CLOSURE AND REOPENING OF SCHOOLS AND UNIVERSITIES DURING THE COVID-19 PANDEMIC: PREVENTION AND CONTROL MEASURES, SUPPORT STRATEGIES FOR VULNERABLE STUDENTS AND PSYCHOSOCIAL NEEDS

EDITED BY: Elena Commodari, Maria Anna Coniglio, Daniela Conti and Valentina Lucia La Rosa

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Topic Editors:
Elena Commodari, University of Catania, Italy
Maria Anna Coniglio, University of Catania, Italy
Daniela Conti, University of Catania, Italy
Valentina Lucia La Rosa, University of Catania, Italy

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EDITORIAL
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Editorial: Closure and Reopening of Schools and Universities During the COVID-19 Pandemic: Prevention and Control Measures, Support Strategies for Vulnerable Students and Psychosocial Needs

Elena Commodari[1], *Valentina Lucia La Rosa*[1]*, *Maria Anna Coniglio*[2] and *Daniela Conti*[3]

[1] Department of Educational Sciences, University of Catania, Catania, Italy, [2] Department of Medical and Surgical Sciences and Advanced Technologies "G.F. Ingrassia", University of Catania, Catania, Italy, [3] College of Business, Technology and Engineering, Sheffield Hallam University, Sheffield, United Kingdom

Keywords: COVID-19, school, university, prevention, health risk perception, vulnerability, psychosocial needs, distance learning

Editorial on the Research Topic

Closure and Reopening of Schools and Universities During the COVID-19 Pandemic: Prevention and Control Measures, Support Strategies for Vulnerable Students and Psychosocial Needs

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***Correspondence:**
Valentina Lucia La Rosa
valarosa@unict.it

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The pandemic event and the consequent lockdown in many countries of the world have raised new issues and, at the same time, stimulated the debate on essential aspects of educational psychology that need to be declined with a specific reference to COVID-19. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO), school and university closures impacted over 90% of the world's student population. In many countries, governments have activated measures to maintain continuity of learning using different forms of distance learning. However, thanks to the introduction of vaccinations to contain the pandemic, schools and universities are starting to resume their activities, adopting varying degrees of strict measures to prevent and control the infection.

In this context, it is necessary to create a reflection on the reopening of schools and universities and on the most appropriate measures to be adopted to manage reopenings effectively, as well as on interventions to support situations of greater vulnerability. Therefore, it is important to focus on the aspects of prevention and promotion of good risk management behaviors, on support measures for the most vulnerable students such as those with special educational needs and disabilities, and on the psychosocial needs that a stressful event such as a pandemic can result in for students, families, and teachers.

The strong impact of the COVID-19 pandemic on the psychological well-being of university students worldwide was confirmed by several studies. In this regard, the study by Awoke et al., conducted on undergraduate health science students of Jimma University (Ethiopia), underlined that over one-third of the participants reported high perceived stress. Furthermore, Swiss university students also reported high levels of anxiety and depression, especially during the early stages of the pandemic, as shown in the study by Amendola et al. In particular, the authors found that older age, female gender, non-Swiss nationality, loneliness, and participants' concern about their health positively predicted anxiety. In contrast, resilience and social support negatively predicted anxiety.

The same finding is also confirmed by Wu et al.'s study of 14,769 Chinese university students. Specifically, the authors reported that the increases in anxiety and depression from pre-pandemic levels were associated with students' gender and the severity of the pandemic in the province where they resided. Finally, De Pasquale et al.'s studies emphasized that the pandemic's experience can be a risk factor for the emergence of problematic behaviors among Italian university students. In particular, the first study reported that anxiety significantly correlated with bulimic behavior, while depression correlated with impulsivity and binge eating behaviors (De Pasquale et al.). The second study confirmed that Italian university students also showed moderate trait and state anxiety, as well as moderate perceived vulnerability to disease (De Pasquale et al.). However, fear of COVID-19 and trait anxiety did not seem to predict the risk of smartphone addiction.

The study by Carpinelli et al. added an important contribution to the Research Topic by focusing on the pandemic experiences of Italian university students with disabilities and specific learning disabilities. The authors reported high levels of satisfaction with emergency remote teaching during the lockdown phase among these students. Furthermore, only 22% of them indicated that they were dissatisfied with the teaching method used.

These results confirm that the psychological well-being of university students should be carefully considered. Therefore, it is necessary to provide adequate crisis-oriented psychological services to support this specific population in addressing the uncertainty associated with the pandemic. In this regard, the brief research report by Rusch et al. is very interesting because it reports the experience of the University of Michigan that activated a school mental health implementation program (TRAILS) designed to improve youth access to evidence-based mental health services. In particular, this report examined the needs of school mental health professionals of the University of Michigan during the early months of the COVID-19 pandemic and how those needs contributed to improving programming and resources provided by the TRAILS program.

In addition, other studies have contributed to investigating some relevant variables associated with the psychological impact of the pandemic and the experience of distance learning among university students. First of all, learning strategies influence students' online learning satisfaction through academic emotions during the COVID-19 pandemic, as reported in the study by Wu et al.. Staller et al. underlined that morning-oriented, conscientious, and open students with low neuroticism seem to better cope with the changed learning situation due to vitality, self-efficacy, and partly their self-determined motivation. Furthermore, according to Zhang et al., adaptability and student engagement are significantly positively correlated with positive academic emotions and negatively correlated with negative ones. As underlined by Wang et al., digital competence is another crucial variable to consider because it indirectly affected academic burnout through its effect on cognitive load and showed a great positive influence on student engagement. The study by Zeng et al. explored the impact of post-traumatic growth on college students' creativity during the COVID-19 pandemic. In this regard, the authors reported that post-traumatic growth affected creativity directly and indirectly through self-efficacy. This association was stronger when the incidence of deliberate rumination was low. According to these findings, the adverse effects of the COVID-19 pandemic can be alleviated through positive psychological interventions on university students to promote these dimensions.

Finally, the interesting contribution by Zhang and Huang focuses on a more specific aspect, namely the impact of the entrepreneurial environment on entrepreneurial self-efficacy and intentions of college students in the post-pandemic era. The authors reported that the factors influencing the entrepreneurial choice of college students included gender, entrepreneurial family history, major, and educational background. Furthermore, entrepreneurial self-efficacy can significantly mediate the impact caused by the post-pandemic entrepreneurial environment on entrepreneurial intentions.

In conclusion, the educational impact of an extraordinary and unexpected event such as the COVID-19 pandemic needs to be deeply investigated. Future studies will have to explore this topic further, especially in light of the reopening of schools and universities, to adapt the organization of teaching and academic life according to students' new needs and experiences.

AUTHOR CONTRIBUTIONS

EC and VLLR were guest associate editors of the Research Topic and wrote the paper text. MC and DC were guest associate editors of the Research Topic and edited the text. All authors contributed to the article and approved the submitted version.

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Adaptability Promotes Student Engagement Under COVID-19: The Multiple Mediating Effects of Academic Emotion

Keshun Zhang[1†], Shizhen Wu[2†], Yanling Xu[3], Wanjun Cao[3], Thomas Goetz[4] and Elizabeth J. Parks-Stamm[5]*

[1] Department of Psychology, Qingdao Psychological and Mental Health Research Institute, Normal College, Qingdao University, Qingdao, China, [2] Student Counselling and Mental Health Center, Qingdao University, Qingdao, China, [3] Department of Psychology, Normal College, Qingdao University, Qingdao, China, [4] Department of Developmental and Educational Psychology, Faculty of Psychology, University of Vienna, Vienna, Austria, [5] Department of Psychology, University of Southern Maine, Portland, ME, United States

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Edited by:
Valentina Lucia La Rosa, University of Catania, Italy

Reviewed by:
Concetta Pirrone, University of Catania, Italy
Maria Guarnera, Kore University of Enna, Italy

****Correspondence:***
Keshun Zhang
keshun.zhang@qdu.edu.cn

[†] These authors share first authorship

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In response to the COVID-19 pandemic, millions of students in China followed an emergency policy called "Suspending Classes without Stopping Learning" to continue their study online as schools across the country were closed. The present study examines how students adapted to learning online in these unprecedented circumstances. We aimed to explore the relationship between adaptability, academic emotion, and student engagement during COVID-19. 1,119 university students from 20 provinces participated in this longitudinal study (2 time points with a 2-week interval). The results showed that adaptability (the ability to respond to changes) and student engagement are significantly positively correlated with positive academic emotion and negatively correlated with negative academic emotion. Furthermore, adaptability not only directly predicts student engagement, but also affects student engagement through the chain mediation of positive academic emotion and negative academic emotion. The results contribute to the gap in knowledge regarding changes in students' learning in response to the outbreak. This study further explains the internal mechanisms mediating the relationship between adaptability and student engagement. It may provide references for educational researchers and universities in dampening the negative effects of COVID-19 on students' learning by improving their adaptability and developing positive academic emotions.

