components, namely, *Fear of Death*, *Death Avoidance*, *Neutral Acceptance*, *Approach Acceptance*, and *Escape Acceptance*. Wong's model is widely used to measure the death attitude of many different people (Gao P. et al., 2018; Haratiyan et al., 2019; Barnett et al., 2020). When Brudek et al. (2020) revised Wong's death attitude scale, they obtained research results that were consistent with the original version. Wang et al. (2020) explored the reliability and validity of the Death Attitude Profile-Revised (DAP-R) in measuring the death attitude of Chinese college students and found that this scale has good reliability and validity when applied to Chinese college students.

Death anxiety refers to an emotional state, including fear, worry, and restlessness that appears when one is reminded of the inevitability of death or is threatened by death (Jiao et al., 2020). A commonly used death anxiety measurement tool is the Templer-Death Anxiety Scale (T-DAS; Templer et al., 1971). Sharif Nia et al. (2020) systematically reviewed the psychometric characteristics of the cross-cultural T-DAS to ensure that it remains an effective and reliable scale when evaluating death anxiety in differing cultural backgrounds. Their results, which included studies in Iran, the United States, Italy, China, Egypt, Spain, and Australia, demonstrated that the T-DAS had remained a reliable tool. It is still commonly used to capture the conscious experience of death anxiety. Most recently, Huang et al. (2019) used the T-DAS to investigate the death anxiety of nurses in oncology departments, showing that the scale continues to be a valid and reliable instrument.

Previous studies have shown that many factors, including religious beliefs, gender, funeral, and family experiences, can influence death attitudes and death anxiety. When Gielen (2006) studied the relationship between Buddhist philosophy and death attitudes, they found that Buddhist philosophy positively affected a person's ability to cope with death anxiety and helped generate a more accepting attitude toward death. Hu's (2010) research explains that Buddhism views death as a renewal of life. When it is understood that it is only a matter of time before death comes, there is no need to fear and worry. Confucianism, the philosophical basis of Chinese traditional culture, also regards death as part of the natural process of life, while Zhuangzi taught that as death happens naturally, no one can avoid or resist it. Zhuangzi's view of life and death can help people feel calm rather than anguish when faced with death.

Wang and Li (2017) investigated the relationship between death attitude and gender in a sample of 1,058 Chinese college students, finding that the level of death anxiety of women is higher than that of men. Yin et al. (2020), who studied death anxiety and death attitude among people of Tibetan and Han nationality, discovered that individuals who attended more funerals had more acceptance of death. Those who had more open discussions about death in the family also exhibited lower individual anxiety. Lázaro-Pérez et al. (2020), meanwhile found that Spanish law enforcement officers who worked during the start of the COVID-19 pandemic had a fear of death score of 82.1%, which was higher than the general situation. The reasons for this high score were the lack of Individual Protection Equipment and high levels of emotional exhaustion. The population at the center of the present study, medical students, differ from the general population as they have received life education and death education in college. Medical students tend to have a higher degree of neutral acceptance of death and a certain understanding of death. They are more likely to accept death than ordinary people and have lower than average fear of death (Liu and Zhang, 2015).

As COVID-19 continues to threaten China, people from all socioeconomic classes have been prompted to discuss the issue of death. Medical students often have to face death during the course of their studies and training. These experiences and their attitudes toward death in those moments affect their learning, life attitudes, and future careers (Shi et al., 2019). The changes medical students experience in their lifestyles and learning environments when they enter clinical practice after completing theoretical studies, as well as the possible exposure to death events, may have a great impact on students' mental state and thoughts (Asadpour et al., 2016). Nia et al. (2016) found that nurses and other health care workers are exposed to diseases, trauma, and violence and that their death anxiety scores may be influenced by age, self-integrity, physical problems, mental illness, religious belief, race, occupational stressors, personal death experience, and media.

According to Jeff Greenberg's Terror Management Theory, self-esteem is an evaluation and feeling of personal value that encapsulates people's experience of their sense of life meaning and value. Terror Management Theory includes believing in the correctness of one's cultural outlook on the world. Due to the influence of Chinese traditional culture, talking about death is often a taboo subject for Chinese natives (Zhang, 2020). This aversion to talking about death can be present even amongst medical students, some of whom will feel uneasy and try to avoid situations in which they might face or think about death (Zeng et al., 2019). But in a hospital environment, medical interns cannot avoid confronting death. When a death occurs, many interns will experience a state of fear, shock, and loss, and feel negative emotions, such as depression and sadness, due to a lack of knowledge and insufficient psychological preparation for such a situation. Some interns even choose to give up on their medical studies after a death event as they are unable to deal with the experience of death (dos Santos and Bueno, 2011). Ma et al. (2020) carried out a comparative study on death attitudes and death anxiety among emergency nurses before and after attending death education and training. The results show that the death education courses that focus on ways of dealing with sudden death can promote positive changes in emergency nurses' attitudes toward sudden death and thereby reduce their death anxiety. Medical schools should strengthen the death education provided to medical students to influence their attitudes toward hospice care and death in a positive direction.

Medical students' attitudes toward death are of particular importance as they adapt from the campus environment to the complex clinical work environment. This study investigated levels of death anxiety and death attitudes among medical interns who navigated this career transition after the outbreak of COVID-19.

RESEARCH HYPOTHESES

This study intends to explore the death attitudes and death anxiety levels among medical interns after the outbreak of COVID-19 and to examine whether COVID-19 has had an impact on death attitudes and death anxiety among this population. The study will examine the following three hypotheses:

1. The theory of terror management has indicated that individuals' background and culture affect their attitudes toward death. We, therefore, assume that the scores of

women's death anxiety will be higher than those of men's, while those with religious beliefs will score lower than those without religious beliefs. In addition, we assume that individuals whose families were more open about death will have lower death anxiety scores and that medical interns who have attended more funerals will have higher scores with respect to neutral acceptance of death.

2. Regarding the relationship between medical interns' death attitude and COVID-19 (Liu and Zhang, 2015; Lázaro-Pérez et al., 2020), we assume that people who have worked with patients with COVID-19 have higher scores of neutral acceptance than those who have not worked in those settings. We further assume that those who have been infected with COVID-19 have higher scores of neutral acceptance of death than those who have not been infected with COVID-19.
3. We used stepwise regression analysis to analyze whether medical interns' gender, religious beliefs, past funeral experience, family atmosphere with regard to death, and experience with COVID-19 could partially predict their death attitude and death anxiety.

METHOD

Participants

This study is based on questionnaires that were distributed to clinical medical students who have left school for clinical practice by the counselor of a medical university in Guangdong in June and July 2022. These students are, mainly, in the fifth year of undergraduate study or the third year of a master's degree. The students were able to choose to voluntarily fill out the questionnaire or could choose not to complete it. The completed questionnaires were collected in July 2022. The study includes 382 college students (mean age = 25.47, *SD* = 3.16) from a medical college in Guangdong province of which 219 (57.3%) were male students, and 163 (42.7%) were female students.

Ethical Approval Statement

This study has been approved by the Academic Ethics Committee of the Corresponding author's institution (ethical code: 2020051506). I certify that I have read and understood the Institution's Policy for Ethical Practice, and I will comply with the ethical principles of these documents. I will submit, as appropriate, a Report on Research Progress or Amendment of an Approved Project if there are significant changes to my research or an adverse incident, in addition to any time when the report for annual progress is due.

Measures

This study adopted a revised version of the attitude toward death profile compiled by Wong et al. (1994) and translated by Liao (2000) known as the Death Attitude Profile-Revised Scale (DAP-R). This scale consists of a total of 32 assessment items. Four key elements are: *Fear of Death*, where individuals facing death experience fear, fright, and other negative thoughts and emotions; *Death Avoidance,* where individuals avoid discussions or thoughts related to death; *Neutral Acceptance,* where individuals believe death to be an integral part of life to be neither feared nor welcomed; *Approach Acceptance,* where individuals see death as a channel to an afterlife in which people will live a happy life after death; and *Escape Acceptance*, where individuals believe that death can end the pain of living and accept death to escape the pain of life due to a deeper fear of continuing to live than of dying. A 5-point Likert scale was used to score each measure. Each item was set as follows: strongly disagree, disagree, uncertain, agree, and strongly agree, which were counted as 1–5 points, respectively, increasing successively. Scores were calculated separately for each dimension. This scale (DAP-R) has been widely used in the investigation of attitudes toward death in China (Zhu and Shi, 2011; Du et al., 2020; Wang et al., 2020). In this study, Cronbach's alpha of the DAP-R's five different death attitudes was: 0.79, 0.82, 0.75, 0.84, and 0.81.

The second measure used in this study is the Chinese Templer Death Anxiety Scale (CT-DAS) which originated from the Templer Death Anxiety Scale (T-DAS). The 3-week retest reliability of the original English version of the scale is 0.83. Yang et al. (2012), with the consent of the original author, created a Chinese version of the measure according to the cross-cultural adaptation guidelines recommended by the Evidence-based Committee of the American College of Orthopaedic Surgeons. The Cronbach's alpha of this version is 0.71. This scale consists of 15 true/false statements designed to measure death attitudes, with reverse coding of the 2nd, 3rd, 5th, 6th, 7th, and 15th items. This scale has been widely used in the investigation of attitudes toward death in China (Chen and Cai, 2020; Guo and Zhang, 2020; He et al., 2020). In this study, the Cronbach's alpha of CT-DAS was 0.68.

This study also took into account participants' gender and religious beliefs, as well as their number of funeral experiences, the ways the participants' families usually talked about death, whether the individual participated in the work against COVID-19, and whether important people around the participant had been infected with COVID-19. The true-false format was used to establish participants' religious beliefs, their participation in work against COVID-19, and whether important people around the participant had been infected with COVID-19. If participants have a religious belief, they are asked to specify the religion they believe in. Participants' funeral experiences were rated on a 5-point scale ranging from 1 = no funeral experiences to 5 = more than four funeral experiences. A final 4-point scale was used to assess the ways in which participants' families spoke about death, ranging from 1 = speaking openly of death to 4 = never speaking of death.

Procedure

Participants completed and submitted the questionnaire online, and participants were paid 5 RMB. Data analysis was conducted using SPSS 23.0. This study will use descriptive analysis to analyze medical interns' attitudes toward death and anxiety toward death, *t*-test and *F*-test to different demographic variables, and stepwise regression analysis to understand the factors that influence attitudes and anxieties toward death. Repeated answers or incomplete questionnaires were eliminated. Of the total 405

TABLE 1 | Results of the death attitudes and death anxiety survey (n = 382).

Project	Number of Items	M ± SD
Death anxiety	15	6.62 ± 2.79
Fear of death	7	2.77 ± 0.68
Death avoidance	5	2.70 ± 0.74
Neutral acceptance	5	4.04 ± 0.61
Approach acceptance	10	2.73 ± 0.60
Escape acceptance	5	2.69 ± 0.76

questionnaires collected in this study, 382 were valid, resulting in an effective recovery rate of 94.3%.

RESULTS

Status Quo of Death Attitudes and Death Anxiety of Medical Interns

For the most part, medical interns' attitudes toward death scored highest in terms of neutral acceptance and lowest in terms of escape acceptance, as seen in **Table 1**.

Effects of Different Variables on Death Attitudes and Anxiety of Medical Interns

Gender

An independent sample t-test was used to compare the scores of medical interns of different genders in death attitudes and anxiety. The scores of medical interns of different genders were statistically significant in the dimension of approach acceptance and death anxiety ($p < 0.05$), as seen in **Table 2**.

Religious Belief

An independent sample t-test was conducted on medical interns with or without religious belief in each dimension of attitude toward death (**Table 3**), with results showing that different groups have a statistical significance in each dimension ($p < 0.05$). All participants with religious beliefs stated their belief to be Buddhism.

Number of Funeral Experiences

A univariate analysis of variance and pair-wise comparisons were conducted on the scores of death attitude and anxiety of medical interns with different funeral experiences (**Table 4**). The results indicated that the different groups have a statistical significance in the dimension of neutral acceptance ($p < 0.05$).

The Way Families Talked About Death

A univariate analysis of variance was performed for each dimension of the attitudes toward death scale to consider differences in medical interns' families' discussions about death (**Table 5**). The results indicate statistically significant scores for each dimension of the attitudes toward death scale for each group.

Notably, the fear of death score was significantly lower among medical interns whose families mentioned death more naturally and more openly as compared to the scores of medical interns whose families mentioned death in an uncomfortable atmosphere.

Whether the Medical Student Has Participated in the Work Against COVID-19

An independent sample t-test for the dimensions of death anxiety and death attitudes was conducted for medical interns who had worked with COVID-19 patients (**Table 6**). The results indicated that the different groups have statistically significant differences in the dimensions of neutral acceptance and approach acceptance ($p < 0.05$).

Whether Significant Persons (Family Member/Friend/Colleague/Neighbor) Have Ever Been Diagnosed With COVID-19

An independent sample t-test was performed on all dimensions of the attitudes toward death scale to compare the results of those medical interns whose family, friends, colleagues, or neighbors had been previously diagnosed as COVID-19 positive with those who did not know anyone diagnosed with COVID-19 (**Table 7**). The results indicated statistically significant differences in three dimensions of the measure: fear of death, death avoidance, and neutral acceptance. Scores for neutral acceptance were highest in medical students whose important persons had been diagnosed with COVID-19.

Regression Analysis of Factors Influencing Death Attitudes and Anxieties Among Medical Interns

Scores for *Death Anxiety, Fear of Death, Death Avoidance, Neutral Acceptance, Approach Acceptance,* and *Escape Acceptance* were used as dependent variables. Six factors additional factors—gender, religious beliefs, number of funeral experiences, the way families talked about death, whether the participant had worked with COVID-19 patients, and whether important persons in their life had been diagnosed with COVID-19—served as independent variables. A multiple stepwise regression method was used (**Table 8**).

For *Death Anxiety*, gender, religious belief and family treatment of death entered the regression equation. The common explanatory quantity of the three factors (R^2) was 7.3%, and the changes in F value were 11.29, 10.19, and 7.63, respectively, all reaching a significance level of < 0.01. The predictive power of death anxiety was 2.9, 2.5, and 1.9% respectively.

For *Fear of Death*, by contrast, the factors that were included in the regression equation were whether the participant knew people diagnosed with COVID-19, their family attitudes toward death, religious belief, and the number of funeral experiences. The common explanation amount of the four factors (R^2) was 10.4%, and the changes in F values were 20.78, 10.40, 7.09, and 3.93, with a significance level of < 0.05. Predictive powers for *Fear of Death* were 5.2, 2.5, 1.7, and 0.9%.

For *Death Avoidance*, religious belief and family treatment of death were included in the regression equation. The common explanation amount of the two items (R^2) was 5.7%, the changes of F values were 12.83 and 9.83, with significance levels of <0.01, and predictive powers of *Death Avoidance* being 3.3 and 2.4%.

TABLE 2 | Results of death attitude and anxiety in different sex.

Project	Gender		T	P	Cohen's d
	Male (*n* = 219)	Female (*n* = 163)			
Death anxiety	6.21 ± 2.65	7.17 ± 2.88	–3.360	0.001	–0.34
Fear of death	2.79 ± 0.67	2.74 ± 0.71	0.673	0.502	–
Death avoidance	2.68 ± 0.75	2.73 ± 0.72	–0.698	0.486	–
Neutral acceptance	4.09 ± 0.50	3.97 ± 0.74	1.908	0.057	–
Approach acceptance	2.79 ± 0.52	2.66 ± 0.68	2.020	0.044	0.21
Escape acceptance	2.72 ± 0.77	2.64 ± 0.74	1.017	0.310	–

TABLE 3 | Results of death attitude and anxiety in different religious beliefs.

Project	Religious belief		T	P	Cohen's d
	Yes (*n* = 122)	No (*n* = 260)			
Death anxiety	6.07 ± 2.86	6.88 ± 2.72	–2.656	0.008	–0.29
Fear of death	2.95 ± 0.70	2.68 ± 0.66	3.542	<0.001	0.39
Death avoidance	2.90 ± 0.75	2.61 ± 0.71	3.582	<0.001	0.39
Neutral acceptance	4.16 ± 0.52	3.78 ± 0.71	5.837	<0.001	0.61
Approach acceptance	2.98 ± 0.63	2.62 ± 0.54	5.731	<0.001	0.61
Escape acceptance	2.83 ± 0.73	2.62 ± 0.76	2.529	0.012	0.28

TABLE 4 | Results of a comparison of death attitude and anxiety of different funeral experiences.

Project	① (*n* = 92)	② (*n* = 77)	③ (*n* = 72)	④ (*n* = 46)	⑤ (*n* = 95)	F	P	Comparing
DAS	6.09 ± 2.56	6.40 ± 2.97	6.84 ± 2.82	7.06 ± 2.88	6.92 ± 2.74	1.63	0.166	–
DAP-R1	2.89 ± 0.63	2.86 ± 0.73	2.73 ± 0.69	2.69 ± 0.68	2.64 ± 1.68	2.10	0.080	–
DAP-R2	2.81 ± 0.72	2.70 ± 0.81	2.65 ± 0.72	2.63 ± 0.73	2.66 ± 0.72	0.698	0.594	–
DAP-R3	3.89 ± 0.65	4.01 ± 0.58	4.01 ± 0.74	4.30 ± 0.45	4.11 ± 0.53	3.80	0.005	① < ④
DAP-R4	2.80 ± 0.60	2.76 ± 0.55	2.78 ± 0.63	2.68 ± 0.54	2.64 ± 0.62	1.05	0.382	–
DAP-R5	2.72 ± 0.70	2.75 ± 0.79	2.67 ± 0.75	2.66 ± 0.75	2.62 ± 0.80	0.356	0.839	–

① No, ② once, ③ twice, ④ three times, ⑤ four times or more; pairwise comparisons were significant at the 0.01 level. DAS (Death anxiety); DAP-R1 (Fear of death); DAP-R2 (Death avoidance); DAP-R3 (Neutral acceptance); DAP-R4 (Approach acceptance); DAP-R5 (Escape acceptance).