Keywords: COVID-19, adaptability, student engagement, academic emotion, university student

INTRODUCTION

Beginning in late 2019, a novel coronavirus disease (COVID-19) spread widely and quickly around China and the world (Guan et al., 2020; Wu and McGoogan, 2020; Zhou et al., 2020). The pandemic brought not only the risk of death and illness, but also heightened stress, anxiety, and depression among individuals in China (Wang and Zhao, 2020; Wang et al., 2020). To contain the virus, the

Ministry of Education of the People's Republic of China initiated a series of emergency management steps, including shutting down schools and initiating online learning (i.e., Suspending Classes without Stopping Learning[1]). As a result, approximately 30 million quarantined university students experienced an unprecedented and unplanned switch from traditional face-to-face learning to online learning from home. The combined psychological pressure caused by COVID-19 and the abrupt change in learning modality created significant challenges for students, with significant impacts on the mental health of university students (Cao et al., 2020). However, no detailed study has examined the impact of university students' adaptability on their learning during the COVID-19 pandemic. Thus, we conducted this study to investigate how adaptability (i.e., the ability to respond to changing, new, and uncertain conditions appropriately) may influence their engagement following the transition to online learning in China during the COVID-19 pandemic.

Student engagement refers to students' active involvement in their learning and academic activities at school. Student engagement can be conceptualized as a three-dimensional construct, including behavioral, affective, and cognitive elements, which forms the basis of students' connectedness to learning (Fredricks and McColskey, 2012). Students' level of student engagement is associated with higher academic achievement (Appleton et al., 2008; Fredricks and McColskey, 2012) and mental health (Steele and Fullagar, 2009). Student engagement has been found to better predict the quality of higher education than resource input and the reputation of academies (Boulton et al., 2019).

As universities moved online in response to COVID-19, student engagement has been identified as a challenge (Farooq et al., 2020; Nickerson and Shea, 2020; Perets et al., 2020). However, very little research has examined the factors that influence student engagement in a pandemic. The present research examines the role of adaptability.

Adaptability is defined as the capacity to modify one's cognition, affect, and behavior constructively, reflecting an individual difference in the way that one responds to changing, new, and uncertain conditions (VandenBos, 2007; Martin et al., 2012). There are three components: cognitive adjustment refers to the modification of one's thoughts, behavioral adjustment refers to the modification of one's actions, and affective adjustment refers to altering one's affective responses (Martin et al., 2012; Holliman, 2013; Holliman et al., 2018). Recent research conducted during the COVID-19 pandemic found adaptability was predicted by students' personality traits (Besser et al., 2020). Specifically, this research found that all five of the big five personality traits significantly predicted adaptability to the COVID-19 pandemic, with extraversion, openness, agreeableness, and conscientiousness positively associated with adaptability, and neuroticism negatively associated. There is also evidence that adaptability is related to student engagement. Martin and colleagues found that a higher level of adaptability was significantly associated with both greater positive student engagement and lower negative student engagement among secondary school students (Martin et al., 2013). Prior research has also found that 1st-year undergraduates' adaptability was a significant direct predictor of both positive and negative behavioral engagement (Collie et al., 2016; Holliman et al., 2018). However, although previous research has examined the role of adaptability in transitions to new school environments (e.g., freshman in college or high school), no research has investigated the role of adaptability in students' response to changes caused by a global pandemic. The evidence mentioned above suggests that adaptability may be an essential antecedent to students' engagement in altered school environments during COVID-19.

The broaden-and-build theory of positive emotions suggests that the form and function of positive academic emotion and negative academic emotion are distinct and complementary (Fredrickson, 2001). Positive academic emotions can broaden the scope of individuals' cognition and activities, and help students envision goals, challenges, and positive thoughts (Fredrickson, 2001; Fredrickson and Joiner, 2018). Students who search out learning opportunities and resources tend to have positive academic emotion. What is more, positive academic emotion can promote students' persistence and efforts in learning (Pekrun et al., 2002). Therefore, positive academic emotions can make students feel more engaged in learning activities (Reschly et al., 2008). On the other hand, students with negative academic emotions (e.g., those who feel nervous, sad, anxious, bored, and disappointed) pay more attention to the threats in their environment, which limits their flexibility to invoke cognitive resources to perform at their best in learning activities (Derakshan et al., 2009). Therefore, negative academic emotions could exert a negative influence on students' academic performance, which could further obstruct student engagement (Putwain et al., 2013). In sum, academic emotions appear to play an essential role in student engagement; whereas positive academic emotions tend to propel student engagement, negative academic emotions can impede student engagement (Zhen et al., 2017).

Furthermore, previous research has indicated that adaptability and academic emotions may work together to impact student engagement. When an individual is faced with novelty and uncertainty, he or she tends to make changes (e.g., in behavior, emotion, and cognition) to adapt to the new conditions. Whereas previous research in this field of adaptability have focused on changes in behavior and cognition (Collie and Martin, 2017), we examine the mediating role of emotion. Although some research has examined emotion regulation during the COVID-19 pandemic (Chen et al., 2020; Jiang et al., 2020; Restubog et al., 2020), the mediating role of emotions for the relationship between adaptation and school engagement is an important piece of the puzzle for understanding students' response to the COVID-19 pandemic. Students who easily adapt to novelty and uncertainty experience positive academic emotions such as enjoyment and pride (Goetz et al., 2008), whereas students who feel unable to adapt are more likely to experience

[1]http://www.moe.gov.cn/

negative academic emotions, such as anxiety and boredom (King and Gaerlan, 2014).

In sum, this investigation has two aims: The first aim is to explore relations between students' adaptability and engagement under COVID-19. The second aim relates to the function of academic emotions. Using a longitudinal design, we examine if adaptability influences academic emotions, and if academic emotions then influence student engagement in response to the wide-ranging changes in students' academic experience during the COVID-19 pandemic, i.e., the possible mediating role of academic emotions.

MATERIALS AND METHODS

Ethics Statement

This study was conducted based on the ethical standards in the WMA Declaration of Helsinki. The Research Ethics Committee of Qingdao University has approved this study. Participants were informed about the precise contents of the study before they started their assessments (including the goal of the research, duration, and anonymity in the surveys and data analyses). Furthermore, all identifiers that could link individual participants to their results were excluded in the data analyses; thus, all analyses were based on anonymous data.

Participants and Design

We collected data via a Chinese online research panel, Wenjuanxing[2], which provides functions equivalent to Amazon Mechanical Turk. Based on random sampling, 1,616 university students voluntarily participated in the Time 1 assessment and 1,119 of these participants took part in the Time 2 assessment (903 females, 216 male), with a 30.75% attrition rate. The age of the sample ranged from 17 to 37 years ($M = 20.42$, $SD = 2.13$). The final sample included 984 undergraduates and 135 postgraduates.

The study involved two assessments in the early stages of online learning. Time 1 (T1) took place from 29 February to 6 March 2020. Time 2 (T2) took place from 13 March to 20 March 2020. Both T1 and T2 focused on students' adaptability, academic emotions, and academic engagement. Identical instruments were used at both times.

Measures

Adaptability

We used the nine-item Adaptability Scale to assess students' adaptability (Martin et al., 2012). This scale contains three items referring to affective adaptability (e.g., "When uncertainty arises, I am able to minimize frustration or irritability so that I can deal with it best") and six items referring to cognitive-behavioral adaptability (e.g., "I am able to think through a number of possible options to assist me in a new situation"). The items were rated on a 7-point scale ranging from 1 (Strongly disagree) to 7 (Strongly agree). The scale was internally consistent ($\alpha_{t1/t2} = 0.97/0.97$).

[2]https://www.wjx.cn/

Academic Emotion

We adapted subscales of the Differential Emotion Scale (Izard et al., 1974) to assess anger, sadness, fear, and enjoyment, and subscales of the Academic Emotions Questionnaire (Pekrun et al., 2002) to assess anxiety, hopelessness, and boredom. Each emotion includes three items, and thus 21 items in total were involved. Six negative differential emotions (i.e., anger, hopelessness, boredom, sadness, fear, anxiety; $\alpha_{t1/t2} = 0.96/0.97$) were grouped into one scale to measure negative academic emotions, and enjoyment ($\alpha_{t1/t2} = 0.88/0.90$) represented positive academic emotion. The items were assessed on a 5-point scale ranging from 0 (Not at all) to 4 (Very strong; e.g., "To what extent did you experience ___ during the past few weeks of learning?" "I felt. . ." "angry").

Student Engagement

The ten-item Engagement Questionnaire (Skinner et al., 2009) was used to assess student engagement with respect to students' behavioral and emotional engagement. For example, "I pay attention in class" was used to assess the behavioral aspect and "Class is fun" assessed the emotional aspect. Each measure employed a 5-point scale ranging from 1 (Not at all true) to 5 (Very true). The scale was internally consistent ($\alpha_{t1/t2} = 0.96/0.96$).

Data Analysis

Data were analyzed with SPSS Version 25.0. PROCESS macro for SPSS was adopted to perform the multiple mediation model (Hayes, 2013). Model 82 was used in PROCESS to test the mediating role of positive and negative academic emotions (mediator) in the relationship between adaptability (independent variable) and student engagement (dependent variable). We used 5000 bootstrap samples and the 95% bias-corrected confidence interval (95% CI) to examine the significance of the multiple mediation effect (Hayes, 2013). The statistical significance level was set at $p < 0.05$.

RESULTS

Common Method Biases

The Harman single-factor test was used to diagnose the common method bias (Podsakoff et al., 2003). The results of principal component factor analysis without rotation showed that there were 11 factors whose eigenvalues were greater than 1. The variance explained by the first factor was 36.07%, below the threshold of 40%. Therefore, the common method bias did not affect the outcome of this study.

Descriptive Statistics and Correlations

The means (M), standard deviations (SD), skewness, and kurtosis, and reliabilities for all variables across the two points are displayed in **Table 1**. All the measures had acceptable reliabilities (ranging from 0.88 to 0.97).

Pearson correlation matrices for the longitudinal relations between variables are displayed in **Table 2**. T1 Adaptability was positively correlated with T1 and T2 positive academic emotion

TABLE 1 | Descriptive statistics of all study variables (n = 1119).

	M	*SD*	Skewness	Kurtosis	α
(1) T1 Adaptability	5.22	1.06	−0.65	1.15	0.97
(2) T1 Positive academic emotion	2.80	0.79	0.08	0.70	0.88
(3) T2 Positive academic emotion	2.85	0.85	0.13	0.34	0.90
(4) T1 Negative academic emotion	1.85	0.70	0.96	0.46	0.96
(5) T2 Negative academic emotion	1.87	0.79	1.02	0.65	0.97
(6) T2 Student engagement	3.59	0.80	−0.13	0.02	0.96

Adaptability (range: 1 to 7), academic emotion (range: 0 to 4), student engagement (range: 1 to 5).

TABLE 2 | Pearson correlations for all study variables (n = 1119).

	1	2	3	4	5	6
(1) T1 Adaptability	–					
(2) T1 Positive academic emotion	0.29**	–				
(3) T2 Positive academic emotion	0.19**	0.45**	–			
(4) T1 Negative academic emotion	−0.32**	−0.13**	−0.10**	–		
(5) T2 Negative academic emotion	−0.34**	−0.13**	−0.07*	0.65**	–	
(6) T2 Student engagement	0.47**	0.22**	0.21**	−0.35**	−0.39**	–

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

(rs = 0.29 and 0.19, respectively; $ps < 0.01$) and negatively correlated with T1 and T2 negative academic emotion (rs = −0.32 and −0.34, respectively; $ps < 0.01$). T2 student engagement was also positively correlated with T1 and T2 positive academic emotion (rs = 0.22 and 0.21, respectively; $ps < 0.01$), but negatively correlated with T1 and T2 negative academic emotion (rs = −0.35 and −0.39, respectively; $ps < 0.01$). Furthermore, the correlation between T1 Adaptability and T2 student engagement was significant ($r = 0.47$, $p < 0.01$).

The Multiple Mediation Effects of Adaptability, Academic Emotion, and Student Engagement

The results of the regression analyses are shown in **Figure 1** and **Table 3**. T1 adaptability positively predicted T2 student engagement (β = 0.260, $p < 0.001$), as well as T1 positive academic emotion (β = 0.216, $p < 0.001$) and T2 positive academic emotion (β = 0.053, $p < 0.05$). T1 adaptability also negatively predicted T1 negative academic emotion (β = −0.211, $p < 0.001$) and T2 negative academic emotion (β = −0.105, $p < 0.001$). T1 positive academic emotion significantly predicted T2 positive academic emotion (β = 0.470, $p < 0.001$), however, T1 positive academic emotion did not predict T2 student engagement (β = 0.039, p = 0.193). A strong regression path was shown between T2 positive academic emotion and T2 student engagement (β = 0.093, $p < 0.001$), between T1 negative academic emotion and T2 negative academic emotion (β = 0.618, $p < 0.001$), and between T1 negative academic emotion and T2 student engagement (β = −0.115, $p < 0.01$).

In order to test the intermediary role of academic emotion in the relationship between adaptability and student engagement, the Bootstrap method was used to sample 5000 times and build a 95% unbiased correction confidence interval. The results show that the chain intermediary effect of T1 and T2 positive academic emotion (β = 0.010, 95% CI [0.003, 0.017]), and T1 and T2 negative academic emotions (β = 0.028, 95% CI [0.016, 0.042]) were significant, indicating a significant mediation by both positive and negative emotions. The model results are shown in **Table 4**. In addition, T1 adaptability had indirect effects on T2 engagement through T2 positive academic emotion (β = 0.005, 95% CI [0.000, 0.012]), T1 negative academic emotion (β = 0.024, 95% CI [0.007, 0.043]), and T2 negative academic emotion (β = 0.021, 95% CI [0.011, 0.032]).

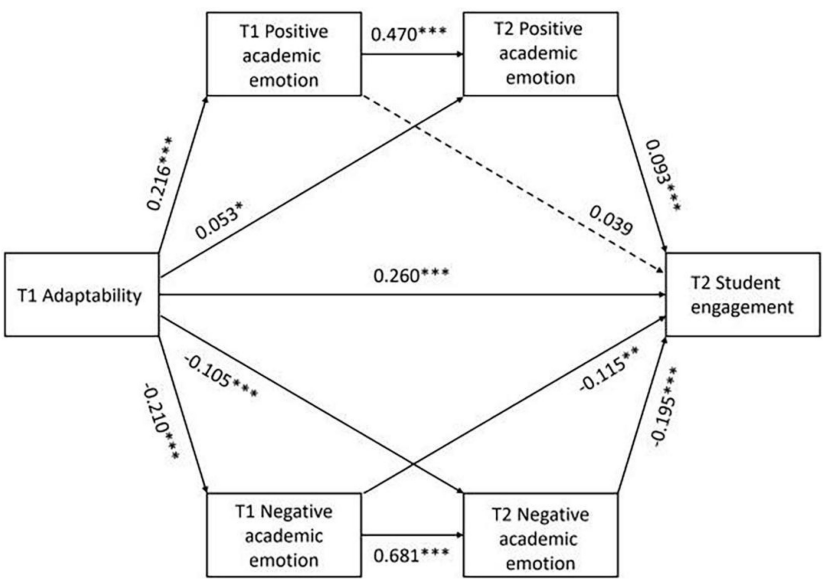

FIGURE 1 | Multiple-mediating test of adaptability, academic emotions, and student engagement.

TABLE 3 | Regression analysis of variable relationships (n = 1119).

Dependent	Predictors	Model Summary				
		F	R^2	β	SE	t
T1 Positive academic emotion	T1 Adaptability	104.97***	0.09	0.216	0.02	10.25
T2 Positive academic emotion	T1 Adaptability	147.84***	0.21	0.053	0.02	2.40
	T1 Positive academic emotion			0.470	0.03	15.58
T1 Negative academic emotion	T1 Adaptability	126.25***	0.10	−0.210	0.02	−11.24
T2 Negative academic emotion	T1 Adaptability	445.77***	0.44	−0.105	0.02	−6.00
	T1 Negative academic emotion			0.681	0.03	25.81
T2 Student engagement	T1 Adaptability	96.00***	0.30	0.260	0.02	12.37
	T1 Positive academic emotion			0.039	0.03	1.30
	T2 Positive academic emotion			0.093	0.03	3.51
	T1 Negative academic emotion			−0.115	0.04	−3.02
	T2 Negative academic emotion			−0.195	0.03	−5.72

***$p < 0.001$.

TABLE 4 | Mediation effects test.