TABLE 5 | Statistical results of different the way families talked about death.

Project	① (*n* = 133)	② (*n* = 70)	③ (*n* = 158)	④ (*n* = 21)	F	p	Comparing
DAS	6.00 ± 2.93	6.25 ± 2.69	6.45 ± 2.92	7.24 ± 2.73	3.56	0.014	① < ④
DAP-R1	2.61 ± 0.67	2.80 ± 0.75	2.87 ± 0.65	2.92 ± 0.71	3.84	0.010	① < ②③④
DAP-R2	2.52 ± 0.68	2.78 ± 0.81	2.79 ± 0.74	2.94 ± 0.65	4.29	0.005	① < ②③④
DAP-R3	4.07 ± 0.65	4.14 ± 0.47	4.04 ± 0.56	3.48 ± 0.90	6.77	<0.001	① > ④
DAP-R4	2.70 ± 0.61	2.72 ± 0.61	2.75 ± 0.57	2.85 ± 0.70	0.501	0.681	–
DAP-R5	2.62 ± 0.78	2.64 ± 0.76	2.74 ± 0.73	2.84 ± 0.77	0.900	0.441	–

① Naturally open talk; ② talk, but the atmosphere is not comfortable; ③ when necessary to talk about; ④ don't talk about it. Pairwise comparisons were significant at the 0.05 level. DAP-R1 (Fear of death); DAP-R2 (Death avoidance); DAP-R3 (Neutral acceptance); DAP-R4 (Approach acceptance); DAP-R5 (Escape acceptance).

The regression equation for *Neutral Acceptance* included four factors, namely, whether important persons had been diagnosed with COVID-19, whether subjects participated in the work against COVID-19, religious belief, and gender. This resulted in a common explanation (R^2) of 47.1%, with predictive powers of 26.0, 17.5, 2.5, and 1.1%, and changes to the *F* value of 133.62, 117.10, 17.33, and 8.05, with a significance level of <0.01.

Religious belief, gender, and whether subjects had worked with COVID-19 patients, were included in the regression equation for *Approach Acceptance*. These three factors produced a common explanation amount (R^2) of 11.3%, and changes to *F* values of 32.85, 8.57, and 5.57, with a significance level of <0.05. The predictors of individuals' approaching acceptability to death were 8.0, 2.0, and 1.3%.

Finally, for *Escape Acceptance*, three factors, religious belief, whether subjects participated in the work against COVID-19, and whether important persons had been diagnosed with COVID-19, were included in the regression equation. The common

TABLE 6 | Results of death attitude and anxiety in participated in the work against COVID-19.

Project	Participated in the work against COVID-19		T	P	Cohen's d
	Yes (*n* = 160)	No (*n* = 222)			
Death anxiety	6.61 ± 2.67	6.63 ± 2.88	–0.063	0.950	–
Fear of death	2.81 ± 0.67	2.74 ± 0.70	0.941	0.347	–
Death avoidance	2.74 ± 0.72	2.67 ± 0.75	0.911	0.363	–
Neutral acceptance	4.16 ± 0.16	3.95 ± 0.78	3.218	0.001	0.37
Approach acceptance	2.81 ± 0.56	2.68 ± 0.61	2.229	0.026	0.22
Escape acceptance	2.77 ± 0.76	2.62 ± 0.75	1.941	0.053	–

TABLE 7 | Results of death attitude and anxiety in significant persons (family member/friend/colleague/neighbor) have ever been diagnosed with COVID-19.

Project	Have ever been diagnosed as COVID-19		T	P	Cohen's d
	Yes (*n* = 76)	No (*n* = 306)			
Death anxiety	7.00 ± 2.87	6.52 ± 2.76	1.317	0.189	–
Fear of death	2.45 ± 0.66	2.85 ± 0.67	–4.559	<0.001	–0.60
Death avoidance	2.51 ± 0.78	2.75 ± 0.72	–2.486	0.013	–0.31
Neutral acceptance	4.67 ± 0.09	3.88 ± 0.59	11.559	<0.001	1.87
Approach acceptance	2.67 ± 0.71	2.75 ± 0.56	–1.008	0.314	–
Escape acceptance	2.73 ± 0.85	2.67 ± 0.73	0.632	0.528	–

explanation amount of the three factors (R^2) was 3.9%, while the amount of change to F values were 6.40, 4.07, and 4.83, achieving a significance level of <0.05. The predictive power of an individual's *Escape Acceptance* is 1.7, 1.2, and 1.0%, respectively.

DISCUSSION

Overall, Chinese medical interns show a moderate degree of death anxiety. This finding is consistent with the results of previous self-reported questionnaires (Deng et al., 2019). In terms of death attitudes, the results of this study suggest that the average score of the neutral acceptance dimension is slightly higher than the median value of 3. The result of this study is higher than the score found by Gao R. et al. (2018). The reason for this difference in score may be found in the experience of the pandemic. Due to COVID-19, medical interns are being exposed to more death events than was typical among medical interns 2 years prior. As such, medical interns who are working during the pandemic are able to build a more positive attitude toward death and are less inclined to try to escape death. The escape acceptance score was the lowest of all dimensions in the scale, indicating that most medical interns do not share the notion that death should be a means to alleviate pain. In the current COVID-19 pandemic, medical interns may be building greater mental fortitude than given the current higher occurrence of death.

The results of this study also indicate that participants' gender, religious beliefs, prior funeral experiences, family attitudes toward death, experience working with COVID-19 patients, and possible knowledge of people diagnosed with COVID-19 caused significant differences in each dimension of the attitude toward death scale. In terms of gender differences, women have a higher level of death anxiety than men. The factors influencing this effect still need further investigation, but it is possible that women are more inclined to express their emotions than men, while men are more inclined to suppress their emotions. Moreover, women are more sensory-oriented, while men are more cognitive-oriented, with the result that men pay more attention to death, but express fewer anxious emotions around it (Jiang, 2016). When patients infected with COVID-19 die in hospital, female medical students' death anxiety will be higher, perhaps because women's psychological stress can be stronger than men's (Zhu et al., 2020). In addition, the death anxiety of female medical students raised slightly when patients who had contracted COVID-19 died at the hospital. Medical students with religious beliefs scored higher in accepting death, and their anxiety concerning death was lower. The questionnaire recorded that the majority of participants believed in Buddhism, which teaches that no person can escape from birth to death and that since the material world is simply a process of existence, nothing can last forever. Buddhism further teaches that samsara is the expression of the flow of life and that after death our consciousness enters various new environments through the force of birth and produces different life forms. Although medical interns with religious beliefs have a high degree of acceptance of death neutrality, in the context of the COVID-19 pandemic, which featured more frequent death events and a shortage of medical protective equipment, the degree of fear of death and death avoidance of medical interns is still relatively high.

Stambrook and Parker (1987) suggested that when adults discuss death-related events, the atmosphere of discussion they create will affect their children's attitudes toward death. This study showed that medical students whose families had a more natural and open atmosphere when discussing death were more likely to have a lesser fear of death and a more natural acceptance of death. This finding is consistent with the research results

TABLE 8 | Summary of stepwise regression analysis of various influencing factors of participants.

	R	R^2	ΔR^2	*F*	ΔF	*B*	β
Death anxiety							
Intercept						5.544	
Gender	0.170	0.029	0.029	11.288**	11.288**	1.026	0.182
religious belief	0.233	0.054	0.025	10.877***	10.194**	0.890	0.149
the way families talked about death	0.270	0.073	0.019	9.920***	7.626**	–0.393	–0.138
Fear of death							
Intercept						2.368	
Whether significant persons (family member/friend/colleague/neighbor) have ever been diagnosed with COVID-19	0.228	0.052	0.052	20.782***	20.782***	0.340	0.197
the way families talked about death	0.278	0.077	0.025	15.848***	10.400**	0.099	0.140
religious belief	0.307	0.094	0.017	13.097***	7.086**	–0.173	–0.117
number of funeral experiences	0.322	0.104	0.009	10.881***	3.930*	–0.045	–0.099
Death avoidance							
Intercept						2.895	
religious belief	0.181	0.033	0.033	12.828***	12.828***	–0.268	–0.168
the way families talked about death	0.239	0.057	0.024	11.478***	9.830**	0.119	0.157
Neutral acceptance							
Intercept						6.552	
Whether significant persons (family member/friend/colleague/neighbor) have ever been diagnosed with COVID-19	0.510	0.260	0.260	133.621***	133.621***	–1.053	–0.680
Whether the medical student has participated in the work against COVID-19	0.659	0.435	0.175	145.775***	117.103***	–0.554	–0.442
religious belief	0.678	0.460	0.025	107.146***	17.328***	0.191	0.144
Gender	0.686	0.471	0.011	83.870***	8.047**	–0.135	–0.108
Approach acceptance							
Intercept						3.689	
religious belief	0.282	0.080	0.080	32.849***	32.849***	–0.391	–0.304
Gender	0.316	0.100	0.020	21.036***	8.568**	–0.169	–0.139
Whether the medical student has participated in the work against COVID-19	0.336	0.113	0.013	16.051***	5.573*	–0.139	–0.114
Escape acceptance							
Intercept						3.918	
Religious belief	0.129	0.017	0.017	6.397*	6.397*	–0.251	–0.154
Whether the medical student has participated in the work against COVID-19	0.164	0.027	0.012	5.258**	4.068*	–0.240	–0.156
Whether significant persons (family member/friend/colleague/neighbor) have ever been diagnosed with COVID-19	0.198	0.039	0.010	5.150**	4.826*	–0.238	–0.125

*$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$.

of Yang et al. (2018). Due to the outbreak of the COVID-19 epidemic, medical interns may face deaths every day. While their resilience may be tested by these events, they are likely to result in a greater acceptance of death.

Medical students who had attended more than four funerals scored significantly lower on the fear of death and death avoidance dimensions when compared to the other groups. This shows that the experience of attending a funeral can help to reduce negative attitudes such as fear of death and death avoidance. This result is consistent with Harrawood et al.'s (2009) survey. Medical interns who had participated in the work against COVID-19 and those who knew people diagnosed with COVID-19 showed a higher degree of neutral acceptance as compared to those who had not. The stepwise regression analysis indicated that previously working with COVID-19 patients and knowledge of people diagnosed with COVID-19 influenced each dimension of medical interns' attitudes toward death. The results further suggested that the outbreak had predictive power.

To conclude, the death anxiety of medical interns remains at a moderate level. In the COVID-19 epidemic, however, the scores for fear of death and escape from death among this population are on the high side. Medical universities should strengthen death education for medical students and provide psychological protection courses during this sudden epidemic. These courses can explore the psychological and social impacts of death, provide professional theoretical knowledge, and establish a

positive view of death in the process of discussion. Such training will help students make correct guidance and treatment decisions for patients and their families in their future clinical work. Given that medical students with Buddhist beliefs have a higher degree of neutral acceptance of death, students with Buddhist beliefs can be selected to lead and carry out various forms of death education such as internship, reading, films, and visiting patients (Yang et al., 2018).

Limitations

A shortcoming of this study lies in the fact that the sampling of participants is limited to students studying in a certain medical college in Guangdong province who have already practiced in clinical practice. This sampling method affects the representativeness of participants. Furthermore, the use of an online questionnaire survey could not avoid the shortcomings of the questionnaire itself because it was impossible to observe each subject directly and record the reaction of the subject when answering questions. The explicit attitudes toward death reported by the participants could not reflect the real and complete individual attitudes toward death experienced internally. Medical interns' implicit attitudes toward death should be explored by an experimental method in the future.

CONCLUSION

During the COVID-19 epidemic, medical interns tend to accept death naturally. In general, they have a neutral acceptance of death. The factors influencing death attitude and death anxiety among medical interns included whether they had participated in the work against COVID-19 and whether they knew people diagnosed with COVID-19. In addition, the study shows that current attitudes toward death can be predicted according to six factors: gender, religious belief, prior participation in work against COVID-19, family atmosphere concerning the discussion of death, whether or not any cherished people had been diagnosed with COVID-19, and the number of instances of attending a funeral.

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 City University of Macau. The patients/participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

YQH was responsible for manuscript writing and data analysis. TL was responsible for data collection. Both authors contributed to the article and approved the submitted version.

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Teaching in Uncertain Times: Expanding the Scope of Extraneous Cognitive Load in the Cognitive Load Theory

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The COVID-19 pandemic caused an unprecedented and highly threatening, constrained, and confusing social and educational environment, we decided to expand the traditional focus of the extraneous load in Cognitive Load Theory (CLT) acknowledging the psychological environment in which learning occurs. We therefore adapted and implemented principles of the CLT to reduce extraneous load for our students by facilitating their educational activities. Given previous empirical support for the principles of CLT, it was expected that the adoption of these principles might enable our students to cultivate attitudes and skills across multiple domains such as online learning and presentation technologies, implementing and maintaining a "classroom atmosphere" in a virtual environment, participating in discussions among large online groups of students, facilitating group work, providing virtual office hours for students, and proactively planning for upcoming semesters.

Keywords: COVID-19, pandemic, Cognitive Load Theory, intrinsic load, extraneous load, germane load, the impact of the situation

INTRODUCTION

The onset of the COVID-19 pandemic caused unprecedented levels of disruption upon all areas of life worldwide (Castelnuovo et al., 2020). Health professions educators struggled to determine the most efficient way to teach students during these times when conventional teaching methods became unexpectedly unavailable. Our goal is to reduce extraneous load for students by adapting and implementing principles of the Cognitive Load Theory (CLT; Sweller, 1988, 2010), especially during times of crisis, such as the uncertain times experienced during the pandemic of SARS-CoV-2.

Rapidly developing educational theories, instruction methods and presentation techniques are enhancing our ability to understand human learning behavior, performance and outcomes, and indeed, how we define learning and its constituents (Ten Cate et al., 2011; Yardley et al., 2012; Khalil and Elkhider, 2016; McInerney and Green-Thompson, 2017; Barbour and Schuessler, 2019; Kardong-Edgren et al., 2019). In this line of research, CLT asserts that humans possess a remarkably adaptive, yet limited, cognitive capacity to learn. Hence, according to CLT, a key strategy to foster learning is to efficiently regulate how this limited cognitive capacity is deployed.

Relying on Atkinson and Shiffrin's (1968) model of human memory, CLT postulates three cognitive components of the human learning architecture: a sensory memory (SM), working memory (WM), and a long-term memory (LTM). SM is assumed to be confined to perception of visual and auditory information. However, it can retain information for only a few seconds (Mayer, 2010; Eriksson et al., 2015). Because only information that rises to awareness can enter the domain of the WM, most of the information entering SM vanishes and only a small portion of the sensory information enters the domain of WM (Simons and Chabris, 1999). CLT assumes that WM displays a limited capacity in dealing with complex, novel, and unorganized information elements obtained through SM. WM can only hold five to nine information elements (the famous "seven plus or minus two") (Miller, 1956), which vanish after a few and up to about 20 s, unless they are revitalized by rehearsal (Fegen et al., 2015; Lucidi et al., 2016; De Schrijver and Barrouillet, 2017; Oberauer, 2019). Furthermore, CLT asserts that the capacity and the characteristic of the working memory is a function of the type of information elements and varies depending upon whether the information elements are novel or have been retrieved from LTM (Sweller, 2010; van Merriënboer and Sweller, 2010).

In contrast to WM, LTM has no known capacity limitations (Witt et al., 2019) and holds cognitive schemas that assist LTM by organizing information (Sporer, 2016). Cognitive schemas vary in their degree of complexity and reduce the amount of information units that are processed concurrently during the problem-solving process, for instance, by clustering new elements together or by integrating new elements in schemas already available in LTM (Anderson, 1980; van den Bosch and Daelemans, 2013; Wirzberger et al., 2018). Frequent reactivation and successful application of a schema leads to automatization and significantly reduces the burden of information processing (Gobet, 2000). According to CLT, the process of construction and automatization of cognitive schemas constitutes learning (van Merriënboer and Sweller, 2010). Therefore, efficient, and successful learning requires an ease in the process of creating and modifying cognitive schemas to optimize intrinsic and extraneous cognitive load for upcoming learning to levels that do not exceed the learner's cognitive capacity and do not impede learning performance of an individual (Reif, 2010).

According to CLT, individuals must deal with three different, but interdependent types of the cognitive load in the process of learning: intrinsic, extraneous, and germane load (Sweller, 1988, 2010). Intrinsic cognitive load originates in the content of information elements and intrinsic nature of the learning tasks. It increases by the number, complexity, and novelty of information elements that must be processed simultaneously in working memory. Simultaneous processing of information depends on the extent of element interactivity. Element refers to a cue (e.g., a piece of information) that has been or needs to be learned (Sweller et al., 1988). Tasks with low Low-element interactivity (e.g., the vocabulary of a foreign language) allow elements to be learned serially rather than simultaneously whereas learning tasks with high-element interactivity requires that several elements must be manipulated in working memory simultaneously (unthreatening a sentence requires understanding all of the words in that sentence). Apart from the complexity and novelty of information element content, it is also decisive how this new information element is presented to the individual (extraneous load). Accordingly, extraneous load is created by instructional procedures. A central premise of CLT alleges that those intrinsic and extraneous cognitive loads are additive. Consequently, in the presence of high intrinsic cognitive load, it would be decisive to reduce the extraneous cognitive load by applying efficient and user-friendly instructional procedures (Sweller, 1994; van Merriënboer and Sweller, 2010; Naismith et al., 2015; Jordan et al., 2020). In contrast to intrinsic and extraneous cognitive load, germane load, refers to the cognitive load that is required to create cognitive schemas and depends on the amount of WM resources used to regulate and deal with intrinsic cognitive load.