Ind		Indirect effect			
		Effect	95% confidence interval		Percentage
			BootLLCI	BootULCI	
Total	Total	0.096	0.073	0.120	26.90%
Ind 1	T1 Adaptability→T1 Positive academic emotion→T2 Student engagement	0.008	−0.006	0.024	2.33%
Ind 2	T1 Adaptability→T2 Positive academic emotion→T2 Student engagement	0.005	0.000	0.012	1.41%
Ind 3	T1 Adaptability→T1 Negative academic emotion→T2 Student engagement	0.024	0.007	0.043	6.82%
Ind 4	T1 Adaptability→T2 Negative academic emotion→T2 Student engagement	0.021	0.011	0.032	5.77%
Ind 5	T1 Adaptability→T1 Positive academic emotion→T2 Positive academic emotion→T2 Student engagement	0.010	0.003	0.017	2.68%
Ind 6	T1 Adaptability→T1 Negative academic emotion→T2 Negative academic emotion→T2 Student engagement	0.028	0.016	0.042	7.89%

Ind 1 = T1 Adaptability→T1 Positive academic emotion→T2 Student engagement; Ind 2 = T1 Adaptability→T2 Positive academic emotion→T2 Student engagement; Ind 3 = T1 Adaptability→T1 Negative academic emotion→T2 Student engagement; Ind 4 = T1 Adaptability→T2 Negative academic emotion→T2 Student engagement; Ind 5 = T1 Adaptability→T1 Positive academic emotion→T2 Positive academic emotion→T2 Student engagement; Ind 6 = T1 Adaptability→T1 Negative academic emotion→T2 Negative academic emotion→T2 Student engagement.

DISCUSSION

In the present study, a multiple mediating model was tested to examine the relations among university students' adaptability, positive and negative academic emotions, and student engagement during the COVID-19 pandemic in China. The results of this study suggest that adaptability can directly affect student engagement, and it can also indirectly influence student engagement through academic emotion.

Consistent with our expectations concerning the importance of adaptability for student engagement, adaptability was found to influence student engagement positively, supporting the behavioral function of adaptability as a propensity that helps individuals to adjust to the demands in their environment (Martin et al., 2013). This result was in line with a previous study (Susana et al., 2015) that showed that students who can adjust to different situations and circumstances are more likely to engage in learning activities. In the novel and challenging situation for Chinese university students after the outbreak of COVID-19, students who are higher in adaptability were better to engage in sustained efforts to cope with new challenges, keep track of their academic work, and adjust their behaviors to manage new learning tasks. Importantly, the present study suggests this level of adaptability positively predicted students' levels of engagement, and thus may lead to different levels of academic performance during COVID-19.

Moreover, our results also speak to the emotional function of adaptability, as adaptability predicted student engagement through academic emotion. Successfully adapting in an academic domain can help students feel effective and capable of achieving academic goals, perceive connections with teachers, and therefore produce pleasant emotions and decrease unpleasant emotions in learning (Rahman et al., 2009). We found that students who were best able to adapt to the impact of COVID-19 experienced more positive academic emotions. Positive academic emotions like enjoyment can direct students to engage in academic tasks,

which can improve their performance (e.g., Ketonen et al., 2016). Pride is another positive academic emotion that can strengthen students' long-term motivation to pursue academic goals (Pekrun et al., 2002; Schwarzer and Taubert, 2002). Most importantly, students with positive academic emotions are more willing to invest effort into learning, reaching higher levels of engagement (King et al., 2015). Students' level of adaptability further predicted their negative emotions, and we found an even stronger impact of adaptability on negative academic emotion than on positive academic emotion. Previous research has identified that negative academic emotions can narrow students' cognitive scope by making them focus on threats or failure, and in turn pull their limited cognitive resources away from the academic tasks at hand (Owens et al., 2012; Ouweneel et al., 2014).

There are some limitations to this study. Firstly, although the current study is longitudinal, the interval between the two time points was short, at only 2 weeks. Because it was unknown how long the online learning changes due to COVID-19 would last, the second survey was carried out 2 weeks after the first to capture the dynamic development of students' learning activities during this time. Secondly, the participants were university students in China, so although they came from more than 20 provinces of China, the generalizability to populations in other cultures should be made with caution. Future research should replicate this model in university students in other regions of the world.

Another interesting future direction would be to examine how university students' health risk perceptions impact their academic emotions and engagement. Both the antecedents (Commodari et al., 2020) and the consequences (Ding et al., 2020) of health risk perceptions during COVID-19 have been examined by recent research. For example, Commodari and La Rosa (2020) examined the relationship between COVID-19 health risk perceptions and emotions among quarantined adolescents in Italy. They found perceived susceptibility negatively predicted positive emotions whereas fear of getting COVID-19 positively predicted negative emotions. The present research suggests that positive and negative emotions resulting from health risk perceptions may impact students' academic engagement. Future research should further examine the role of students' adaptability in responding to information regarding risk in addition to adapting to changes in the academic environment.

CONCLUSION

The present longitudinal study examined the behavioral and emotional function of adaptability. The results suggest that adaptability under COVID-19 directly increases student engagement (behavioral perspective), and indirectly promotes student engagement by enhancing positive academic emotion and dampening negative academic emotions (emotional perspective). This study provides an important preliminary understanding of how university students' adaptability influences their academic engagement via academic emotions under COVID-19. Thus, the present findings have relevance to efforts to understand how to support students to successfully navigate challenging environmental conditions and promote effective adjustment to challenges, including global pandemics.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: https://osf.io/3k7v9/?view_only=e5738638d1244f66bd3df8548ee46452.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Qingdao University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

KZ and SW conceived and designed the survey, performed the survey, and contributed materials and analysis tools. KZ and YX analyzed the data. KZ, SW, YX, WC, TG, and EP-S wrote the manuscript. KZ, YX, and EP-S literature research. All authors contributed to the article and approved the submitted version.

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REFERENCES

Appleton, J. J., Christenson, S. L., and Furlong, M. J. (2008). Student engagement with school: critical conceptual and methodological issues of the construct. *Psychol. Sch.* 45, 369–386. doi: 10.1002/pits.20303

Besser, A., Flett, G. L., and Zeigler-Hill, V. (2020). Adaptability to a sudden transition to online learning during the COVID-19 pandemic: understanding the challenges for students. *Scholarsh. Teach. Learn. Psychol.* doi: 10.1037/stl0000198 [Epub ahead of print].

Boulton, C. A., Hughes, E., Kent, C., Smith, J. R., and Williams, H. T. P. (2019). Student engagement and wellbeing over time at a higher education institution. *PLoS One* 14:e0225770. doi: 10.1371/journal.pone.0225770

Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., et al. (2020). The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Res.* 287:112934. doi: 10.1016/j.psychres.2020.112934

Chen, R. N., Liang, S. W., Peng, Y., Li, X. G., and Zhao, J. B. (2020). Mental health status and change in living rhythms among college students in China during the COVID-19 pandemic: a large-scale survey. *J. Psychosom. Res.* 137:110219.

Collie, R. J., Holliman, A. J., and Martin, A. J. (2016). Adaptability, engagement and academic achievement at university. *Educ. Psychol.* 37, 632–647. doi: 10.1080/01443410.2016.1231296

Collie, R. J., and Martin, A. J. (2017). Students' adaptability in mathematics: examining self-reports and teachers' reports and links with engagement and achievement outcomes. *Contemp. Educ. Psychol.* 49, 355–366. doi: 10.1016/j.cedpsych.2017.04.001

Commodari, E., and La Rosa, V. L. (2020). Adolescents in quarantine during COVID-19 pandemic in Italy: perceived health risk, beliefs, psychological experiences and expectations for the future. *Front. Psychol.* 11:2480. doi: 10.3389/fpsyg.2020.559951

Commodari, E., La Rosa, V. L., and Coniglio, M. A. (2020). Health risk perceptions in the era of the new coronavirus: are the Italian people ready for a novel virus? A cross-sectional study on perceived personal and comparative susceptibility for infectious diseases. *Public Health* 187, 8–14. doi: 10.1016/j.puhe.2020.07.036

Derakshan, N., Smyth, S., and Eysenck, M. W. (2009). Effects of state anxiety on performance using a task-switching paradigm: an investigation of attentional control theory. *Psychon. Bull. Rev.* 16, 1112–1117. doi: 10.3758/PBR.16.6.1112

Ding, Y., Xu, J., Huang, S., Li, P., Lu, C., and Xie, S. (2020). Risk perception and depression in public health crises: evidence from the COVID-19 crisis in China. *Int. J. Environ. Res. Public Health* 17:5728. doi: 10.3390/ijerph17165728

Farooq, F., Rathore, F. A., and Mansoor, S. N. (2020). Challenges of online medical education in Pakistan during COVID-19 pandemic. *J. Coll. Physicians Surg. Pak.* 30, 67–69. doi: 10.29271/jcpsp.2020.Supp1.S67

Fredricks, J. A., and McColskey, W. (2012). "The measurement of student engagement: a comparative analysis of various methods and student self-report instruments," in *Handbook of Research on Student Engagement*, eds S. L. Christenson, A. L. Reschly, and C. Wylie (Boston, MA: Springer US), 763–782. doi: 10.1007/978-1-4614-2018-7_37

Fredrickson, B. L. (2001). The role of positive emotions in positive psychology. The broaden-and-build theory of positive emotions. *Am. Psychol.* 56, 218–226. doi: 10.1037//0003-066x.56.3.218

Fredrickson, B. L., and Joiner, T. (2018). Reflections on positive emotions and upward spirals. *Perspect. Psychol. Sci.* 13, 194–199. doi: 10.1177/1745691617692106

Goetz, T., Frenzel, A. C., Hall, N. C., and Pekrun, R. (2008). Antecedents of academic emotions: testing the internal/external frame of reference model for academic enjoyment. *Contemp. Educ. Psychol.* 33, 9–33. doi: 10.1016/j.cedpsych.2006.12.002

Guan, W., Ni, Z., Hu, Y., Liang, W., Ou, C., He, J., et al. (2020). Clinical characteristics of coronavirus disease 2019 in China. *N. Engl. J. Med.* 382, 1708–1720. doi: 10.1056/NEJMoa2002032

Hayes, A. (2013). Introduction to mediation, moderation, and conditional process analysis. *J. Educ. Meas.* 51, 335–337. doi: 10.1111/jedm.12050

Holliman, A. J. (2013). *The Routledge International Companion to Educational Psychology*. Abingdon: Routledge.

Holliman, A. J., Martin, A. J., and Collie, R. J. (2018). Adaptability, engagement, and degree completion: a longitudinal investigation of university students. *Educ. Psychol.* 38, 785–799. doi: 10.1080/01443410.2018.1426835

Izard, C. E., Dougherty, F. E., Bloxom, B. M., and Kotsch, W. E. (1974). *The Differential Emotions Scale: A Method of Measuring the Subjective Experience of Discrete Emotions*. Nashville, TN: Vanderbilt University.

Jiang, H.-J., Nan, J., Lv, Z.-Y., and Yang, J. (2020). Psychological impacts of the COVID-19 epidemic on Chinese people: exposure, post-traumatic stress symptom, and emotion regulation. *Asian Pac. J. Trop. Med.* 13, 252–259.

Ketonen, E. E., Haarala-Muhonen, A., Hirsto, L., Hänninen, J. J., Wähälä, K., and Lonka, K. (2016). Am I in the right place? Academic engagement and study success during the first years at university. *Learn. Individ. Dif.* 51, 141–148. doi: 10.1016/j.lindif.2016.08.017

King, R. B., and Gaerlan, M. J. M. (2014). How you Perceive Time Matters for how you Feel in School: investigating the link between time perspectives and academic emotions. *Curr. Psychol.* 33, 282–300. doi: 10.1007/s12144-014-9213-x

King, R. B., Mcinerney, D. M., Ganotice, F. A., and Villarosa, J. B. (2015). Positive affect catalyzes academic engagement: cross-sectional, longitudinal, and experimental evidence. *Learn. Individ. Dif.* 39, 64–72. doi: 10.1016/j.lindif.2015.03.005

Martin, A. J., Nejad, H., Colmar, S., and Liem, G. A. D. (2012). Adaptability: conceptual and empirical perspectives on responses to change, Novelty and Uncertainty. *Aust. J. Guid. Coun.* 22, 58–81. doi: 10.1017/jgc.2012.8

Martin, A. J., Nejad, H. G., Colmar, S., and Liem, G. A. D. (2013). Adaptability: how students' responses to uncertainty and novelty predict their academic and non-academic outcomes. *J. Educ. Psychol.* 105, 728–746. doi: 10.1037/a0032794

Nickerson, L. A., and Shea, K. M. (2020). First-Semester organic chemistry during COVID-19: prioritizing group work, flexibility, and student engagement. *J. Chem. Educ.* 97, 3201–3205. doi: 10.1021/acs.jchemed.0c00674

Ouweneel, E., Le Blanc, P. M., and Schaufeli, W. B. (2014). On being grateful and kind: results of two randomized controlled trials on study-related emotions and academic engagement. *J. Psychol.* 148, 37–60. doi: 10.1080/00223980.2012.742854

Owens, M., Stevenson, J., Hadwin, J. A., and Norgate, R. (2012). Anxiety and depression in academic performance: an exploration of the mediating factors of worry and working memory. *Sch. Psychol. Int.* 33, 433–449. doi: 10.1777/0143034311427433

Pekrun, R., Goetz, T., Titz, W., and Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: a program of qualitative and quantitative research. *Educ. Psychol.* 37, 91–105. doi: 10.1207/S15326985EP3702_4

Perets, E. A., Chabeda, D., Gong, A. Z., Huang, X., Fung, T. S., Ng, K. Y., et al. (2020). Impact of the emergency transition to remote teaching on student engagement in a Non-STEM undergraduate chemistry course in the time of COVID-19. *J. Chem. Educ.* 97, 2439–2447. doi: 10.1021/acs.jchemed.0c00879

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., and Podsakoff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *J. Appl. Psychol.* 88, 879–903. doi: 10.1037/0021-9010.88.5.879

Putwain, D., Sander, P., and Larkin, D. (2013). Academic self-efficacy in study-related skills and behaviours: relations with learning-related emotions and academic success. *Br. J. Educ. Psychol.* 83, 633–650. doi: 10.1111/j.2044-8279.2012.02084.x

Rahman, R. J., Thøgersenntoumani, C., Thatcher, J., and Doust, J. (2009). Psychological need satisfactions as predictors of motivation and psychological outcomes following exercise rehabilitation. *Psychol. Health* 24, 330–330.

Reschly, A., Huebner, E., Appleton, J., and Antaramian, S. (2008). Engagement as flourishing: the contribution of positive emotions and coping to adolescents' engagement at school and with learning. *Psychol. Sch.* 45, 419–431. doi: 10.1002/pits.20306

Restubog, S. L. D., Ocampo, A. C. G., and Wang, L. (2020). Taking control amidst the chaos: emotion regulation during the COVID-19 pandemic. *J. Vocat. Behav.* 119:103440. doi: 10.1016/j.jvb.2020.103440

Schwarzer, R., and Taubert, S. (2002). "Tenacious goal pursuits and striving toward personal growth: proactive coping," in *Beyond Coping: Meeting Goals, Visions and Challenges*, ed. E. Frydenberg (Oxford: Oxford University Press), 19–35. doi: 10.1093/med:psych/9780198508144.003.0002

Skinner, E. A., Kindermann, T. A., and Furrer, C. J. (2009). A motivational perspective on engagement and disaffection conceptualization and assessment of children's behavioral and emotional participation in academic activities in the classroom. *Educ. Psychol. Meas.* 69, 493–525. doi: 10.1177/0013164408323233

Steele, J. P., and Fullagar, C. J. (2009). Facilitators and outcomes of student engagement in a college setting. *J. Psychol.* 143, 5–27. doi: 10.3200/JRLP.143.1.5-27

Susana, C., Mats, G., and Lena, A. (2015). The relationship between classroom quality-related variables and engagement levels in Swedish preschool classrooms: a longitudinal study. *Eur. Early Child. Educ. Res. J.* 25, 122–135. doi: 10.1080/1350293x.2015.1102413

VandenBos, G. R. (ed.) (2007). *). American Psychological Association Dictionary of Psychology*. Washington, DC: American Psychological Association.