EXPANDING THE SCOPE OF EXTRANEOUS COGNITIVE LOAD

Despite abundant work on extraneous cognitive load (Klepsch et al., 2017; Sewell et al., 2019), one piece of research seems to be surprisingly missing in the literature as learning and instructional procedures do not occur in a situational vacuum. This assertion challenges the substantive definition of extraneous cognitive load as it assumes that situational characteristics may ease or deteriorate the process of development, modification, and automatization of cognitive schemas over and above the quality of the instructional process. Therefore, the concept of "extraneous cognitive load" must encompass the broad diversity and complexity of situational factors under which learning materials are presented. We sought to address this limitation in the present work.

The issue of efficient use of cognitive resources pertains to medical students. Medical education follows a highly challenging, fast paced, and dense curriculum (Stevens, 2018; Buja, 2019). Previous research has established that independent of myriad daily life stressors, college life under *normal* circumstances is an extremely stressful and critical period (Anderson et al., 2003; Hamilton, 2006). Medical students have been consistently reporting high levels of stress, anxiety, and depression (Iqbal et al., 2015; Ludwig et al., 2015; Brenneisen Mayer et al., 2016; Rotenstein et al., 2016; Fawzy and Hamed, 2017; Moutinho et al., 2017). However, it is crucial to emphasize that online education was well-established prior to the COVID-19 pandemic (Castro and Tumibay, 2021) and online instruction has been ubiquitous in medical education (Jiang et al., 2021). However, COVID-19 imposed an unprecedented pressure on medical students to adapt rapidly to a sudden pivot from traditional face-to-face instruction to online instruction without any lead-time to prepare for such a massive change. Therefore, it was crucial to identify and prevent potential sources of cognitive overload for our students to support the learning performance and wellbeing of our students. Hence, in times of a health pandemic such as the current COVID-19, it seems particularly plausible to assume that an abrupt shift to online teaching elevates anxiety and fear among students and exacerbates efficient use of their cognitive resources.

Given the urgency of the COVID-19 pandemic, and in the absence of any prior experience and evidence-based recommendations for how to support and enhance learning experiences of all students by shifting to online instruction, we decided to apply CLT to enhance students' learning capabilities. CLT is a well-known theory that uses cognitive structures such as working memory and long-term memory to explain human learning. This decision was encouraged by empirical evidence in the past supporting the principles of CLT during non-pandemic times (van Merriënboer and Sweller, 2010; Sweller et al., 2011, 2019).

Therefore, we have adapted several theory-based strategies to ease the burden of learning for our students and to train them to become lifelong learners during this time of crisis. Many of these strategies focus on aiding students to acquire the skills needed for problem-solving and self-assessment and build on their existing knowledge.

The strategies that are presented in this paper are the outcome of the reflections of our team in dealing with COVID-19 pandemic challenges to prepare for online-only instruction. In addition, we capitalized on our experiences as we explored the efficiency of these strategies in teaching the four medical school courses Behavioral Science, Psychopathology, Promotion and Maintenance of Health, and Cardiovascular in the Spring and Fall semesters of 2020. These four courses were interrupted or severely affected by the COVID-19 pandemic and had to be shifted toward online-only teaching and have been evaluated by students. Following the recommendations and feedback of our students, we discuss several strategies to alleviate the extraneous load for our students.

ALLEVIATING EXTRANEOUS LOAD

As highlighted above, extraneous load is generated by the means of instruction and is not essential to comprehending the information (Sweller, 2010). However, it occupies cognitive resources and can overwhelm the WM (Stillwell et al., 2017; Jordan et al., 2020). Building upon our recent work (Mohiyeddini, sub.), we decided to purposefully alleviate the extraneous load for our students when shifting toward online-only teaching. We utilized and adapted the following five well-researched principles of CLT (van Merriënboer and Sweller, 2010).

1. *Split attention principle: this principle suggests providing one integrated source of information, avoiding temporal split attention (sources distributed in time), and/or spatial split attention (sources distributed in space).*

We anticipated that two different clusters of information produced by the COVID-19 learning environment might overwhelm each individual's attention, challenge their internal locus of control (Abdalla et al., 2019), and create confusion: *Firstly*, we provided information related to how to create a functioning and efficient learning environment at home. To manage and integrate this information and enhance the internal locus of control (Sigurvinsdottir et al., 2020), we instituted a department-wide shared team communication platform (Slack^R)[1] at the beginning of COVID-19 pandemic to communicate issues related to the pandemic following empirical evidence that show access to valid and reliable information reduces ambiguity and anxiety (Stamenkovic et al., 2018; Sancak and Akal, 2019). We used our departmental Slack workspace in order to integrate information regarding students' briefing, teaching, supervision, and mentoring into one tool. *Secondly*, we sought to manage COVID-19 related health- and safety information. Therefore, we thoughtfully engaged in current information and provided it with high-fidelity. To deal with this challenge, we developed a "COVID-19 updates" Slack channel to share information updates both from within our own health system as well as national/scientific news. This channel offered the most up-to-date scientific news, free from speculations and online rumors. By extension, this channel was used to reduce fear and confusion amongst relatives, friends, and communities of our students by providing a trusted information source.

2. *Worked example principle: this strategy suggests providing learners with worked examples that offer a full solution that learners may cautiously study and comprehend.*

During our orientation to shift toward online-only education, we developed several "how to" documents and offered online support at the beginning of the transition period. Further, we offered students several workshops for online education. These courses were delivered by several experts in online teaching who were able to reduce many of the "unknowns" for the students by providing detailed worked examples of how to be a successful participant in online learning.

As an effort to create an effective online learning environment for virtual team-based learning (TBL) activities, by using a shared online assignment platform we ensured that appropriate instruction and support were provided to help teams complete the assignments both effectively and efficiently. For instance, students were provided with guides for how to use the video conferencing tools and the learning management system for quizzes and application exercises. In addition, they were required to attend live synchronous ungraded TBL sessions to practice in a safe and risk-free environment. To decrease further extraneous cognitive load, we followed literature-based guidelines for TBL implementation. For example, we used a highly recommended software tool specifically designed for synchronous online TBL (InteDashboard^R Inc., Singapore).[2] This online tool automates all the TBL components (pre-class preparation, readiness assurance, and application exercises) and TBL peer feedback as well. Students conveniently access InteDashboard from within our Learning Management System (Moodle and Zoom).

3. *Completion principle: "This principle suggests substituting conventional tasks with completion tasks which provide a partial solution that must be completed by the learners"* (van Merriënboer and Sweller, 2010, p. 90*).*

[1] www.slack.com

[2] www.intedashboard.com

TBL sessions were delivered during the curriculum using InteDashboard. This facilitated delivery of partial solutions during some TBL sessions. For poor-performing students who required remediation of a course, synchronous didactic lectures were offered in order to work closely with those students and concentrate on deficiencies in learning rather than on those areas in which the student had already demonstrated mastery. Interactive approaches were encouraged, such as flipped classroom and dialogical narrative approaches.

4. *Modality principle: this principle suggests providing a narrated text to a visual source (multimodality) instead of combining the visual source with an explanatory text in writing (unimodal).*

We solicited narrated guidelines from students to use digital guides for online classes. Furthermore, our faculty created narrated demonstrations of available tools illustrating best practices in online teaching. In addition, laboratory sessions (e.g., in pathology) in the Cardiovascular course were presented using narrated slides supported by brief video clips.

5. *Redundancy principle: Replace multiple self-contained sources with one source of information.*

We investigated all available technology options already in place within our curriculum (including Moodle, WebEx, USeeYou, Google Hangouts, and Panopto lecture recording). While we created one page "How-to" guides for less frequently used software tools, we have excelled in the curation of stand-alone and vetted resources for students use. WebEx was used for synchronous instruction with the entire class, with a feature to allow break-out sessions to facilitate small group work (which could be moderated by instructors). Reassembly of these small groups was also useful for collective debriefings. YouSeeU (YouSeeU^{R} Inc., Loveland Co.)[3] was already familiar to the students as they had been using it routinely for reflections in courses prior to COVID-19. Google Hangouts (Google^{R} Inc., Mountain View, CA, United States)[4] was introduced to students as a platform to mediate small group discussions and group work using video conferencing and screen-sharing. Lastly, Panopto (Panopto Inc., Pittsburgh, PA, United States)[5] was also familiar to students as it was the software that was used for live lecture capture before COVID-19 and is now used for recording of asynchronous sessions by faculty for students. For instance, in the Promotion and Maintenance of Health course, a service-learning program was introduced to students in the first 2 weeks. Prior to the COVID-19 pandemic, sources of information were accessible to students as written instructions or as part of in-person instruction of site directors. This year, students were provided short video presentations of each site director to introduce community partner organizations. This consolidated presentation replaced what was previously obtained from multiple sources. Following student team commitments to serve with individual community partners, online training was made available online. In this way students were engaged in team projects aligned to the goal-free principle.

[3]www.youseeu.com

[4]https://meet.google.com/

[5]www.panopto.com

DISCUSSION AND CONCLUSION

Most recently, Wilcha (2020) presented a systematic review of 39 articles that provide insight how several medical schools successfully implemented a variety of web-based resources and developed novel interactive forms of virtual learning for their students. However, our analysis of these articles and our extensive database searches in PubMed, Eric, PsycINFO, and PsycARTICLES revealed that our paper seems to be the first that discusses the applicability of Cognitive Load Theory in shifting toward online learning. This paper adds to our knowledge on the CLT, online education, and virtual collaborations among students for several reasons:

First, this paper shows that psychological theories can be applied to provide guidance in managing a non-voluntary process of change that was forced upon an academic institution and its students. The rationale provided in this paper could be used to develop, maintain, and enhance online teaching, supervision, and research activities during normal times as well. The digital nature of our socially distant world requires training and experience with online learning. This approach could also be used to proactively develop contingency plans and toolboxes to maintain and facilitate learning in dealing with national and international disasters in the future.

Second, our theory-driven approach provides a novel avenue to enhance the quality of online learning along with implementing purely technology-based teaching aids such as narrated PowerPoint presentations (Hampton et al., 2017), recorded lectures (Broussard and Wilson, 2018), online web-based tools (Wilson et al., 2021), use of videos (Forbes et al., 2016), using blogs (Kaup et al., 2020), and flipped classrooms (Flugelman et al., 2021).

Third, our adaptation of the CLT principles to reduce the extraneous load (such as split attention principle) rests on the assumption that these principles may serve to enhance the psychological environment for learners by reducing fear and worrisome-related thoughts because of exposure to scientifically questionable information and suggestions. In addition, our approach highlights that online education can capitalize on and profit from educational and psychological theories on learning to provide theory-based guidelines to students. Fourth, we believe our abrupt, but organized move toward online-only teaching may have enhanced the perception of the internal locus of control among students (Abdalla et al., 2019; Boyraz et al., 2019) by enhancing the sense of personal control over the situation. Furthermore, we assume that holding an early in-person workshop to demonstrate usage of online platforms might help our students to prevent a sense of helplessness, by demonstrating that our department was both theoretically and technically prepared to provide support through the COVID-19 pandemic (Lester, 2012; Shaw, 2020). Sixth, our approach can foster the quality of learning during normal times. Cultivating a culture of online collaborations can be beneficial to maintaining

and fostering national and international collaborations among students as well. Last, our approach delivers a theory-based example of how to create a virtual collaborative space for educational activities among students which may add to their traditional face-to-face scholarly skills and resources.

As is inherent to the nature of an opinion article, this paper suffers from two major limitations: (1) Our paper does not provide empirical evidence to support our claims and suggestions. Instead, we relied on empirical evidence that have supported the principles of CLT during normal times and apply those to the times of the COVID-19 pandemic. (2) This paper reflects theory-driven changes that were implemented on an individual academic institution's actions to enhance students' learning and, hence, contains bias and lacks external validity. (3) By applying an empirically investigated theory such as CLT, we have also adopted the shortcomings of this theory. For instance, it is still unclear how cognitive load can be measured (Holton, 2009). CLT neglects interindividual differences by learning and assumes that instructional materials can be the same for all learners. In addition, Moreno (2010) criticizes a lack of conceptual clarity regarding terms such as cognitive load, mental load, and mental effort. In addition, Reif (2010) highlighted that minimizing cognitive load doesn't constitute necessarily a more efficient learning condition as a low cognitive load may result in boredom, ultimately diminishing a learner's motivation to learn. Another key shortcoming of CLT is that it might be immune to empirical falsification. For instance, it seems challenging to experimentally vary the level of cognitive load independent from learning performance of individuals as CLT equates poor learning performance with high levels of cognitive load. Relatedly, de Jong (2010) emphasizes that germane cognitive load is a *post hoc* explanation that lacks theoretical basis. However, remote teaching seems to offer itself as an inherent component of future higher education. Therefore, we aim to provide empirical evidence to highlight the importance of theory-driven online learning strategies to minimize the cognitive load for students.

AUTHOR CONTRIBUTIONS

CM provided the idea and theoretical background and designed the manuscript. TT, SK-E, JG, IH, and SL contributed to the different parts of the manuscript. All authors contributed to the article and approved the submitted version.

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Technostress and academic motivation: direct and indirect effects on university students' psychological health

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Introduction: Research has well demonstrated that the pandemic entailed several implications among university students worldwide in terms of increased use of Information and Communication Technologies (ICTs), technostress, disruptions in academic goals and motivation processes, and growing psychological suffering. Responding to the new research need to go in-depth into the processes linking technostress and motivation dimensions to inform current research/interventions, the present study aimed to explore the direct effects of perceived Technostress dimensions (Techno-Overload, Work-Home Conflict, Pace of Change, Techno-Ease, Techno-Reliability, and Techno-Sociality) and Academic Motivation dimensions (Amotivation, Intrinsic, and Extrinsic Motivation dimensions) on students' perceived levels of Anxiety/Depression and test the potential indirect effect (mediating role) of Academic Motivation dimensions in the associations between Technostress and psychological health conditions.

Methods: Overall, 1,541 students from five European countries (Czech Republic, Greece, Italy, Serbia, United Kingdom) completed a survey comprising a Background Information Form, the Technostress Scale, the Academic Motivation Scale-College, and the Hospital Anxiety and Depression Scale. Hayes' PROCESS tool was used to test direct and indirect (mediating) effects.

Results: Data revealed that Techno-Overload, Work-Home Conflict, Amotivation, and Extrinsic Motivation-Introjected had a direct negative effect, whereas Techno-Ease, Techno-Reliability, Techno-Sociality, all Intrinsic Motivation dimensions, and Extrinsic Motivation-Identified had a direct protective role for students' psychological health. The significant indirect role of motivation dimensions in the associations between Technostress dimensions and Anxiety/Depression was fully supported.

Discussion: Findings allow gaining further insight into the pathways of relationships between technostress, motivation, and psychological health, to be used in the current phase, featured by the complete restoration of face-to-face contacts, to inform the development of tailored research and interventions, which

address lights and shadows of the technology use, and which take into account the necessity to enhance its potentials yet without impairing students' motivation and psychological health.

KEYWORDS

academic motivation, information and communication technologies, mediating effects, protective factors, psychological health, risk factors, technostress, university students

1. Introduction

University students are recognized globally as a population vulnerable to poor wellbeing (Zivin et al., 2009; Auerbach et al., 2018). Indeed, research conducted worldwide has highlighted remarkable rates of severe psychological disease, in particular anxiety and depression, which were substantially higher than those reported among the general population (Eisenberg et al., 2007; Ibrahim et al., 2013; Quek et al., 2019; Mavrandrea and Giovazolias, 2022).

The school-to-college transition typifies one pivotal shift, in terms of increased personal duties and responsibilities as well as new financial, social, and relational needs and demands (Galvin et al., 2020; Parker et al., 2021). Moreover, whether several lifetime mental disorders have first onset around emerging adulthood—that is the more common age of beginning college/university (Kessler et al., 2005; Giovazolias et al., 2010)—the psychological suffering and the severity of symptoms may be even exacerbated due to the concerns and perceived pressures about academic life, performance/success, and future plans (Beiter et al., 2015).

Noteworthy, the number of university students with a serious mental illness has risen globally during the COVID-19 pandemic (Browning et al., 2021; Charles et al., 2021; Gritsenko et al., 2021; Xu et al., 2021), which has imposed key changes and further challenges in their daily life (Aristovnik et al., 2020; Zurlo et al., 2020), resulting in declining levels of motivation and difficulties in self-regulation (Means et al., 2020; Gonzalez-Ramirez et al., 2021; Hicks et al., 2021; Tasso et al., 2021; Usher et al., 2021; Corpus et al., 2022), growing rates of stress and difficulties in concentrating (Son et al., 2020; Baltà-Salvador et al., 2021; Somma et al., 2021; Zurlo et al., 2022a,b), and increased anxiety and depression (Cao et al., 2020; Husky et al., 2020; Rusch et al., 2021).

Recent research has warned that several students are still experiencing difficulties in re-adjusting to the new circumstances, reporting increases in perceived stress linked to technology use, and weakening of in-person relational and social abilities, apathy, disengagement, as well as decreased focus, motivation, and psychological health (Parker et al., 2021; Caron et al., 2022; Corpus et al., 2022; Curelaru et al., 2022; Singh et al., 2022; Stoian et al., 2022).

Accordingly, there is an urgent need to provide updated research accounting for the impact this prolonged condition may have left. The present study therefore will target university students and seek to provide evidence that could foster interventions promoting their psychological health in the post-emergency time, featured by the complete restoration of in-presence courses and face-to-face contacts. This is by investigating on direct and indirect effects of two key variables, namely technostress dimensions and academic motivation dimensions, on students' anxious and depressive symptomatology.

1.1. Technostress and psychological health among university students

Technostress is a term defined by Brod (1984) to describe the human cost of the technological revolution, namely the effects—in terms of psychophysical health outcomes—of the perceived difficulties in dealing with, and adjusting to, the ICTs use.

Based on a multidimensional and transactional approach to stress (Lazarus and Folkman, 1984), several studies have identified and categorized different Technostress dimensions, namely Techno-Overload, Work-Home Conflict, Pace of Change, Techno-Ease, Techno-Reliability, and Techno-Sociality (Moore and Benbasat, 1991; Moore, 2000; DeLone and McLean, 2003; Ayyagari et al., 2011; Tarafdar et al., 2011; Kemp et al., 2019).

Specifically, *Techno-Overload* (i.e., the perception of being under pressure, forced to work faster, and longer due to the use of ICTs), *Work-Home Conflict* (i.e., the perception of lack of boundaries between work/study and private life due to the use of ICTs), and *Pace of Change* (i.e., the perception of frequent ICT-related changes and updates) have been considered as significant risk factors able to substantially exacerbate psychological suffering. Conversely, *Techno-Ease* (i.e., the perception of easiness in the use of ICTs to reach the desired outcomes), *Techno-Reliability* (i.e., the perception of trustworthiness of ICTs to carry out the desired activities), and *Techno-Sociality* (i.e., the perception of the use of ICT as a social communication tool, so that individuals can reach or be reached by other people from a distance and at any time) have been considered protective factors that foster adjustment and wellbeing (Ayyagari et al., 2011; Tarafdar et al., 2011; Galvin et al., 2022).

The effects of technology use in terms of individual, relational, and social wellbeing have been highly debated within international research in terms of both lights and shadows (Berg-Beckhoff et al., 2017; Vilhelmson et al., 2017; Charalampous et al., 2019; Baumeister et al., 2021). Indeed, ICTs use may simultaneously entail not only risks (e.g., techno-overload, misuse/abuse of technology, invasion of privacy, difficulties in planning time for academic activities, excessively relying on technology for social life rather than for face-to-face

interactions, difficulties in "disconnecting" from the virtual world) but also resources (e.g., socialization, collaboration, exchanging of information/advice/support; connections to others beyond time/space boundaries, flexibility, time-saving) (Wellman et al., 2001; Haythornthwaite, 2005; Gemmill and Peterson, 2006; Suhail and Bargees, 2006; Ragu-Nathan et al., 2008; Chayko, 2014; Brivio et al., 2018; Kemp et al., 2019; Lattie et al., 2019; Dietz et al., 2020; Thomas et al., 2020; Borle et al., 2021; Kniffin et al., 2021).

Undoubtedly, the COVID-19 pandemic has added complexity to the international debate on risks and resources linked to ICTs, due to their prolonged, extensive, and almost exclusive use to maintain social/relational life (Aguilera-Hermida, 2020; Garfin, 2020; Papouli et al., 2020; Kniffin et al., 2021). This was particularly true in the educational and academic contexts (Panisoara et al., 2020), which was already featured by significant and growing changes and pressures in recent decades (Zurlo et al., 2016; European Commission, 2017, 2020) and—afterward—among the most deeply impacted sector by the pandemic (Plakhotnik et al., 2021).

In particular, within a period of creeping technological revolution, the onset of the pandemic resulted in academic activities being abruptly shifted to online platforms, and technology use increased quantitatively and changed qualitatively (Garfin, 2020; Papouli et al., 2020; Sundarasen et al., 2020; Browning et al., 2021; Kniffin et al., 2021). Indeed, students were required to spend a greater and prolonged amount of time per day online/using technological devices (i.e., blue light exposure) (Browning et al., 2021; Gruba et al., 2021; Hagedorn et al., 2021; Hosen et al., 2021; Mack et al., 2021; Reinhart et al., 2021; Yadav et al., 2021; Yu et al., 2021), which resulted in increased levels of perceived load, psychological suffering (Hussein et al., 2020; Al-Kumaim et al., 2021; Lemay et al., 2021; Malik and Javed, 2021; Morales-Rodriguez, 2021), and anxiety and depression (Sundarasen et al., 2020; Chinna et al., 2021; Denisov et al., 2021; Dirzyte et al., 2021; Gao et al., 2021; González-López et al., 2021; Xu and Wang, 2023). This was particularly harmful to those who were already considered problematic ICTs users, as they were forced to further increase their time "on screen" during the pandemic (Cai et al., 2021; Hosen et al., 2021; Islam et al., 2021; Xie et al., 2021).

Within this portrait, whether there is substantial evidence of the direct impact of Technostress dimensions on students' wellbeing (e.g., Nadeem et al., 2018; Abbas et al., 2020; Wang et al., 2020, 2021; Galvin et al., 2022), some recent studies have also underlined that the extensive technology use during the pandemic has also had a detrimental effect in terms of decrease in motivation as well as increase in apathy and disengagement (Parker et al., 2021; Corpus et al., 2022; Curelaru et al., 2022; Stoian et al., 2022), suggesting the need to explore the unique link between ICTs use and self-regulation/motivational processes in the current time.

1.2. Academic motivation and university students' psychological health

Motivation and self-regulation processes represent essential components for optimal human functioning and key aspects in students' life (Yoo and Marshall, 2022), determining academic success and wellbeing (Pisarik, 2009; Kotera et al., 2022; Mašková et al., 2022), in terms of performance (Ali, 2020; Tan, 2020) and psychological health (Ryan and Deci, 2000; Marler et al., 2021; Juntunen et al., 2022).

The self-determination theory (SDT; Deci and Ryan, 1985) represents one of the most recognized motivation theories globally and has been widely applied in research and interventions targeting the educational context (Deci et al., 1991; Müller and Louw, 2004; Ryan et al., 2006; Liu et al., 2016; Howard et al., 2021; Kritikou and Giovazolias, 2022). Within the self-determination theory, the experience of autonomy in motivation processes is defined as the extent to which people behave according to self-endorsed values. The regulation of behaviors can be situated along a continuum ranging from a complete lack of motivation and self-determination (i.e., amotivation) to high autonomy (i.e., internal regulation/intrinsic motivation), passing through high control (i.e., external regulation/extrinsic motivation) (Ryan and Deci, 2000). The more behaviors are regulated by autonomous motives, the more individuals will flourish and experience greater wellbeing. This hypothesis has been confirmed in several domains, including education (Ryan and Deci, 2000; Vansteenkiste et al., 2008).

Considering university students, based on the SDT, a specific measurement tool—namely the Academic Motivation Scale—College version (AMS-C; Vallerand et al., 1992)—has been developed and internationally adopted (e.g., Chong and Ahmed, 2012; Stover et al., 2012; Ardeńska et al., 2016; Zurlo et al., 2023). The AMS-C covers university students' Amotivation, three types of Intrinsic Motivation (i.e., Motivation To Know; Motivation Toward Accomplishment; Motivation To Experience Stimulation), and three types of Extrinsic Motivation (i.e., External Regulation; Introjected Motivation; Identified Motivation), allowing to address the multidimensionality of the theoretical framework.

In detail, Amotivation refers to a condition by which neither intrinsic nor extrinsic factors boost students' actions. Either they do not act or they act passively, as they feel incapable, powerless, and/or do not associate the link between their behavior and the expected outcomes. Students who are mainly amotivated are more likely to report poor academic outcomes, isolation/lowered sense of belonging to the university community, and reduced wellbeing (Vallerand et al., 1997; Baker, 2004; Ratelle et al., 2007; Marler et al., 2021).

On the opposite, at the highest level of autonomous functioning, intrinsic motivation describes students who perceive a sense of inherent enjoyment and pleasure from academic life (i.e., understanding new things; surpassing oneself; stimulating sensations). This results in feelings of freedom, satisfaction, and wellbeing (Ryan and Deci, 2000; Jie et al., 2022).

Finally, considering extrinsic motivation, some students may be mainly driven by external forces/pressures (typically from family and society) to enroll at university and to achieve academic success. These students may perform actions to receive rewards/prevent penalties in grades (i.e., external regulation) or to avoid feeling guilty or ashamed about being disloyal to, and/or incompliant with, others' expectations (i.e., introjected regulation). However,

extrinsically motivated students may also perform actions that are accepted/recognized as personally valuable and meaningful (i.e., identified regulation), displaying a more autonomous regulation, better performance, and higher wellbeing (Liu et al., 2016).

Generally, there is clear evidence about the detrimental effect of amotivation, on the one hand, and positive effect of the more autonomous types of motivation, such as intrinsic motivation and identified regulation, on the other hand, on wellbeing and psychological health (Pisarik, 2009; Ryan and Deci, 2017; Kotera et al., 2022; Mašková et al., 2022). In contrast, evidence on the association between psychological outcomes and more controlled types of motivation, such as external and introjected regulation, is less straightforward. Whereas multiple studies have found a negative effect of controlled motivation on psychological outcomes (e.g., Pisarik, 2009; Ryan and Deci, 2017), there are also studies that show no such association (Kotera et al., 2022; Mašková et al., 2022).

Recent research has increasingly explored motivation from a multidimensional/transactional perspective, with particular reference to its mediating role within broader processes (Dana et al., 2021). In this direction, evidence suggests the mediating role of motivation in the relationship between academic self-efficacy and procrastination (Malkoç and Mutlu, 2018), parenting style and life satisfaction (Stavrulaki et al., 2021), personality types and social networking site addiction (Chen and Roberts, 2020), psychological needs and engagement/burnout (De Francisco et al., 2020), and situational job-related stressors and burnout (Rubino et al., 2009).

However, despite the abundance of research targeting students by focusing independently on technostress (Liu, 2010; Henderson et al., 2015; Lattie et al., 2019; Papouli et al., 2020) and academic motivation (Vallerand et al., 1992; Kritikou and Giovazolias, 2022; Kvintova et al., 2022; Mašková et al., 2022), to the best of our knowledge, research exploring the mediating role of academic motivation in the associations between technostress dimensions and psychological health is lacking. Yet, undoubtedly, the COVID-19 pandemic/containment measures and the current post-pandemic conditions have unveiled this fairly new research need.

1.3. The present study

Considering the literature and the research needs reported above, the present study aimed to test the direct effects of perceived Technostress dimensions (i.e., Techno-Overload, Work-Home Conflict, Pace of Change, Techno-Ease, Techno-Reliability, Techno-Sociality) and Academic Motivation dimensions (i.e., Amotivation; Intrinsic Motivation—To Know, Toward Accomplishment, Experience Stimulation; and Extrinsic Motivation—Identified, Introjected, External Regulation) on students' psychological health as measured by perceived levels of Anxiety and Depression, and the potential indirect effect (mediating role) of Academic Motivation dimensions in the associations between Technostress and psychological health conditions.

Specifically, taking into account the previously established effects of Technostress dimensions on students' wellbeing and, in particular, on the one hand, the negative impact of perceived stress linked to techno-overload, managing the pace of technological change, and weaker boundaries between work and home due to ICTs use, and, on the one other hand, the positive impact of perceived ICTs as easy, reliable, and helpful in being connected/communicate with others (e.g., Tarafdar et al., 2011; Abbas et al., 2020; Wang et al., 2021; Galvin et al., 2022), the following hypothesis has been tested:

> *Hypothesis One* (H1): Technostress dimensions will be significantly related to university students' psychological health. Specifically, Techno-Overload, Work-Home Conflict, and Pace of Change will be significantly positively related to Anxiety and Depression (H1.a) while Techno-Ease, Techno-Reliability, and Techno-Sociality will be significantly negatively related to Anxiety and Depression (H1.b).

Moreover, considering recent studies suggests that the extensive technology use during the pandemic has had an influence on self-regulation processes, impairing motivation, increasing apathy and disengagement (Parker et al., 2021; Corpus et al., 2022; Curelaru et al., 2022; Stoian et al., 2022), the following hypothesis has been examined:

> *Hypothesis Two* (H2): Technostress dimensions will be significantly related to university students' Academic Motivation. Specifically, Techno-Overload, Work-Home Conflict, and Pace of Change will be significantly positively related to Amotivation (H2.a), while Techno-Ease, Techno-Reliability, and Techno-Sociality will be significantly negatively related to Amotivation (H2.b).

Furthermore, considering the well-demonstrated positive impact of more autonomous types of motivation and the negative impact of amotivation on wellbeing, along with the mixed evidence on the association between more controlled types of motivation and psychological health (e.g., Pisarik, 2009; Ryan and Deci, 2017; Kotera et al., 2022; Mašková et al., 2022), the following hypothesis has been developed and was tested:

> *Hypothesis Three* (H3): Academic Motivation dimensions will be significantly related to university students' psychological health. Specifically, Amotivation will be significantly positively related to Anxiety and Depression (H3.a), while Intrinsic Motivation dimensions will be significantly negatively related to Anxiety and Depression (H3.b).

Finally, in line with the growing number of studies supporting the potential mediating role of motivation (e.g., Chen and Roberts, 2020; Stavrulaki et al., 2021), and given the new strict bond between ICTs use and academic motivation as one of the marks deriving from the pandemic (e.g., Parker et al., 2021; Corpus et al., 2022; Curelaru et al., 2022; Stoian et al., 2022), it is sound to hypothesize that academic motivation may—at least partially—explain the relationship between perceived technostress dimensions and psychological health among university students. The following hypothesis was, therefore, explored:

> *Hypothesis Four* (H4): Academic Motivation dimensions will play as significant mediators in the associations between Technostress dimensions and university students' psychological health.

2. Materials and methods

2.1. Participants and sampling

The present cross-sectional and multi-national study raised in the context of a broader European Project (Masked for Blind Review). National surveys were made available online using Qualtrics platform and were widely disseminated in five European countries (i.e., Czech Republic, Greece, Italy, Serbia, United Kingdom) as part of the project. Data were collected over the period from March 2022 to December 2022. Students were asked to participate in the online survey *via* both institutional channels (e.g., academic mailing lists) and informal channels (e.g., social media groups), and they were given all the relevant information about the research project. The research was performed in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards, and students were provided with all the information about the privacy policy (e.g., the treatment and the confidentiality of their data). The project was approved by the Ethical Committee of each institution involved. Overall, 2,227 university students accessed the Qualtrics survey; of those, 1,901 provided informed consent. However, 1,541 students completed the survey in all its parts and were included in the final dataset.

2.2. Measures

The questionnaire included a section on background information, along with validated measures for Technostress dimensions, Academic Motivation, and Psychological Health Outcomes.

2.2.1. Background information

The background information section included single-item questions on Sex, Age (in years), Ethnicity, Number of people living in the household, Course of Study, and Employment status. In addition, daily time (in hours) in using ICTs was also asked.

2.2.2. Technostress dimensions

Technostress Dimensions were assessed using the Technostress Scale (Ayyagari et al., 2011), which consists of 17 items on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree) and divided into six subscales, namely Techno-Overload (three items; e.g., "I feel pressured due to ICTs"); Work-Home Conflict (three items, e.g., "Using ICTs blurs boundaries between my university/work life and my home life"); Techno-Ease (three items, e.g., "It is easy to get results that I desire from ICTs"); Techno-Reliability (three items, e.g., "ICTs behave in a highly consistent way"); Techno-Sociality (two items, e.g., "The use of ICTs enables others to have access to me"); Pace of Change (three items, e.g., "I feel that the way ICTs work changes often"). The scale has been adopted globally and is recognized as a statistically valid tool for assessing Technostress dimensions (e.g., Christ-Brendemühl and Schaarschmidt, 2020; Camacho and Barrios, 2022; Galvin et al., 2022). In the present study, confirmatory factor analysis revealed satisfactory goodness-of-fit indices for the original six-factor model: that is, comparative fit index (CFI) = 0.957; Tucker–Lewis index (TLI) = 0.944; goodness-of-fit index (GFI) = 0.996; Bentler–Bonett non-normed fix index (NNFI) = 0.944; Bentler–Bonett normed fix index (NFI) = 0.949; root mean square error of approximation (RMSEA) = 0.058; and standardized root mean square residual (SRMR) = 0.046. Cronbach's α and McDonald's ω values were also satisfactory (Supplementary Table 1).

2.2.3. Academic motivation

Academic Motivation dimensions were assessed using the Academic Motivation Scale—College version (AMS-C; Vallerand et al., 1992), which consists of 28 items on a 7-point Likert scale ranging from 1 (Does not correspond at all) to 7 (Corresponds a lot) and divided into seven subscales, namely Amotivation (four items, e.g., "I once had good reasons for going to college; however, now I wonder whether I should continue"); Extrinsic Motivation—External Regulation (four items, e.g., "In order to obtain a more prestigious job later on"); Extrinsic Motivation—Introjected (four items, e.g., "Because of the fact that when I succeed in college I feel important"); Extrinsic Motivation—Identified (four items, e.g., "Because I think that a college education will help me better prepare for the career I have chosen"); Intrinsic Motivation—To Know (four items, e.g., "For the pleasure I experience when I discover new things never seen before"); Intrinsic Motivation—To Experience Stimulation (four items, e.g., "For the pleasure that I experience when I read interesting authors"); Intrinsic Motivation—Toward Accomplishment (four items, e.g., "Because college allows me to experience a personal satisfaction in my quest for excellence in my studies"). The scale is one of the main tools adopted and tested internationally, and its psychometric proprieties are widely demonstrated (e.g., Stover et al., 2012; Wilkesmann et al., 2012; Slezackova and Bobková, 2014; Vasić, 2019; Zurlo et al., 2023). In the present study, confirmatory factor analysis revealed adequate goodness-of-fit indices for the original seven-factor model: that is, CFI = 0.919; TLI = 0.907; GFI = 0.971; NNFI = 0.907; NFI = 0.908; RMSEA = 0.066; SRMR = 0.054. Moreover, Cronbach's α and McDonald's ω values were satisfactory (Supplementary Table 1).