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., McIntyre, R. S., et al. (2020). A longitudinal study on the mental health of general population during the COVID-19 epidemic in China. *Brain Behav. Immun.* 87, 40–48. doi: 10.1016/j.bbi.2020.04.028

Wang, C., and Zhao, H. (2020). The impact of COVID-19 on anxiety in Chinese university students. *Front. Psychol.* 11:1168. doi: 10.3389/fpsyg.2020.01168

Wu, Z., and McGoogan, J. M. (2020). Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) Outbreak in China summary of a report of 72 314 cases from the Chinese center for disease control and

prevention. *Jama J. Am. Med. Assoc.* 323, 1239–1242. doi: 10.1001/jama.2020.2648

Zhen, R., Liu, R.-D., Ding, Y., Wang, J., Liu, Y., and Xu, L. (2017). The mediating roles of academic self-efficacy and academic emotions in the relation between basic psychological needs satisfaction and learning engagement among Chinese adolescent students. *Learn. Indiv. Dif.* 54, 210–216. doi: 10.1016/j.lindif.2017.01.017

Zhou, F., Yu, T., Du, R., Fan, G., Liu, Y., Liu, Z., et al. (2020). Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *Lancet* 395, 1054–1062. doi: 10.1016/s0140-6736(20)30566-3

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A Longitudinal Study on Generalized Anxiety Among University Students During the First Wave of the COVID-19 Pandemic in Switzerland

Simone Amendola[1,2], Agnes von Wyl[1], Thomas Volken[3], Annina Zysset[3], Marion Huber[3] and Julia Dratva[3,4]*

[1] School of Applied Psychology, Zurich University of Applied Sciences, Zurich, Switzerland, [2] Department of Dynamic and Clinical Psychology, Faculty of Medicine and Psychology, Sapienza University of Rome, Rome, Italy, [3] School of Health Professions, Zurich University of Applied Sciences, Winterthur, Switzerland, [4] Medical Faculty, University of Basel, Basel, Switzerland

Objective: The COVID-19 pandemic and government measures implemented to counter the spread of the infection may be a major stressor affecting the psychological health of university students. This study aimed to explore how anxiety symptoms changed during the pandemic.

Methods: 676 students (76% females) at Zurich University of Applied Sciences participated in the first (T0) and second (T1) survey waves. Anxiety symptoms were assessed using the Generalized Anxiety Disorder-Scale-7 (GAD-7). Risk and protective factors (e.g., COVID-19-related variables) were examined.

Results: GAD-7 scores decreased significantly from T0 to T1 (mean change: −0.446, SE = 0.132, 95% CI: −0.706, −0.186, t = −3.371, df = 659, p = 0.001). Participants with moderate-to-severe anxiety score were 20.2 and 15.6% at T0 and T1, respectively. The following positively predicted anxiety: older age, female gender, non-Swiss nationality, loneliness, participants' concern about their own health, and interaction between time and participants' concern about their own health. Resilience and social support negatively predicted anxiety.

Conclusions: Our findings provide information for public health measures and psychological interventions supporting the mental health of university students during the COVID-19 emergency.

Keywords: anxiety, longitudinal, lockdown, coronavirus, COVID-19 pandemic, linear mixed model

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***Correspondence:**
Agnes von Wyl
agnes.vonwyl@zhaw.ch

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INTRODUCTION

On March 13, 2020, to contain the spread of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), which causes coronavirus disease 2019 (COVID-19), and protect the population, the Swiss government (Federal Council, 2020) canceled face-to-face educational activities, banned all events involving more than 100 people, decided to partially close its borders, and implemented border controls. The government subsequently banned non-essential retail commercial activities and gatherings of more than 5 people. Based on health monitoring of the

spread of COVID-19 within Switzerland, 1,103,149 tests for COVID-19 confirmed 44,592 cases from the beginning of the outbreak up to September 7, 2020. **Figure 1** shows the trend of the COVID-19 pandemic in Switzerland from February 25 to September 7, 2020. On April 3, there were 20,505 confirmed cases and 666 deaths due to COVID-19 in Switzerland. The cumulative number of cases and deaths over the previous week (i.e., from March 28 to April 3) were 6,429 and 366, respectively. On April 30, confirmed COVID-19 cases and deaths were 29,705 and 1,754, respectively. Confirmed COVID-19 cases and deaths over the previous week were 811 and 155, respectively (i.e., from April 23 to April 30).

Sudden or unexpected stressful and potentially dangerous natural events can cause an increase in mental distress in adults (McLaughlin et al., 2010). Previous studies showed increased levels of psychological distress (e.g., anxiety, anger) during isolation for Middle East Respiratory Syndrome (MERS) (Jeong et al., 2016) and during the outbreak of novel swine-origin influenza A (H1N1) (Jones and Salathé, 2009). Moreover, anxiety levels closely mirrored the daily number of new cases during the 2003 outbreak of severe acute respiratory syndrome (SARS) in Hong Kong (Leung et al., 2005).

The adaptive function of the normal anxiety response is to prepare the individual to detect and cope with threats or danger (Bateson et al., 2011). Genetic, psychosocial, and environmental factors influence the propensity and persistence of the anxiety response and the emergence of clinical anxiety (Hettema et al., 2005; Bergstrom and Meacham, 2016; Fullana et al., 2020; Zimmermann et al., 2020b). Stressful events represent an important risk factors for the emergence of anxiety symptoms and difficulties in regulating negative emotions (Anyan et al., 2017; Ding et al., 2020; Schneider et al., 2020). Furthermore, feelings of loneliness, intolerance of uncertainty, worry and fear generalization are related to symptoms of anxiety (Dar et al., 2017; Hamm, 2019; Lauriola et al., 2019; Stegmann et al., 2019; Danneel et al., 2020). Recent studies showed that 29 and 24% of the general population reported moderate-to-severe symptoms of anxiety during the initial outbreak of COVID-19 in China (Wang et al., 2020) and the United Kingdom (Fancourt et al., 2020), respectively. The percentages of moderate-to-severe anxiety in those countries were lower before the COVID-19 pandemic (Huang et al., 2019; Giebel et al., 2020). Importantly, recent findings raise concern for the mental health of university students. In Jordan, Naser et al. (2020) looked at depression and anxiety and observed a higher prevalence of anxiety among university students (38 and 21%, respectively) than among healthcare professionals (21 and 11%) and among university students than in the general population (16 and 9%). Naser et al. see a possible explanation for these results in students' major concerns about the impact of the pandemic on their university education and performance. An increase in symptoms of anxiety has also been registered among Chinese and Greek university students (Kaparounaki et al., 2020; Wang and Zhao, 2020).

Although the acute impact of the pandemic on students' psychological well-being has been confirmed in the literature, most of the available studies are cross-sectional. To date, few longitudinal studies have explored symptoms of anxiety among university students during the COVID-19 pandemic. Findings on changes in anxiety levels are mixed. One study (Li et al., 2020) observed a decrease in symptoms of anxiety and depression after 2 weeks of confinement measures to minimize spread of the coronavirus, whereas two studies (Elmer et al., 2020; Zimmermann et al., 2020a) indicated an increase in the severity of anxiety.

In light of the above, the first aim of the present study was to increase knowledge on the course of symptoms of anxiety in Swiss university students during the COVID-19 outbreak. This issue deserves more attention, as previous studies found close relationships between psychological distress, poor academic performance, and career outcomes (Tartas et al., 2011; Raskind et al., 2019). Moreover, symptoms of anxiety can lead to later adverse mental health outcomes and reduced quality of life (Fichter et al., 2010; Kasteenpohja et al., 2018). We hypothesized that anxiety symptoms in Swiss university students were higher when daily COVID-19 cases and deaths were constantly increasing (i.e., at T0) than when they were decreasing (i.e., at T1). The second aim of our study was to explore a wide range of individual and contextual factors to identify risk and protective factors in anxiety during the pandemic.

MATERIALS AND METHODS

Participants and Procedure

Students at the Zurich University of Applied Sciences (ZHAW) (N = 13,500) in Switzerland were invited to participate in a web survey exploring the impact of the COVID-19 pandemic on students' psychophysical health. In the present study, we report the results of the analysis of responses concerning impact on mental health by university students who participated at both the first (T0) and second (T1) wave (N = 676). The surveys lasted about 20–25 min and ran for a total of 7 working days (i.e., from April 3–14, 2020 for the first wave; from April 30 to May 11, 2020 for the second wave).