2.2.4. Psychological health outcomes: anxiety and depression

Psychological Health Outcomes were assessed in terms of Anxiety and Depression using the Hospital Anxiety and Depression Scale (HADS; Zigmond and Snaith, 1983), which consists of 14 items on a 4-point Likert scale divided into two subscales: Anxiety (seven items, e.g., "Worrying thoughts go through my mind") and Depression (seven items, e.g., "I have lost interest in my appearance"). Anxiety and Depression scores were also converted into percentages, and a score of 11 was considered the cutoff point in order to define the perceived clinically relevant levels of symptoms (Zigmond and Snaith, 1983). The scale has been extensively adopted internationally, and its statistical validity is well-demonstrated (Costantini et al., 1999; Michopoulos et al.,

2008; Bužgová et al., 2015; Ilic et al., 2021). In the present study, confirmatory factor analysis revealed satisfactory goodness-of-fit indices for the original two-factor model: that is, CFI = 0.936; TLI = 0.924; GFI = 0.975; NNFI = 0.924; NFI = 0.925; RMSEA = 0.060; SRMR = 0.045. In addition, Cronbach's α and McDonald's ω values were also satisfactory (Supplementary Table 1).

2.3. Data analysis

First, preliminary analyses were conducted. Specifically, descriptive statistics were carried out for background information, Technostress dimensions, Academic Motivation dimensions, and Psychological Health outcomes. Clinical levels of Anxiety and Depression were also calculated (cutoff = 11; Zigmond and Snaith, 1983). Moreover, preliminarily to hypotheses testing, Pearson's correlations were carried out between study variables. Therefore, direct and indirect effects were tested using Hayes' PROCESS tool for SPSS (Model 4; Preacher and Hayes, 2008; Hayes, 2017), which is an advanced regression-based approach. Following the four recommended steps for conducting mediation analyses, the following statistics were evaluated: (1) the effects of Technostress dimensions on Anxiety/Depression (H1); (2) the effects of Technostress dimensions on Academic Motivation dimensions (H2); (3) the effects of Academic Motivation dimensions on Anxiety/Depression (H3); (4) the effects of Technostress dimensions on Anxiety/Depression through Academic Motivation dimensions (H4). To verify the significance of the indirect effects, the Z Sobel test (Sobel, 1982) and bias-corrected bootstrapped test with 5,000 replications to ensure the 95% confidence interval were used (Hayes and Scharkow, 2013). Partner Country was used as control variable. All the statistical analyses were carried out using the Statistical Package for the Social Sciences (SPSS; version 21) and JAva Structural Program (JASP; version 0.17.1).

3. Results

Characteristics of participants are reported in Table 1. Moreover, considering clinically relevant cases, data revealed that 36.6% of students (n = 555) displayed clinical levels of Anxiety whereas 11.3% (n = 171) reported clinical levels of Depression.

Table 2 illustrates the means, standard deviations, and findings from preliminarily Pearson's correlations among study variables. Data revealed statistically significant associations among study variables, providing evidence endorsing the testing of direct and indirect hypotheses. However, given the non-significance of the associations of both *Pace of Change* and *Extrinsic Motivation-External Regulation* with neither anxiety nor depression, these two variables were not included in the final analyses (direct and indirect hypotheses testing). This was decided due to the necessity to keep parsimony in statistical models.

With respect to *Hypothesis One* (H1), Techno-Overload, and Work-Home Conflict were significantly positively related to Anxiety and Depression (H1.a), while Techno-Ease, Techno-Reliability, and Techno-Sociality were significantly negatively related to Anxiety and Depression (H1.b).

TABLE 1 Background characteristics (N = 1.541).

Characteristic	Value
Sex *n* (%)	
Women	1.082 (70.2)
Men	432 (28.0)
Other	9 (0.6)
Prefer not to say	18 (1.2)
Age in years *M (SD)*	
Age	22.36 (6.07)
Ethnicity *n* (%)	
White/Caucasian	1.368 (88.8)
Asian	64 (4.2)
Chinese	5 (0.3)
Black	23 (1.5)
Hispanic/Latino	12 (0.8)
Middle/Near Eastern	8 (0.5)
Mixed ethnicity	38 (2.5)
Other	13 (0.8)
Missing	10 (0.6)
Number of people living in household *M (SD)*	
Number of people	3.23 (1.61)
Course of study *n*(%)	
Bachelors	1.211 (78.6)
Masters	290 (18.8)
PhD or equivalent	31 (2.0)
Other	9 (0.6)
Employment *n*(%)	
Full-time	177 (11.5)
Part-time	438 (28.4)
Not employed	836 (54.3)
Other	88 (5.7)
Missing	2 (0.1)
Number of daily hours using ICTs *M (SD)*	
Number of hours	6.75 (3.11)
Czech Republic	6.99 (3.13)
Greece	5.98 (2.76)
Italy	6.79 (3.16)
Serbia	6.15 (3.19)
United Kingdom	7.44 (3.12)

With respect to *Hypothesis Two* (H2), Techno-Overload and Work-Home Conflict were significantly positively related to Amotivation (H2.a), and Work-Home Conflict was also significantly positively related to Extrinsic Motivation—Introjected.

TABLE 2 Means (M), standard deviations (SD), and Pearson's correlations among the study variables ($N = 1.541$).

	M (SD)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Technostress dimensions																
1. Techno-overload	10.13 (4.25)	1														
2. Work-home conflict	10.47 (4.55)	0.52**	1													
3. Techno-ease	15.97 (3.64)	−0.27**	−0.09**	1												
4. Techno-reliability	14.28 (3.48)	−0.29**	−0.12**	0.56**	1											
5. Techno-sociality	11.60 (2.27)	−0.07**	0.01	0.37**	0.37**	1										
6. Pace of change	13.72 (4.10)	0.15**	0.12**	0.03	0.00	0.13**	1									
Academic motivation																
7. Intrinsic motivation—to know	21.56 (5.55)	0.00	0.01	0.15**	0.13**	0.18**	0.06*	1								
8. Intrinsic motivation—toward accomplishment	17.64 (6.49)	−0.02	0.03	0.08**	0.11**	0.13**	0.16**	0.65**	1							
9. Intrinsic motivation—experience stimulation	16.65 (6.59)	0.05*	0.03	0.06*	0.08**	0.08**	0.10**	0.72**	0.61**	1						
10. Extrinsic motivation—identified	21.64 (5.45)	−0.01	0.01	0.13**	0.18**	0.19**	0.11**	0.47**	0.46**	0.38**	1					
11 Extrinsic motivation—introjected	18.22 (6.47)	0.03	0.07**	0.04	0.08**	0.13**	0.13**	0.31**	0.63**	0.26**	0.36**	1				
12. Extrinsic motivation—external regulation	19.72 (6.04)	0.01	0.05*	0.11**	0.16**	0.14**	0.07**	0.06*	0.20**	0.01	0.55**	0.39**	1			
13. Amotivation	7.44 (5.02)	0.13**	0.15**	−0.08**	−0.08**	−0.13**	0.03	−0.49**	−0.34**	−0.29**	−0.36**	−0.09**	−0.02	1		
Psychological health outcomes																
14. Anxiety	9.12 (4.54)	0.28**	0.25**	−0.16**	−0.19**	−0.05*	0.03	−0.09**	−0.08**	−0.06*	−0.03	0.13**	0.02	0.20**	1	
15. Depression	5.88 (3.71)	0.23**	0.24**	−0.12**	−0.17**	−0.11**	0.03	−0.23**	−0.19**	−0.15**	−0.16**	−0.02	−0.01	0.33**	0.60**	1

*$p < 0.05$; **$p < 0.01$.

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TABLE 3 Path coefficients: direct and indirect effects of technostress dimensions and academic motivation on anxiety/depression.

Independent variable	Mediator	Dependent variable	Path A[a] (95% C.I.)	Path B[b] (95% C.I.)	Direct Effect[c] (95% C.I.)	Indirect Effect[d] (95% C.I.)	Sobel's Z[e]
Techno-overload	Amotivation	Anxiety[f]	0.17 (0.11, 0.22)***	14 (0.10, 0.19)***	28 (0.23, 0.33)***	02 (0.01, 0.04)***	4.23***
		Depression[f]	0.17 (0.11, 0.22)***	23 (0.20, 0.27)***	17 (0.13, 0.21)***	04 (0.02, 0.06)***	5.15***
Work-home conflict	Extrinsic motivation—introjected	Anxiety[f]	0.10 (0.03, 0.17)***	07 (0.04, 0.11)***	24 (0.19, 0.29)***	01 (0.00, 0.02)***	2.24*
	Amotivation	Anxiety[f]	0.15 (0.10, 0.21)***	15 (0.10, 0.19)***	23 (0.18, 0.27)***	02 (0.01, 0.04)***	4.25***
		Depression[f]	0.15 (0.10, 0.21)***	23 (0.20, 0.27)***	16 (0.12, 0.20)***	04 (0.02, 0.05)***	5.12***
Techno-ease	Intrinsic motivation—to know	Anxiety[f]	0.24 (0.17, 0.32)***	−0.05 (−0.09, −0.01)*	−0.20 (−0.26, −0.13)***	−0.01 (−0.02, −0.00)*	−2.14*
		Depression[f]	0.24 (0.17, 0.32)***	−0.14 (−0.18, −0.11)***	−0.09 (−0.14, −0.04)***	−0.04 (−0.05, −0.02)***	−5.12***
	Intrinsic motivation—toward accomplishment	Depression[f]	0.16 (0.07, 0.25)***	−0.10 (−0.13, −0.07)***	−0.11 (−0.16, −0.06)***	−0.02 (−0.03, −0.01)**	−3.15**
	Intrinsic motivation—experience stimulation	Depression[f]	0.15 (0.06, 0.23)***	−0.09 (−0.11, −0.06)***	−0.12 (−0.17, −0.07)***	−0.01 (−0.02, −0.00) **	−2.88**
	Extrinsic motivation—identified	Depression[f]	0.21 (0.14, 0.28)***	−0.10 (−0.14, −0.07)***	−0.11 (−0.16, −0.06)***	−0.02 (−0.04, −0.01)***	−4.03***
	Amotivation	Anxiety[f]	−0.13 (−0.20, −0.06)***	0.16 (0.12, 0.21)***	−0.19 (−0.25, −0.13)***	−0.02 (−0.04, −0.01)***	−3.33***
		Depression[f]	−0.13 (−0.20, −0.06)***	0.24 (0.21, 0.28)***	−0.10 (−0.14, −0.05)***	−0.03 (−0.05, −0.02)***	−3.64***
Techno-reliability	Intrinsic motivation—to know	Anxiety[f]	0.24 (0.16, 0.32)***	−0.04 (−0.09, −0.00)*	−0.26 (−0.32, −0.19)***	−0.01 (−0.02, −0.00)*	−2.02*
		Depression[f]	0.24 (0.16, 0.32)***	−0.14 (−0.18, −0.11)***	−0.15 (−0.20, −0.09)***	−0.03 (−0.05, −0.02)***	−4.86***
	Intrinsic motivation—toward accomplishment	Depression[f]	0.24 (0.15, 0.34)***	−0.10 (−0.13, −0.07)***	−0.16 (−0.21, −0.11)***	−0.02 (−0.04, −0.01)***	−4.09***
	Intrinsic motivation—experience stimulation	Depression[f]	0.25 (0.16, 0.34)***	−0.08 (−0.11, −0.05)***	−0.16 (−0.22, −0.11)***	−0.02 (−0.03, −0.01)***	−3.77***
	Extrinsic motivation—introjected	Anxiety[f]	0.14 (0.15, 0.24)***	0.10 (0.06, 0.13)***	−0.28 (−0.35, −0.22)***	0.01 (0.00, 0.03)**	2.64**
	Extrinsic motivation—identified	Depression[f]	0.31 (0.24, 0.39)***	−0.09 (−0.13, −0.06)***	−0.15 (−0.22, −0.10)***	−0.03 (−0.04, −0.02)***	−4.43***
	Amotivation	Anxiety[f]	−0.15 (−0.22, −0.07)***	0.16 (0.12, 0.20)***	−0.25 (−0.31, −0.18)***	−0.02 (−0.04, −0.01)***	−3.46***
		Depression[f]	−0.15 (−0.22, −0.07)***	0.24 (0.21, 0.28)***	−0.15 (−0.20, −0.10)***	−0.03 (−0.05, −0.02)***	−3.83***
Techno-sociality	Intrinsic motivation—to know	Anxiety[g]	0.46 (0.34, 0.58)***	−0.06 (−0.10, −0.02)**	−0.09 (−0.19, 0.01)	−0.03 (−0.05, −0.01)**	−2.63**
		Depression[f]	0.46 (0.34, 0.58)***	−0.15 (−0.18, −0.11)***	−0.12 (−0.20, −0.04)**	−0.07 (−0.10, −0.04)***	−5.70***
	Intrinsic motivation—toward accomplishment	Anxiety[f]	0.38 (0.24, 0.53)***	−0.05 (−0.08, −0.01)*	−0.10 (−0.20, −0.00)*	−0.02 (−0.04, −0.00)*	−2.30*

(Continued)

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TABLE 3 (Continued)

Independent variable	Mediator	Dependent variable	Path A[a] (95% C.I.)	Path B[b] (95% C.I.)	Direct Effect[c] (95% C.I.)	Indirect Effect[d] (95% C.I.)	Sobel's Z[e]
Techno-sociality		Depression[f]	0.39 (0.24, 0.53)***	−0.10 (−0.13, −0.07)***	−0.15 (−0.23, −0.07)***	−0.04 (−0.06, −0.02)***	−4.24***
	Intrinsic motivation—experience stimulation	Depression[f]	0.29 (0.16, 0.43)***	−0.08 (−0.11, −0.05)***	−0.16 (−0.24, −0.08)***	−0.02 (−0.04, −0.01)***	−3.35***
	Extrinsic motivation—introjected	Anxiety[f]	0.35 (0.21, 0.49)***	0.09 (0.06, 0.13)***	−0.15 (−0.25, −0.05)**	0.03 (0.02, 0.05)***	4.51***
	Extrinsic motivation—identified	Depression[f]	0.47 (0.35, 0.58)***	−0.10 (−0.14, −0.07***	−0.14 (−0.22, −0.06)***	−0.05(−0.07, −0.03)***	−4.62***
	Amotivation	Anxiety[g]	−0.31 (−0.42, −0.20)***	0.17 (0.13, 0.22)***	−0.06 (−0.16, 0.03)	−0.05 (−0.08, −0.03)***	−4.50***
		Depression[f]	−0.31 (−0.42, −0.20)***	0.24 (0.21, 0.28)***	−0.11 (−0.19, −0.03)**	−0.08 (−0.12, −0.04)***	−5.20***

Only significant mediation models were displayed. All the paths are controlled by partner country.
[a] Path A, effect of independent variable on mediator.
[b] Path B, effect of mediator on dependent variable.
[c] Direct effect, effect of independent variable on dependent variable controlling for the mediator.
[d] Indirect effect, effect of independent variable on dependent variable through the mediator.
[e] Sobel's Z, Sobel test results for indirect effect.
[f] Partial mediation.
[g] Full mediation.
*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

Moreover, Techno-Ease, Techno-Reliability, and Techno-Sociality were significantly negatively related to Amotivation (H2.b), and they were also significantly positively related to all Intrinsic Motivation dimensions.

With respect to *Hypothesis Three* (H3), Amotivation was significantly positively related to Anxiety and Depression (H3.a), while all the Intrinsic Motivation dimensions were significantly negatively related to Anxiety and Depression (H3.b). Considering Extrinsic Motivation dimensions, Extrinsic Motivation—Identified was significantly negatively related to Depression while Extrinsic Motivation—Introjected was significantly positively related to Anxiety.

With respect to *Hypothesis Four* (H4), Academic Motivation dimensions acted as significant mediators in the associations between Technostress dimensions and university students' psychological health conditions. Table 3 shows path coefficients (direct and indirect effects) of Technostress dimensions and Academic Motivation on Anxiety/Depression.

Specifically, data highlighted the negative impact of Techno-Overload and Work-Home Conflict on Anxiety and Depression *via* Amotivation, as well as the negative impact of Work-Home Conflict on Anxiety *via* Extrinsic Motivation—Introjected. Differently, data enlightened the positive impact of Techno-Ease, Techno-Reliability, and Techno-Sociality on psychological health *via* Amotivation, *via* all Intrinsic Motivation dimensions as well as *via* Extrinsic Motivation—Identified.

Figure 1 illustrates the indirect effect of Amotivation, Intrinsic Motivation—To Know, and Intrinsic Motivation—Toward Accomplishment in the associations between Technostress dimensions (Techno-Overload, Work-Home Conflict, Techno-Ease, Techno-Reliability, and Techno-Sociality) and Anxiety/Depression.

Figure 2 shows the indirect effect of Extrinsic Motivation—Introjected in the associations between Technostress dimensions (Work-Home Conflict, Techno-Ease, Techno-Reliability, and Techno-Sociality) and Anxiety.

Figure 3 illustrates the indirect effect of Intrinsic Motivation—Experience Stimulation and Extrinsic Motivation—Identified in the associations between Technostress dimensions (Techno-Ease, Techno-Reliability, and Techno-Sociality) on Depression.

4. Discussion

The present multi-national study provides information on university students' experience at the current time, offering tailored indications on ICTs use and motivation processes, and fostering the understanding of the dimensions that may directly and/ or indirectly impact their psychological health conditions. This is also due to the need for timely identifying and supporting the great number of students who are still struggling in re-adjusting to the post-emergency condition and/or reported clinically relevant levels of Anxiety and Depression. In the present study, the remarkable number of students reporting clinically relevant levels of anxiety (about 40%) and depression levels (about 11%) regrettably sustains this need.

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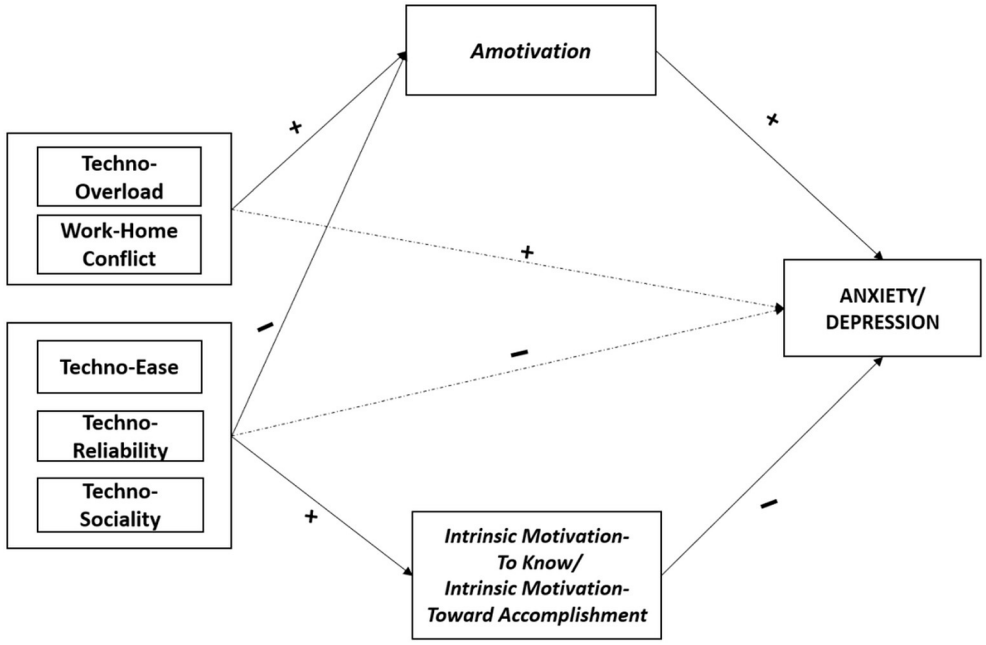

FIGURE 1
Summary—the mediating role of amotivation, intrinsic motivation—to know, and intrinsic motivation—toward accomplishment in the associations between technostress dimensions and anxiety/depression. Mediating variables are displayed in italics; psychological health outcomes are displayed in capital. Symbols (+, −) indicate the directions of the associations.

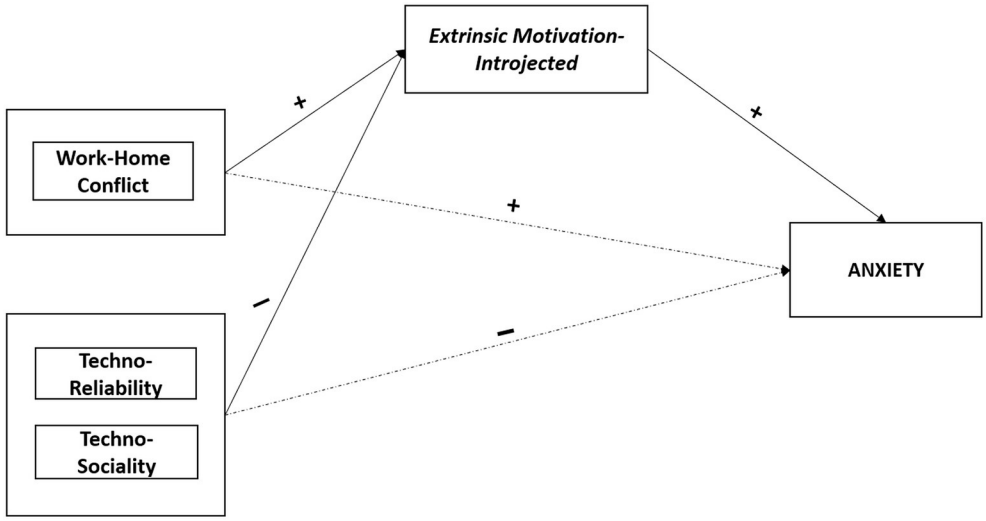

FIGURE 2
Summary—The mediating role of extrinsic motivation—introjected in the associations between technostress dimensions and anxiety. Mediating variables are displayed in italics; psychological health outcomes are displayed in capital. Symbols (+, −) indicate the directions of the associations.

The current study provided updated evidence allowing us to go in-depth into the process linking technostress dimensions, academic motivation, and psychological health, so contributing to the international debate on the role of ICTs, in terms of risks but also of potential resources. As a result, the findings can help to inform evidence-based interventions effectively promoting students' wellbeing.

First, we found support for *Hypothesis One* (H1) and *Hypothesis Two* (H2), on the impact of Technostress dimensions (except for Pace of Change)—respectively—on students' psychological health (H1) and Amotivation (H2), in the expected directions. Moreover, considering H2, our findings highlighted further statistically significant associations, which—instead—were not hypothesized *a priori* due to the still lacking research in this

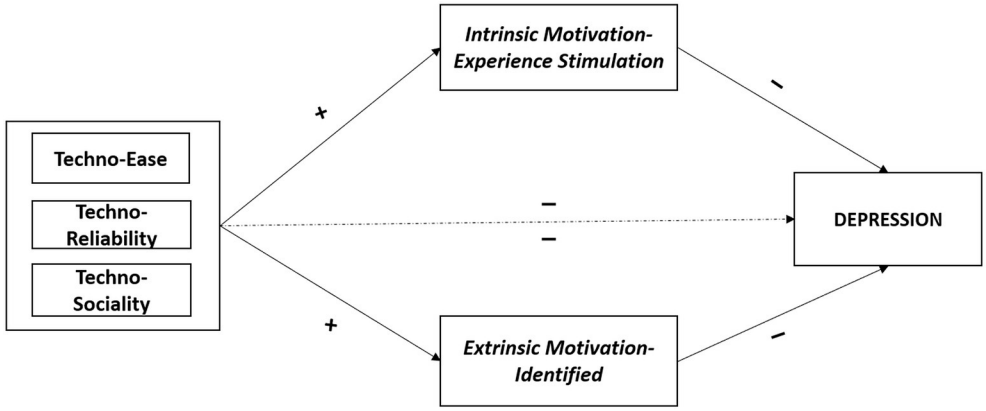

FIGURE 3
Summary—the mediating role of intrinsic motivation—experience stimulation and extrinsic motivation—identified in the associations between technostress dimensions and depression. Mediating variables are displayed in italics; psychological health outcomes are displayed in capital. Symbols (+, −) indicate the directions of the associations.

field. Specifically, Work-Home Conflict was found significantly positively related to Extrinsic Motivation—Introjected, whereas Techno-Ease, Techno-Reliability, and Techno-Sociality were found to significantly positively relate to all Intrinsic Motivation dimensions. These data offered further evidence on the direct relationship between Technostress dimensions and Academic Motivation dimensions, fully endorsing the meaningfulness to test more complex pathways of associations among them. Moreover, these data corroborate with the international research evidence on the detrimental role of technology overuse/abuse/misuse (Thomée et al., 2007; Brooks, 2015; Brivio et al., 2018; Marler et al., 2021; Juntunen et al., 2022), as well as on the protective role of specific technology-related dimensions, in terms of Techno-Ease, Techno-Reliability, and Techno-Sociality (Saadé and Kira, 2009; Shah et al., 2012; Bower, 2019; Galvin et al., 2022).

Second, we found support for *Hypothesis three* (H3), again highlighting associations in the expected directions. These data were in line with evidence on the relationship between motivation/self-regulation processes and wellbeing (Ryan and Deci, 2000; Marler et al., 2021; Juntunen et al., 2022) and, in particular, the well-demonstrated negative role of Amotivation (Vallerand et al., 1997; Baker, 2004; Ratelle et al., 2007; Marler et al., 2021) and the role of Intrinsic Motivation dimensions as key resources (Ryan and Deci, 2000; Jie et al., 2022) for students' psychological health. However, when considering extrinsic motivation, we made no hypothesis on the direction of associations with anxiety/depression due to the mixed evidence reported in the literature. Our data revealed that higher levels of Extrinsic Motivation—Introjected were found to be associated with increased anxious symptoms, while higher levels of Extrinsic Motivation—Identified were associated with lower depressive symptoms.

These findings supported the need to promote, within the higher educational context, processes toward internalization, appropriation, and re-appropriation of the individual and autonomous motivation to enter and continue university. From this perspective, when extrinsically motivated, behaviors are controlled to obtain a reward/to avoid a constraint so that students perform actions mainly to fulfill social/familiar expectations. Accordingly, the experiences of external pressures to achieve academic success, together with the actual duties and challenges to be faced, may indubitably exacerbate students' concerns, worries, and anxiety. Differently, extrinsically motivated students, who display a more autonomous regulation, may have greater tools and resources to deal with academic demands, reporting lower psychopathological risk (Ryan and Deci, 2000; Liu et al., 2016).

Notwithstanding the interest in these results, the key finding from the present study concerns the evidence supporting *Hypothesis four* (H4), namely the mediating role (indirect effects) of Academic Motivation dimensions in the associations between Technostress dimensions and psychological health reported by university students. In line with research highlighting the mediating role of motivation within broader processes (Rubino et al., 2009; Malkoç and Mutlu, 2018; Chen and Roberts, 2020; De Francisco et al., 2020; Stavrulaki et al., 2021), this study provides original evidence on the underlying mechanisms linking ICTs use and Anxiety/Depression *via* Academic Motivation.

Considering the unique interplay between Technostress dimensions and Academic Motivation dimensions, our results underlined both vicious and virtuous circles that could be used for developing tailored support interventions addressing both lights and shadows of ICTs use. In particular, with respect to the process linking technology-related risk factors (i.e., Techno-Overload and Work-Home Conflict), Academic Motivation, and Psychological Health, data have highlighted the negative impact of Techno-Overload and Work-Home Conflict on Anxiety and Depression partially *via* Amotivation, as well as the negative impact of Work-Home Conflict on Anxiety partially *via* Extrinsic Motivation—Introjected. Therefore, high stress related to technological burden and conflict between academic/work and private life due to ICTs use may detriment students' psychological health also through the impairment of motivation and self-regulation process.

From this perspective, even after the end of the COVID-19 emergency, and as a key mark resulting from the prolonged containment measures, we believe that these data suggest that students who still rely excessively on technological devices in order to perform academic activities (e.g., use of online platforms to meet

professors and social networks to stay in touch with colleagues) can also experience lowered motivation and high psychological suffering. This could be due to the increasing withdrawal from the university community by these students (Marler et al., 2021), often resulting in a perceived distance between their own experience and that of colleagues, and a lowered sense of autonomy over their own choices. Alongside, considering emerging adulthood (i.e., within an already complex transitional moment of growth and challenging path toward independence), the increasingly thin and blurred boundaries between academic/work and personal/family life due to the pandemic may have even hindered the possibility to accomplish internalizing processes of academic motivation. Accordingly, these students could be at higher risk of passively performing academic activities mainly to avoid feeling guilty or ashamed about being incompliant with family expectations (i.e., introjected motivation).

These underlined processes should be carefully considered when defining support interventions for students, due to the high risk of a vicious circle exacerbating anxiety (i.e., due to perceived growing social/family pressures to have success, fears to be left behind and performing worse than all the other students, concerns about the future), sense of helplessness, loneliness, and hopelessness (Beiter et al., 2015).

Considering protective factors linked to technology use (virtuous circles), the current study highlighted the positive impact of Techno-Ease, Techno-Reliability, and Techno-Sociality on psychological health *via* Amotivation, *via* all Intrinsic Motivation dimensions, and *via* the more autonomous extrinsic motivation factor, namely Extrinsic Motivation—Identified.

From this perspective, results confirmed previous research indicating that the perceived easiness of using ICTs and the perceived reliability of technological devices may represent important resources able not only to enhance performance (Bower, 2019) but also to promote individuals' wellbeing (Saadé and Kira, 2009; Shah et al., 2012). These findings provided evidence highlighting the need to furnish students with adequate information and tools to effectively use ICTs. Faculty members and university staff/authorities may, therefore, consider the meaningfulness to provide students with further resources and technical assistance to master challenges in technology use (Ragu-Nathan et al., 2008; Heckel and Ringeisen, 2019). Indeed, despite students being considered digital natives, they may still lack the theoretical knowledge required for particular skills, or have some limitations in their use of technology that could hinder their learning. This is particularly true considering that, following the emergency transition to distance learning, students were required to abruptly adapt to effectively use new platforms, and this may have increased their shame and sense of ineffectiveness when unable to use ICTs (Aguilera-Hermida, 2020; Sundarasen et al., 2020; Browning et al., 2021), potentially resulting in loss of motivation, withdrawals, and even leaving intentions. Conversely, when students perceive easiness in the use of ICTs as well as the trustworthiness of ICTs to reach the desired outcomes and to keep in touch with others this may result in a higher sense of autonomy, increased pleasure and enjoyment for academic paths and, therefore, result in higher psychological wellbeing.

Moreover, interestingly, whereas data suggested that academic motivation partially explains the relationship between the majority of Technostress dimensions with students' psychological health, findings on Techno-Sociality also revealed some full mediations. Specifically, the relationship between Techno-Sociality and Anxiety was fully mediated by both Intrinsic Motivation—To Know and Amotivation. These findings seem to suggest a more intimate link between the social and relational features of ICTs and motivational process and endorsed the idea that ICTs use should not be stigmatized in itself, as it can help students to stay active, connected, and engaged and, therefore, to report higher wellbeing. From this perspective, support interventions should carefully consider that ICTs can represent a key relational tool for students (Liu, 2010; Henderson et al., 2015; Lattie et al., 2019; Papouli et al., 2020; Thomas et al., 2020), but also a double-edged sword—without the required awareness (Wellman et al., 2001; Haythornthwaite, 2005; Gemmill and Peterson, 2006; Suhail and Bargees, 2006; Brivio et al., 2018; Kniffin et al., 2021).

Overall, these results recommend the importance of planning interventions accounting for the need to face students' difficulties in effectively using ICTs and in re-adjusting to in-person life, so disconnecting from the exclusive virtual world experienced for a prolonged time. In this direction, interventions should also take into account the need to support the building of a sense of academic community and social support networks (both face to face and by ICTs), in order to promote the development/restoration of students' active choice of their academic path, while reducing, at the same time, the risks—in terms of wellbeing—of the excessive use/misuse of technology.

Notwithstanding the potential strengths of the study, our findings should be interpreted also considering some methodological limitations. Firstly, the cross-sectional design of our study does not allow causal conclusions to be drawn. Moreover, the links between Technostress and Academic Motivation could also be bidirectional, may change over time, and may be not linearly related to the expression of psychopathology. Therefore, future research could be conducted with a longitudinal design to study the hetero-determination of the contextual relationship. Second, despite the sample comprising students from five European countries, the overall homogeneity of our sample, which predominately consisted of young and Caucasian students, limits the generalizability of our findings to the university students' population. In addition, despite the analyses being conducted controlling for partner country, so accounting for the potential impact of this factor, country specificities were not analyzed, requiring these findings to be interpreted and used with caution. Indeed, country differences were not the focus of the present study and further dimensions should be explored in future (e.g., socio-cultural factors, differences in the adoption of online learning pre-, during, and post-pandemic emergency, as well as differences in higher education systems). Nonetheless, despite the needed caution, these data could be used to develop research and support interventions within European countries.

In conclusion, despite these limitations, the study provides original evidence on the pathways of relationships between ICT use, motivation, and psychological health, to be used in the current phase, featured by the complete restoration of face-to-face contacts, to inform the development of tailored research and

interventions fostering students' motivation and promoting their psychological health.

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 Ethical Committee of Psychological Research of the University of Naples Federico II (Protocol Code: 14/2022). The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors contributed to the study design, revised the manuscript, and approved the final 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/fpsyg.2023.1211134/full#supplementary-material

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Medical students on the COVID-19 frontline: a qualitative investigation of experiences of relief, stress, and mental health

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Objective: During the early stages of the COVID-19 pandemic, medical students were abruptly removed from clinical rotations and transitioned to virtual learning. This study investigates the impact of this shift on students' wellbeing and preparedness for advanced training.

Methods: Through qualitative research methods, including semi-structured interviews, the experiences of medical students working on the COVID-19 frontline were explored.

Results: The comprehensive findings of the study shed light on the profound emotional journey that medical students embarked upon during the relentless public health crisis. Within the chaos and overwhelming demands of the pandemic, medical students discovered a profound sense of purpose and fulfillment in their contributions to the welfare of the community. Despite the personal sacrifices they had to make, such as long hours, limited social interactions, and potentially risking their own health, students reported feelings of relief and gratitude.

Conclusion: Tailored support systems for medical students' wellbeing are crucial for improving healthcare delivery during crises. Medical schools should adopt a holistic curriculum approach, integrating interdisciplinary learning and prioritizing student wellbeing. Recognizing the pandemic's impact on students and implementing targeted support measures ensures resilience and contributes to an improved healthcare system.

KEYWORDS

education, wellbeing, medical student, COVID-19, healthcare professional, qualitative study

1. Introduction

Medical students have experienced unprecedented disruptions in their personal and professional lives during the COVID-19 pandemic (1, 2). These disruptions included a shift to online learning, where many medical schools switched to remote teaching, impacting the quality of education and students' ability to adapt (3). Clinical rotations and practical experiences, crucial for skills development, were often limited or canceled due to safety concerns (4). Students working in healthcare settings faced the risk of exposure to COVID-19, causing anxiety about their health (5). Licensing exams for medical professionals were frequently rescheduled or altered, adding stress for students preparing for these critical assessments. Financial hardships related to the pandemic affected students' ability to cover tuition, living expenses, and other costs. Additionally, some students experienced delayed graduation as a result of disruptions in coursework and clinical training (6).

The COVID-19 pandemic has accelerated the already alarming rates of burnout and other mental health challenges experienced by clinicians and trainees alike (7). The current body of medical education research has extensively investigated the effects of the COVID-19 pandemic on healthcare workers and medical students independently, with many studies reporting negative outcomes for stress, fatigue, and somatic symptoms like insomnia, anxiety, anger, rumination, decreased concentration, depression and loss of energy (8, 9). In one survey, it was revealed that over half of the responding students (54.5%) indicated experiencing stress levels that spanned from moderate to extreme (10). According to a recent meta-analysis (11), the prevalence of depression symptoms among medical students during the COVID-19 pandemic was nearly twice that of the pre-pandemic estimates (12). Another systematic review and meta-analysis have unveiled a notably high prevalence of depression and anxiety among medical students. Specifically, the study found that the prevalence of depression stood at 37.9%, while anxiety was reported at 33.7%. These figures are notably higher when compared to the rates observed in the general population and among healthcare workers (13).