Methods and anxiety symptoms at baseline have been published in detail in Dratva et al. (2020). The study sample involved students (N = 2,429) from all ZHAW faculties despite students from the school of health professions and social work were slightly overrepresented (35 and 31% of the total sample at baseline, respectively) (Dratva et al., 2020). Furthermore, a total of 70% were female students and the median age was 25 years (interquartile range 23–28) (Dratva et al., 2020).

Participants' informed consent was obtained before starting the survey. Anonymity of participants was ensured by asking them to generate a personal code at the start of the web survey for the merging of follow-up survey data. The study was approved by both the local cantonal ethics committee (BASEC-Nr. Req-2020-00326) and the ZHAW data protection officer.

Measures

Sociodemographic and COVID-19-related variables. Participants provided sociodemographic information at T0, including age, gender, degree program (i.e., BSc or MSc), social status of parents at student age 16 years, and nationality.

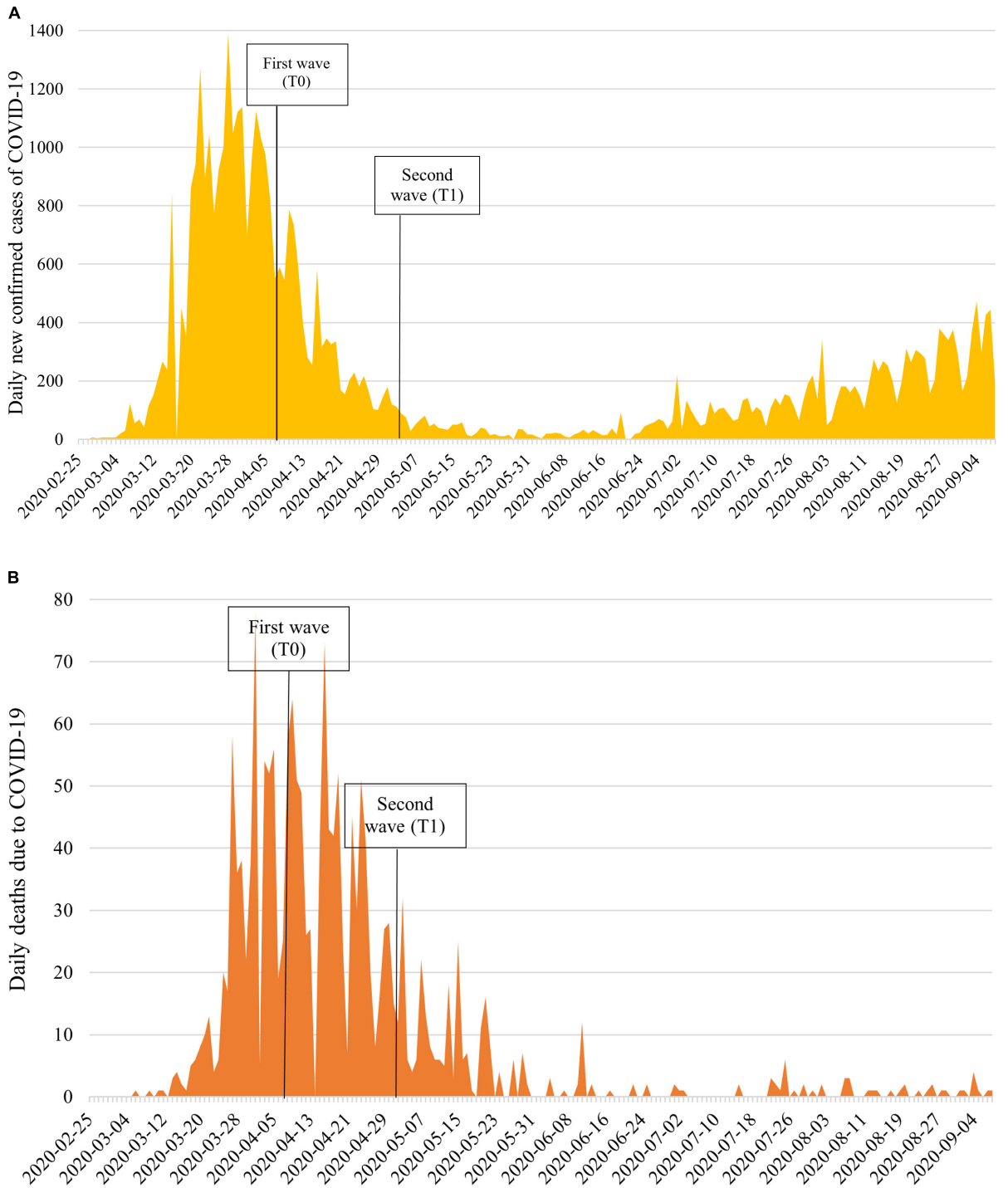

FIGURE 1 | National epidemic trend of the daily number of: **(A)** People testing positive for SARS-Cov-2, and **(B)** Deaths due to COVID-19 in Switzerland from February 25–September 7, 2020.

A set of questions on COVID-19 related concerns and students' life was partly specifically developed for this target group and their context and partly adapted from previous studies (Essadek and Rabeyron, 2020; Sotomo, 2020; Wathelet et al., 2020). The questions specifically designed for this study was developed by the authors representing researchers, lecturers and students. Five students of different faculties piloted the questionnaire reporting any technical and content issues.

Students were asked at T0 and T1 about the effects of the COVID-19 pandemic and the public health measures on their

student and everyday life. They were asked to agree or not agree with statements by responding on a 5-point Likert scale ranging from 1 (*completely disagree*) to 5 (*completely agree*). Students' worry about semester completion and a feeling of loneliness in everyday life were explored (i.e., "I am worried about my semester completion" and "I am lonely," respectively). Responses were then dichotomized as 0 (i.e., *I disagree completely, I tend to disagree, neutral or partially disagree and partially agree, not relevant*) and 1 (i.e., *I tend to agree, I completely agree*).

We assessed the concerns that students had about themselves or their family (parents, siblings, grandparents, their own child/child of partner, other relatives) in the context of COVID-19 at T0 and T1. Response options for the question, "Are you concerned about your own health in the context of the pandemic?" (and "Are you concerned about your [family member] health in the context of the pandemic?") were 1 (*I have no concerns*), 2 (*some concerns*), 3 (*big concerns*), and not relevant. A question about concerns about their family members' (omitting their child/child of partner) financial situation was also presented in the same manner. Responses were dichotomized as 0 (*I have no concern, I have some concerns, not relevant*) and 1 (*I have big concerns*) for concern for their own health, for significant others' health, and for family members' financial situation.

Finally, students' symptoms and testing for COVID-19 were assessed using the following statements with dichotomous response options (*no, yes*) at T0 and T1: "Have you had symptoms in the past 4 weeks that would be compatible with a COVID-19 infection? For example, cough (usually dry), sore throat, shortness of breath, and fever, muscle pain"; "Have you had a COVID-19 test in the past 4 weeks?"; "Have you tested positive for COVID-19?".

Alcohol and marijuana consumption (Hibell et al., 2009). Participants were asked about binge drinking behavior at T0, i.e., how many times (if any) they had drunk 5 or more units of alcohol on one occasion during the past 30 days [i.e., one unit is a glass of beer (about 0.5 L) or a glass of wine/sparkling wine (about 0.2 L) or a bottle of alcopop (about 0.33 L) or a glass of spirits (about 0.04 L)]. Participants responded on a 6-point Likert scale ranging from 1 (*never*) to 6 (*10 or more times*). The answer was dichotomized as 0 (*never*) and 1 (*at least once*).

Marijuana consumption in the past 30 days was also explored at T0 (adapted from Hibell et al., 2009). Participants responded on a 9-point Likert scale ranging from 1 (*I do not use it*) to 9 (*10 or more times*). The answer was dichotomized as 0 (*no use*) and 1 (*at least once*).

The *Oslo Social Support Scale* (OSSS-3) (Dalgard, 1996) is a short questionnaire to explore social support through three items on the number of close confidants, sense of concern or interest from other people, and relationship to neighbors (Kocalevent et al., 2018). High values represent strong levels of social support. In the present study, Cronbach's alpha was 0.53.