A limited number of medical students had the opportunity to work on the COVID-19 frontlines (14). This opportunity arose as medical schools and healthcare institutions across different countries recognized the heightened demand for extra support and manpower during this time of crisis. Consequently, medical education policies initiated various programs and initiatives to mobilize medical students to join healthcare teams. These initiatives aimed to bolster healthcare capacities and address the surge in demands brought about by the COVID-19 pandemic (14, 15). For instance, to mitigate the burden experienced by the local healthcare system, the University Hospital of Basel created an off-site Triage and Test Centre (TTC) which was located in the Preachers' Church and staffed by an interprofessional team of nurses, physicians, and military service members to screen and evaluate patients with COVID-19-like symptoms (16, 17). Given their availability and eagerness to support the frontline care (18), medical students were recruited to work at the TTC voluntarily. Medical students were allowed to assist healthcare professionals by performing clinical assessments on numerous patients and conducting nasopharyngeal and oropharyngeal swabs. Additionally, they offered their support across various hospital departments, including different wards and the emergency department, to support the medical staff. The students were divided into two groups, with each group working for three consecutive days before rotating. To formalize their roles, each student received an official employment contract and comprehensive insurance coverage, ensuring that they were compensated for their valuable contributions. More details regarding this initiative can be found elsewhere (16). It's important to note that the extent and nature of student involvement may have varied widely, depending on the specific circumstances and healthcare systems in different regions and at different times during the pandemic.

There is an urgent need for a deeper understanding of students' wellbeing, including the factors that influence it and the impact of the pandemic on it. This is particularly crucial considering the pre-existing concerns regarding the wellbeing of medical students, which have been further intensified by the pandemic (19). Although existing research has touched on medical student wellbeing (20), the pandemic's urgency and unprecedented circumstances demanded a dedicated study. While prior studies have provided valuable insights (21), there remains a knowledge gap in understanding the specific experiences and emotional journey of medical students who actively participated in crisis response teams. The rising rates of burnout and departures from medicine highlight the need to prioritize wellbeing among medical trainees. Understanding how medical students responded to the pandemic can inform strategies to enhance healthcare resilience during future crises (22, 23).

Since a recent study by Luong et al. suggested that educational adaptations and innovations implemented during the pandemic were perceived by some trainees as beneficial for fostering wellbeing (23), our purpose was to explore this finding with a unique cohort of learners. We've previously reported that medical students who volunteered at the TTC perceived the experience as meaningful in fostering their professional development and professional identity formation (16). Here, we delve into the experiences that impacted medical students' personal health and wellbeing during the pandemic. By doing so, we aim to contribute to our understanding of trainees' health and wellbeing and evaluate the outcome of pandemic-related adaptations. These findings have the potential to shed light on the challenges faced by medical students and assess the strategies put in place to protect their psychological wellbeing as the medical education landscape adapts to a new normal.

2. Materials and methods

Research ethics approval was obtained by the Ethics Commission of Northwest and Central Switzerland (EKNZ, Req-2021-00518).

Abbreviations: CGT, constructivist grounded theory; COVID-19, Coronavirus Disease 2019; ED, emergency department; EKNZ, ethics commission of Northwest and Central Switzerland; MD, medical doctor; OSCE, objective structured clinical examinations; PPE, personal protective equipment; TTC triage test center.

2.1. Study design

This research followed a constructivist grounded theory (CGT) approach. CGT was chosen as the methodological approach for this qualitative study due to its ability to explore and generate theoretical insights that emerge from the data, allowing for a nuanced understanding of participants' perspectives and experiences within the context under investigation. Given the rare circumstances of the study context and the understudied and theorized social processes such as learner wellbeing during COVID-19, this approach was also appropriate to investigate sensitive topics regarding participants' experiences and perceptions during the pandemic.

2.2. Recruitment and participants

Participants were recruited via word-of-mouth through a TTC Chat Group, a private messaging group whose members comprised all medical students from the University of Basel who participated in the TTC. The interviewed participants suggested other possible interview candidates, therefore the recruitment strategy evolved into a snowball sampling approach, which allowed for the recruitment of less experienced students with little to no pre-pandemic bedside clinical training. Participants were sampled for both gender and level of training. Recruitment was stopped once theoretical sufficiency was achieved. This was operationalized as the point at which additional data failed to generate new knowledge. Hence, the data provided a sufficient description of the phenomena explored (24). Therefore, we concluded that the data collection after twenty-one semi-structured interviews. All interviews were audio-recorded, anonymized, and transcribed verbatim.

2.3. Study procedure and data collection

ZS interviewed all 21 participants between May and October 2020. The semi-structured interview guide was created by JK and ZS interviews were conducted in Swiss German, with selections translated into English for review by English-speaking team members. To ensure the interviews were conversational, we changed the interview language based on the participants as ZS interviewed them as a peer. The full interview guide can be find in the **Supplementary material**. During interviews, ZS explored participants' experiences working on the COVID-19 frontlines, asking questions aimed at understanding perceived effects on learning and wellbeing. Specifically, the interview guide included questions about professional development, work-life balance and potential health and psychological changes. Therefore, the exploration produced two analyses: the first focused on learning and developing professional identity, already published (16), and the second presented here focuses on wellbeing.

2.4. Data analysis

We followed an iterative data collection and analysis process. ZS and JK read the transcripts and developed a codebook together by open coding. Specifically, constant comparative analysis was used to compare the data across categories to identify and refine thematic patterns, both examining data across transcripts and collecting new data to enrich the evolving analysis (16). During this process, we reviewed data excerpts translated into English to "check" (25) interpretations and to identify opportunities to generate a deeper understanding. The research team used Quirkos Version 2.3.1 to manage the data.

2.5. Research team and reflexivity

Data were co-constructed between participants and researchers, meaning that, as researchers, we brought our knowledge, beliefs, and experiences into the research. The research team consisted of various members with different backgrounds and experiences, as well as expertise in medical education, qualitative research, and patient care. BB, RS, AP, AM, RB, CN, JK, and KL were all healthcare professionals involved in different aspects of medical education and patient care. The team members regularly supervised and taught medical students, emphasizing their understanding of the medical education process. Our individual pandemic-related situations [working as a surgical educator, while pregnant during a pandemic (JK), home-schooling children amidst work-related responsibilities (AM, KAL), leading the TTC and working in the ED of a tertiary, academic hospital (RB, CN), disruptions to traditional postgraduate (RS, AP) and undergraduate medical education (ZS, BB)] colored both the questions we asked during interviews and how we interpreted the data.

3. Results

Twelve female and nine male participants between the ages of 20 and 26 and in years 2–6 of medical school participated in this study. Most participants described initial fears about the impact of the pandemic on others, with some participants expressing concerns about becoming infected themselves. The work on the frontlines was both physically and mentally demanding but switching to online learning and canceling several exams lifted some of this stress. Interestingly, most medical students perceived the experiences on the frontlines as positive, and COVID-19-related disruptions were perceived by students as a relief from typical medical student agendas and responsibilities, even for those working on the frontlines: "*Everything was cancelled. Suddenly, I did not have volleyball training twice a week or a match. I had a lot more time for myself. and I have to say that it has improved my mental health*" *(P15)*. For participants, working on the COVID-19 frontlines was a coping strategy for "*having a daily structure*" *(P5)*, "*being kept busy*" *(P20)*, "*being able to leave the house*" *(P2)*, and "*staying socially engaged*" *(P1)*. Below, we illustrate these findings with representative quotes from the participants. The following headings provide an overview of the key aspects examined in our study and each heading represents a distinct area of investigation that contributes to a comprehensive understanding of the challenges faced by medical students.

3.1. Perceptions of the impact of COVID-19

The initial reactions of medical students to the pandemic ranged from "*it's just another flu*" (P16) to "*an apocalyptic scenario*" (P18), illustrating the uncertainty everyone was managing early on. Most participants did not realize the impact and severity of COVID-19 during the early stages of the pandemic: "*I just observed the development of the coronavirus and thought to myself: 'It is an infectious disease like the flu, which is just there, but does not do anything hazardous*" (P1). Others felt concerned or even frightened about the new virus, describing: "*At the beginning, I took it a lot more seriously and had a bit of this doomsday mood, so I thought: 'Oh my God, we all have to die!*"' (P18). While most participants held either of these general views on the pandemic, they all reported distinct instances when they realized that the virus was serious, and that the pandemic would indeed impact their daily lives.

The pandemic brought rapid and unexpected disruptions that had a unique impact on the mental health and stress of medical students. They faced challenges as both members of the general public and as students. Social lives changed drastically, and educational experiences were greatly affected, with medical universities closing, exams being cancelled, and in-person lectures shifting online. These disruptions were particularly disheartening for senior medical students, making graduation feel disappointing and anti-climactic.

3.2. Feeling safe, but fearful of infection

For some participants, their wellbeing changed over time as knowledge about the virus increased. The possibility of infection was a recurrent issue for the medical students, however. Within their role in the TTC, they learned how to protect themselves through the appropriate use of personal protective equipment (PPE):

> *"I liked that we were protected to avoid getting infected with the virus; they provided good masks, plus glasses and all sorts of things. I think hygiene was pushed a lot in the days at Preacher's Church. The hospital hygiene staff came every day to a point where it was almost annoying" (P9).*

However, not all participants felt safe using PPE. Some students persevered with working at Preacher's Church despite their anxiety that they might get infected: *"While taking the swab, I just had a lot of trouble with these masks, they were never airtight on me. And then the air still came out to the right and left, even if I tied knots. my feeling was just: 'I do not think I'm well protected now'" (P7).* Another participant explained, *"When I made swabs the whole time, I sometimes felt that I could easily get infected, even if I took all protective measures" (P16).*

Most students did not fear catching COVID-19 during their time at the TTC, however: *"Fear would be exaggerated, but I've already had a little respect. And then I just thought to myself: 'No matter where you go, the risk of getting infected is the same or even higher than in Preacher's Church" (P5).* Instead, most medical students accepted the risk of catching the virus, viewing it as a tradeoff for having the opportunity to work, learn, and serve the community by volunteering at the TTC: *"At the beginning, I had this attitude that I absolutely have to help, that I'm young and if I would catch the virus, it wouldn't be so bad. . ." (P18).* As one participant outlined, *"There was no reason for me not to work at the Church, even if I put myself in danger. I do it for the society" (P15).* Another student highlighted: *". . . it is not just about me and my health but also about the welfare of everyone and those who couldn't do it for themselves." (P4).*

3.3. Mental health, stress factors, and coping strategies

While medical students faced a mix of stressors during the pandemic, they also experienced relief as certain educational responsibilities were canceled or shifted online, allowing them to prioritize their wellbeing. Notably, exams were conducted virtually and had a more formative nature rather than being high-stakes assessments. One student reported, "*I think that took the stress off a bit. I studied anyway, but never with the intensity that I usually do.*" (P13). Another participant confirmed: "*The pressure from the exam was pretty much off for me because the exam was only formative, and therefore, I had less stress during my studies*" (P5).

One of the biggest challenges overall was maintaining a daily life structure. As one participant explained:

> *"For me, the biggest challenge was somehow still finding a daily routine. Well, at first, I did not think it was that bad to always be at home; it was also a relief somehow because otherwise, there is always a lot going on. I thought to myself that I could simply cancel all appointments without a bad conscience. . . and then it was just more and more difficult to maintain a daily routine. . ."* (P15).

Despite potential risks and added stresses, working permitted social connection to others. At the beginning of the pandemic, students felt isolated, recognizing: "*I've had moments once or twice when I felt alone and thought I could not meet anyone and do anything anyway, and the whole situation was still taking too long*" (P1). Therefore, for many medical students, work was a unique opportunity for socialization during the lockdown: *"Otherwise, you were never allowed to see people. The Preacher's Church [. . .] brought normality into everyday life."* (P8). The frontlines were also a place to build new relationships and to network: "*I made a couple of good friends from the 6th annual course with whom I even meet for riding bikes*" (P1). Participants mentioned positive social interactions and collaborations with other medical students and the supervising physicians, nurses, and military service members working at the TTC. One student reflected on the interactions with various people: "*You came into contact with others quite a lot. We had lunch together, also with the soldiers, I thought that was cool too. . . a completely new atmosphere that came into the Preachers Church*" (P12). Another participant summarized their experiences as "*fun, above all you finally saw people again, also from different annual courses, and I found it interesting with the soldiers because they were people with whom I would otherwise never have had contact*" (P1).

Generally, participants reported being positively affected by working on the pandemic frontlines, interpreting it as a coping mechanism that allowed them to escape the confines of their lockdown reality. One participant reported, "*Psychologically, I felt some sort of relief because if you can do something in such a crisis, it takes away the feeling of powerlessness*" (P18). Doing something with purpose and structure motivated some participants to join the frontlines: "*You were able to take a lot of motivation out of it because you knew that you would do something useful with your time. Somehow it often did not feel like working at all*" (P11).

4. Discussion

The current study provides some insights into how medical students managed their health and wellbeing and which coping strategies they used to maintain these phenomena within their dual roles as learners and healthcare providers. Most participants had experienced both sides of the pandemic. On the one side, participants' fear and uncertainty caused by the novel coronavirus and lockdowns aligned with the pandemic-related experiences of medical students in other contexts (16). Participants' experiences also resonate with the four types of pandemic-related fears described by Schimmenti et al. (26). The first is the fear of or for the body, in the case of medical students working on the frontline and getting infected due to inappropriate use of PPE. Second, fear for significant others, meaning that the medical students feared a family member getting sick or worse, catching COVID-19 due to their work or infecting close friends or family members. Third is the fear of not knowing or knowing, such as the stress of uncertainty and unpredictability. Finally, there was fear of taking action or inaction, where medical students reported feeling obligated to help during a crisis, but with reluctance.

Despite the stressors participants faced, they were also relieved and grateful for the opportunity to learn and work on the pandemic frontlines, describing their incorporation into the workforce as a positive experience that allowed them to feel useful while also serving their health and wellbeing needs. Indeed, in contrast to earlier quantitative studies reporting a decline in the mental health of medical students during the pandemic (8, 9), our participants' accounts suggest that certain disruptions and advancements in medical education during the early stages of the pandemic may have had a stabilizing and positive impact on the wellbeing of some students. These observations align with the findings of Luong et al. (27), who reported that having more time for self-care was perceived to facilitate wellbeing despite the chaos and trauma of a global pandemic. For participants in our study, we speculate that their active involvement in a unique learning environment was a significant factor affecting their wellbeing during the pandemic. It served a purpose in permitting the students to socialize at a point in the pandemic when most of the world was locked down. Based on our findings, we synthesized a conceptual model (**Figure 1**) showing that medical students' health and wellbeing depend on various work- and pandemic-related factors.

Having more time for self-care and engaging in altruistic opportunities are known to mitigate burnout (28, 29). Moreover, in the medical education context, high stakes assessments are notorious for creating angst amongst learners that can interfere with learning and impair wellbeing (30). It's little wonder that participants were relieved when traditional assessments were adapted to a lower stakes format early in the pandemic. What is surprising is how the potential benefits of these disruptions and innovations have been overlooked—or perhaps disregarded—amidst a widespread desire to, return to, normal.

Can educational disruptions and innovations like the TTC have value for learner wellbeing beyond the pandemic context? Given that the burnout crisis in medicine is worsening despite decades of efforts to mitigate it, creativity is urgently needed. For instance, although service-learning opportunities are regularly offered across undergraduate medical education (31) they are rarely, if ever, framed as a wellbeing intervention. Despite having selected a profession that focuses on treating and healing others, many medical students lack hands-on experience until the latter part of their training. Participants' incorporation into frontline service creates special learning environments where students can advance their clinical skills in the midst of a new and previously unfamiliar environment, as demonstrated in our prior research (18).

Those who learn coping skills are significantly less likely to experience feelings of insecurity or depression (32). We found that working on the COVID frontlines helped medical students find their way back to reality again. Furthermore, active involvement in pandemic-related work provided purpose and freedom for medical students, fostering social connections and new relationships. Virtual learning relieved exam-related pressures and allowed flexible study routines. These positive experiences raise the question of expanding virtual platforms and online courses for improved wellbeing and learning outcomes. However, it is important to consider that the overuse of online communication and learning platforms could also be harmful to students' wellbeing, potentially promoting increased isolation and burnout (33). Together with the deprivation of their home environment, these additional considerations might only help exacerbate the already prevalent mental health issues among medical students (34).

The increased psychological stress experienced by clinicians and medical students can result in adverse consequences. At an individual level, it can lead to mental health issues, physical health challenges, reduced career satisfaction, academic difficulties, and compromised job performance (35, 36). Socio-politically, it strains the healthcare workforce, impacts the quality of care, and increases healthcare costs. Economically, it leads to productivity loss, extended training periods, and higher staff turnover rates, all contributing to financial burdens on healthcare institutions. Addressing stress through support and policy measures is essential for mitigating these far-reaching effects on both individuals and the healthcare system (37).

While engaging medical students in clinical work from early on can be beneficial in returning empowerment by acting as a coping mechanism and improving mental health (38), some potential drawbacks need to be carefully considered and addressed to ensure the wellbeing of students and quality of patient care. These include increased stress and burnout due to the challenges of balancing academic coursework, clinical duties, and personal lives. Early engagement may also result in limited exposure to foundational knowledge and theoretical concepts, potentially compromising students' understanding and competence. The time and energy required for clinical work may impact students' academic performance, necessitating careful balance (39).

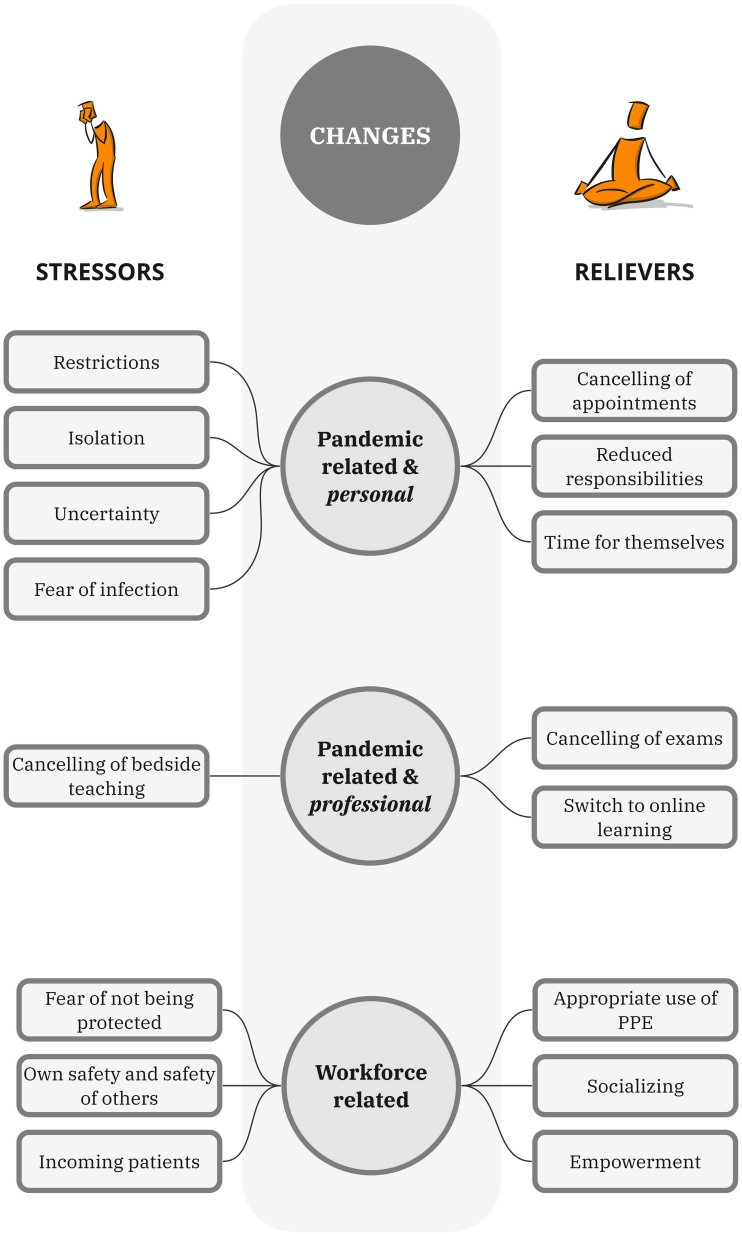

FIGURE 1
Factors contributing to amplification and relief of pandemic and workforce-related stress.

However, when innovating curricula to enhance trainee wellbeing, it is also crucial to consider the potential impact on faculty wellbeing. While improving trainee wellbeing is important, the added responsibilities and burdens placed on faculty members during the implementation of new initiatives can potentially strain their own wellbeing and work-life balance. To address this, it is essential to provide adequate support, resources, and opportunities for faculty members to ensure that their wellbeing is prioritized. Collaboration and open communication between faculty and administration are key to identifying and mitigating potential challenges and barriers. By taking a comprehensive approach that considers the wellbeing of both trainees and faculty, curricular innovations can be implemented to support the overall wellbeing of the educational community (40).

Medical schools should adopt a holistic curriculum approach that integrates interdisciplinary learning and collaboration to address the physical, emotional, and social wellbeing of students. Longitudinal support programs should be implemented to provide ongoing guidance and resources throughout their training and careers. It is crucial to promote research and evaluation to refine interventions based on feedback from students and educators. Furthermore, medical education workplaces should foster discussions supporting work-life integration and incorporate lessons from the pandemic to enhance the learning environment and student support systems. Mindfulness and self-care workshops can empower students to prioritize their wellbeing and effectively cope with stressors in their professional lives (27). Reflective practices and self-assessment exercises within the curriculum

can help students regularly assess their wellbeing and take proactive steps to maintain their mental health (28). Establishing wellbeing committees that facilitate open communication between administration, faculty, and students can also alleviate anxiety and ensure a supportive environment for seeking assistance and addressing discomfort (12).

4.1. Limitations

Our study has several limitations that should be considered when interpreting the findings. Firstly, it's important to note that our research was conducted during the first wave of the COVID-19 pandemic. Consequently, the experiences and perceptions of medical students may have evolved over time, and the applicability of our findings to later phases of the pandemic may be limited. Additionally, limitations of our study include that it exclusively presents the perspectives of medical students who willingly participated in interviews regarding their experiences within a new learning environment at the TTC. It is important to acknowledge that these findings may not encompass the views of all medical students who were part of the TTC.

Furthermore, all interviews were conducted by ZS, a fellow medical student, with the intention of fostering an informal and open dialog among peers on this subject. Nevertheless, we recognize that certain participants might have chosen not to address sensitive topics during this unprecedented epidemic period, potentially impacting the comprehensiveness of our findings. Our study also took place in a Western-country context where medical students had the opportunity to work voluntarily on the COVID-19 frontlines. This circumstance may constrain the transferability of our findings to medical students in settings where such experiences were less common. We acknowledge that medical education and the pandemic's impact on students can vary significantly across different regions and cultures. While our highly contextualized student experiences closely resemble those reported in other studies, variations in healthcare systems and pandemic responses across different regions could result in different experiences among medical students (27). Collecting data from another country or other regions with different restrictions or burdens of the pandemic may have described different lived experiences (6, 20, 21). Lastly, while our study suggests the importance of tailored support systems and a holistic curriculum approach for medical students, we did not provide specific recommendations or strategies for implementing these changes in medical education. These limitations should be taken into account when interpreting our findings and considering their applicability in different contexts and phases of the pandemic.

5. Conclusion

The COVID-19 pandemic has been disruptive to medical students. This study highlights the experiences of medical students on the COVID-19 frontline regarding relief, stress, and mental health. Despite the challenges they faced, participants expressed relief and gratitude for the opportunity to work on the frontline, describing it as a positive experience that fulfilled their sense of purpose and addressed their health and wellbeing needs. The findings emphasize the need for tailored support systems, including longitudinal programs, mindfulness workshops, and open communication. Addressing these challenges is crucial for improving the wellbeing of medical students and enhancing healthcare delivery during crises.

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 humans were approved by the Ethics Commission of Northwest and Central Switzerland (EKNZ, Req-2021-00518). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

JK and ZS: conceptualization, methodology, software, quirkos 2.3.1, and data curation. JK and AP: validation and writing—review and editing. JK, ZS, RS, AP, BB, and KL: formal analysis. ZS: investigation. CN and RB: resources. JK, AP, RS, and ZS: writing—original draft preparation. JK, AM, and KL: supervision. All authors have visualization, read, and agreed to the published version of the manuscript.

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 imperative for cross-cultural medical education in globalized healthcare

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Current healthcare systems are like living creatures. They are highly complex, multi-faceted, and dynamic. They must constantly change and adapt; they are like a melting pot, brimming with both rich and diverse cultures from all corners of the world. Beyond just nationality, these systems can include many languages, religious beliefs, socioeconomic backgrounds, and unique health practices. The tides of globalization, multicultural societies, migration, and international collaboration are continuously reshaping how healthcare providers are educated and how healthcare is delivered in an equitable, inclusive, and fair manner. To keep pace with, and within, these highly vibrant socio-cultural frameworks, Cross-Cultural Medical Education is needed to educate healthcare professionals. This education is essential to create professionals who are not just skilled, but who are also culturally savvy and able provide fair and equal care to patients from all sorts of backgrounds. It provides professionals with foundational knowledge to navigate the complex landscape of diverse patient populations. Cross-Cultural Medical Education is thus of paramount importance to satisfy the need for effective cross-cultural communication and understanding in patient care preferences, ultimately leading to improved health outcomes.

KEYWORDS

cross-cultural medical education, cultural awareness, health care, health equity, globalization

Healthcare settings now mirror the rich and diverse cultures of the world, transcending geographical and cultural boundaries. Extending beyond just nationality, this diversity encompasses lingual diversity, religious beliefs, socioeconomic backgrounds, and health practices. The diversity in healthcare systems is fostered by complex, multi-faceted, and dynamic interplay between globalization, multicultural societies, migration, and international collaboration. A plethora of empirical studies delineates the impacts of sociocultural factors, race, and ethnicity on health and clinical care (Hill et al., 1990; Berger, 1998). Therefore, Cross-Cultural Medical Education is needed to ensure culturally competent and skilled healthcare professionals are available to provide equitable patient care to patients with diverse religious, ethnic, cultural, socioeconomic backgrounds, and perspectives. The unique health-related beliefs and norms of a patient are shaped by these factors. These factors shape traditions and habits that can significantly impact the recognition of symptoms, thresholds for seeking care, health behaviors, adherence to treatment and preventive measures and medications, and communication preferences (Denoba et al., 1998; Betancourt et al., 1999; Coleman-Miller, 2000; Einbinder and Schulman, 2000; Flores, 2000; Gornick, 2000; Williams and Rucker, 2000). Consequently, sociocultural differences between patient and provider must be acknowledged and addressed in medical education to provide future physicians the skills

and knowledge to successfully navigate the complex landscape of diverse patient populations and to be able to provide effective care to patients.

Failing to address these cultural differences can lead to misunderstandings, medical errors including misdiagnoses, and suboptimal treatment outcomes. Empirical evidence shows that patient dissatisfaction, distrust, poor adherence, and poorer health outcomes are most likely to occur when the cultural diversity of patients and providers are ignored and not communicated during the medical encounter (Betancourt et al., 1999; Cooper-Patrick et al., 1999; Langer, 1999; Morales et al., 1999; Stewart et al., 1999; Flores, 2000). Patient satisfaction, adherence to treatment, and overall health outcomes are improved with culturally tailored care that respects patients' cultural values and beliefs (Betancourt et al., 2003; Beach et al., 2005).

According to Betancourt (2003), three key factors inspired the emergence of Cross-Cultural Medical Education: The need for preparing providers to be able to provide healthcare for a growing, diverse population (Zweifler and Gonzalez, 1998), to help to eliminate the pervasive racial/ethnic disparities in medical care seen today 9, and the standards put forward by accreditation bodies for medical training (i.e., the Liaison Committee on Medical Education) that require cross-cultural curricula as part of undergraduate medical education (Liaison Committee on Medical Education, n.d.).

There is another important issue that must be addressed that underscores the necessity of Cross-Cultural Medical Education in addition to these three factors. It is the recognition that healthcare providers themselves bring their own cultural backgrounds into their encounters with the healthcare system, with their colleagues, and with their patients (Betancourt, 2003). This aspect of cultural transaction is often overlooked, however, providers' personal beliefs, values, and biases can significantly influence their interactions and decision-making processes. As such, current cross-cultural education must be extended to comprehensively address these influences. In other words, it is not only the culture of the patient that matters; the provider's "culture" is equally important. Historical factors for patient mistrust, provider bias, and their impacts on physicians' decision-making have also been documented (Betancourt, 2003). Failure to take sociocultural factors into account may lead to stereotyping, and, in the worst cases, biased or discriminatory treatment of patients based on race, culture, language proficiency, or social status. Training that encourages self-reflection and awareness of one's own cultural identity can be incorporated to ensure healthcare providers can become more empathetic and effective in their practice. This approach involves exercises and techniques that promote self-reflection, including understanding one's culture, biases, tendency to stereotype, and appreciation for diverse health values, beliefs, and behaviors. Examples from this training include having open conversations exploring the impacts of racism, classism, sexism, homophobia, and other types of discrimination in healthcare; determining whether providers have ever dealt with feeling "different" in some way and how they have dealt with that; attempting to identify—using patient descriptors or vignettes—hidden biases the student may have based on subconscious stereotypes; determining the student's reaction to different visuals of patients of different races/ethnicities; and discussing ways in which individuals in the students' families have interacted with the healthcare system (Betancourt, 2003; Betancourt et al., 2003; Liaison Committee on Medical Education, 2020; Liaison Committee on Medical Education, n.d.). By integrating these elements into Cross-Cultural Medical Education, future healthcare professionals can be better prepared to navigate their own cultural influences and those of their patients, leading to more equitable and effective healthcare outcomes.

Medical schools have adopted various approaches to integrate cross-cultural education into their curricula. For instance, these schools have dedicated standalone courses on cultural competence, covering topics such as cultural awareness, communication skills, and addressing health disparities among different ethnic and socioeconomic groups (Betancourt, 2003; Liaison Committee on Medical Education, 2020). Cultural content has also been integrated across various medical disciplines, to emphasize that cultural considerations are not isolated concepts, but they are integral to every facet of healthcare delivery (Betancourt et al., 2003). Another promising approach is the exposure of students to culturally diverse patient cases by utilizing simulation and case-based learning that allows students to engage in real-world scenarios involving diverse patients. This approach has shown it fosters critical thinking and empathy in students while they navigate complex cross-cultural dynamics. It encourages students to apply their cultural knowledge to make informed decisions and provide patient-centered care (Dogra et al., 2009).

However, while the integration of cross-cultural education into medical curricula has been deemed a necessity to foster healthcare delivery, the success of its implementation faces several challenges and barriers. First, well-validated and applicable faculty training and development are needed to adequately train and equip faculty members with the knowledge, skills, and attitudes required to aid students in navigating diverse cultural scenarios and to guide them through the complexities of culturally diverse and sensitive healthcare (Dogra et al., 2009). This need calls for comprehensive faculty development programs that emphasize cultural awareness, communication skills, and an understanding of the psycho-social determinants of health affecting diverse populations (Betancourt, 2003). Second, developing and implementing cross-cultural educational courses, materials, and training often requires additional financial resources, including funding for curriculum development and integration, cultural exchange experiences, and technology to facilitate cross-cultural interactions. Third, the integration of cross-cultural education may cause resistance to change within academic institutions. Faculty members, administrators, and even students may harbor implicit cultural biases that can impede their willingness to acknowledge and appreciate diverse values, norms, or perspectives. A multifaceted approach is required to addressing these biases, including educational campaigns to raise awareness, diversity and inclusion training, and fostering open dialogues and exchanges about cultural stereotypes and prejudices (Chapman et al., 2018). Finally, the development of valid and reliable assessment tools that capture the nuances of cultural competence is an essential companion to this infusion of cross-cultural education. Traditional assessment methods, such as written exams, may not effectively evaluate a student's ability to interact with culturally diverse patients in real-world healthcare settings. Objective structured clinical examinations with cross-cultural scenarios, standardized patient interactions, and reflective portfolios

are some strategies employed to evaluate students' cultural sensitivity, communication skills, and patient-centered care (Luo et al., 2021).

Addressing these challenges are key to further enhancing the effectiveness of Cross-Cultural Medical Education. As healthcare systems evolve so must cross-cultural medical education. Therefore, faculty development programs should include interactive workshops, seminars, and cultural immersion experiences to keep paste with changes in the sociocultural environment for healthcare systems and to deepen educators' understanding of diverse patient backgrounds and adjust and improve their teaching methods. Certainly, the economic burden of educating culturally aware and sensitive educators must be addressed by pursuing financial support to be sought through grants, partnerships with cultural organizations, and government funding. Academic institutions should address and overcome resistance to change by implementing continuous diversity and inclusion training, along with creating platforms for open dialogue and discussions on implicit biases and cultural stereotypes. Innovative assessment tools that go beyond traditional methods should be developed, including technology-driven simulations and real-time feedback from culturally diverse standardized patients.

Despite these challenges, the field of healthcare will continue to be confronted with a pressing need to adapt and ensure equitable patient care for individuals from numerous backgrounds. It is essential for healthcare professionals to be proficient in culturally sensitive care to navigate the complex landscape of diverse patient populations. Medical educators must remain committed to incorporating feedback, evolving best practices, and innovative teaching strategies to ensure that future healthcare professionals are well-equipped to provide high-quality, culturally competent care to all patients, thereby improving overall health outcomes and achieving health equity. Cross-Cultural Medical Education has now become of paramount importance, an imperative, to satisfy the need for effective cross-cultural communication and understanding in patient care.

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

CM: Conceptualization, Writing – original draft.

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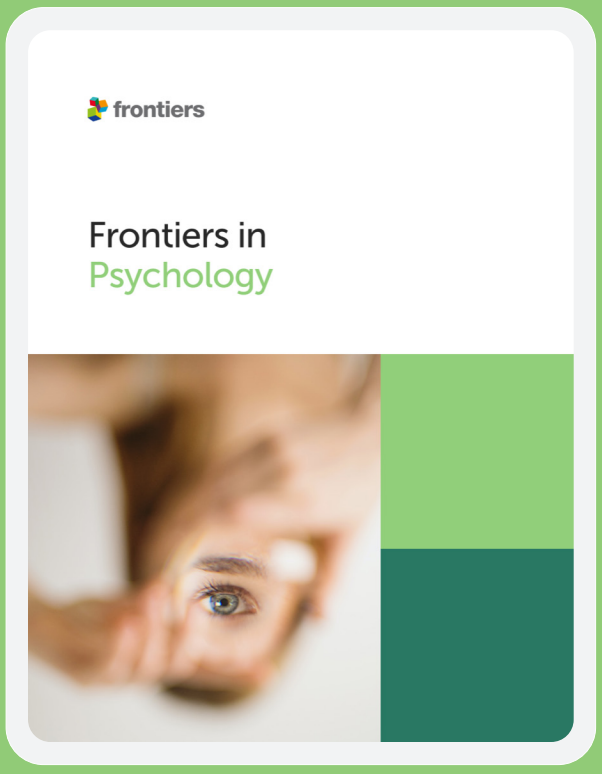

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