The *Brief Resilient Coping Scale* (BRCS) (Sinclair and Wallston, 2004) is a brief self-report questionnaire that assesses resilient coping conceptualized as the tendency to cope with stress in a highly adaptive manner. It comprises four items. Participants respond on a 5-point Likert scale (from 1 (*does not describes me at all*) to 5 (*describes me very well*). The total score varies between 4 to 20, with higher scores indicating higher resilience. In the present study, Cronbach's alpha was 0.59.

The *Generalized Anxiety Disorder-Scale-7* (GAD-7) (Spitzer et al., 2006) is a self-report questionnaire that explores the anxiety level as experienced by participants in the last 2 weeks. Anxiety symptoms were investigated at T0 and T1. The GAD-7 includes seven items to be rated on a 4-point Likert scale 0 (*not at all*) to 3 (*nearly every day*). The total score ranges from 0 to 21, with higher scores indicating higher levels of anxiety. Furthermore, the resulting score could be categorized into four levels of anxiety: minimal (0–4), mild (5–9), moderate (10–14) and severe (15–21). In the present study, Cronbach's alpha was 0.86 at T0 and 0.88 at T1.

Statistical Analyses

Descriptive statistics (i.e., frequencies, prevalence, mean, standard deviation) were applied to evaluate the characteristics of the sample. Univariate analysis of variance (ANOVA) and Chi-square test of independence were used to investigate differences according to gender. Cramer's V was used to express effect size in the latter analyses.

Mean-level stability was analyzed with paired samples T-tests and differential stability with Pearson correlations between baseline (T0) and follow-up (T1) anxiety scores. We used linear mixed models (LMMs) to examine changes in anxiety symptoms over time and the associations between anxiety and a set of time-constant covariates (i.e., predictors measured at baseline T0: age, gender, degree program, social status of parents, nationality, social support, resilient coping, binge drinking, marijuana use) as well as a set of time-varying covariates (i.e., measured at T0 and T1: worry about completing the semester, feeling of loneliness, concern for their own health, concern for family members' health, and concern for family members' financial situation, COVID-19 symptoms). The continuous outcome model included a random (subject−specific) intercept and an autoregressive model of order 1 for the residuals within participants using maximum likelihood estimates of parameters. All continuous predictor variables were mean-centered before they were entered into the LMMs.

Initially, all predictors of anxiety symptoms were fitted separately; in the final model, all measures were fitted jointly to determine the unique relevance of predictors after accounting for the influence of all other predictors. Estimated marginal mean scores and standard error were reported examining the significant effect of interaction terms.

All data were analyzed using SPSS Version 25. P values <0.05 were considered statistically significant.

RESULTS

Table 1 reports the sociodemographic, COVID-19-related, and psychosocial characteristics of the study population; 76% ($n = 514$) of the sample participants were women.

COVID-19-Related Factors

At T0, 18.9% ($n = 128$) of participants had symptoms in the past 4 weeks compatible with COVID-19 infection, 1.9% ($n = 13$)

TABLE 1 | Sample's characteristics at the first (T0) and second wave (T1).

	T0			T1		
Variable	**Total *n* (%)**	**Men *n* (%)**	**Women *n* (%)**	**Total *n* (%)**	**Men *n* (%)**	**Women *n* (%)**
Sociodemographic						
Age (M ± SD)	26.67 (5.83)	26.58 (4.29)	26.71 (6.24)	–	–	–
Pursued degree (Master's)	94 (13.9)	15 (9.3)	79 (15.4)	–	–	–
Parents' social status (M ± SD)	5.66 (1.55)	5.74 (1.48)	5.64 (1.57)	–	–	–
Nationality (Switzerland)	602 (93.9)	141 (95.9)	460 (93.3)	–	–	–
COVID-19-related						
Worry about completing semester[a]	308 (45.6)	69 (42.9)	238 (46.3)	415 (61.4)	86 (53.4)	328 (63.8)
Feeling lonely[b]	203 (30.0)	64 (40.0)	139 (27.6)	201 (29.7)	52 (32.7)	149 (29.2)
Health concern	16 (2.4)	1 (0.6)	15 (2.9)	15 (2.2)	2 (1.2)	13 (2.5)
Health concern for others [a,b]	300 (44.4)	51 (31.7)	249 (48.4)	251 (37.1)	40 (24.8)	211 (41.1)
Financial concern for others	125 (18.5)	22 (13.7)	103 (20.0)	94 (13.9)	17 (10.6)	77 (15.0)
Binge drinking[b]	146 (21.6)	55 (43.0)	91 (22.9)	–	–	–
Marijuana use	65 (9.6)	19 (12.8)	45 (9.0)	–	–	–
COVID-19 symptoms	128 (18.9)	26 (17.6)	102 (20.4)	60 (8.9)	9 (5.6)	51 (9.9)
COVID-19 test	13 (1.9)	3 (2)	9 (1.8)	11 (1.6)	0 (0)	11 (2.1)
COVID-19 positive test	2 (0.3)	0 (0)	2 (1.35)	1 (0.1)	–	1 (0.19)
Mental health						
OSSS-3 (M ± SD)	10.48 (1.82)	9.93 (1.79)	10.65 (1.80)	–	–	–
BRCS (M ± SD)	15.38 (2.24)	15.41 (2.02)	15.36 (2.30)	–	–	–
GAD-7 (M ± SD)	6.30 (4.30)	5.44 (4.07)	6.57 (4.35)	5.87 (4.39)	5.25 (4.08)	6.05 (4.47)

OSS-3, Oslo Social Support Scale; BRCS, Brief Resilient Coping Scale; GAD-7, Generalized Anxiety Disorder Scale.
[a] *Significant gender difference ($p < 0.05$) at T1.*
[b] *Significant gender difference ($p < 0.05$) at T0.*

had a COVID-19 test, and two participants tested positive for the disease. At T1, 8.9% ($n = 60$) of participants had symptoms in the past 4 weeks compatible with COVID-19 infection, 1.6% ($n = 11$) had a COVID-19 test, and one participant tested positive for the disease.

Regarding the effect of the COVID-19 pandemic on the students' academic life, almost half (45.6%, $n = 308$) of the sample felt worried about completing the semester at T0 and more than half (61.4%, $n = 415$) at T1. A significant gender difference was detected only at T1 ($\chi^2 = 5.59$, $df = 1$, $p = 0.018$, Cramer's V = 0.091). More women (63.8%, standardized residual = 0.7) reported worry about completing the semester than men (53.4%, standardized residual = −1.3). Furthermore, about a third (T0: 30%, $n = 203$; T1: 29.7%, $n = 201$) reported feeling lonely in everyday life, with gender difference only at T0 ($\chi^2 = 8.83$, $df = 1$, $p = 0.003$, Cramer's $V = 0.115$). More men (40.0%, standardized residual = 2.2) than women (27.6%, standardized residual = −1.2) experienced loneliness at baseline.

A small percentage (T0: 2.4%, $n = 16$; T1: 2.2%, $n = 15$) of the study population showed high concern for their own health. 44.4% ($n = 300$) and 37.1% ($n = 251$) of the students reported to be worried about the health of family members at T0 and T1, respectively. Health concern for family members was associated with gender at both T0 ($\chi^2 = 13.96$, $df = 1$, $p < 0.001$, Cramer's $V = 0.144$) and T1 ($\chi^2 = 13.78$, $df = 1$, $p < 0.001$, Cramer's $V = 0.143$). More women (T0: 48.4%, standardized residual = 1.4; T1: 41.1%, standardized residual = 1.4) than men (T0: 31.7%, standardized residual = −2.4; T1: 24.8%, standardized residual = −2.6) were worried about the health of family members.

Furthermore, 18.5% ($n = 125$) and 13.9% ($n = 94$) of the students reported being worried about the financial situation of family members at T0 and T1, respectively.

Binge drinking and marijuana consumption (i.e., at least on one occasion) was reported by 21.6 and 9.6% of the students, respectively, during the past month at T0. Only binge drinking was associated with gender ($\chi^2 = 19.52$, $df = 1$, $p < 0.001$, Cramer's $V = 0.193$). More men (43%, standardized residual = 3.3) than women (22.9%, standardized residual = −1.9) showed binge drinking behavior.

Symptoms of Anxiety: Risk and Protective Factors

Table 2 shows the prevalence of anxiety levels according to cut-off scores provided by the authors of the GAD-7. Participants with moderate-to-severe anxiety score decreased from 20.2% ($n = 133$) to 15.6% ($n = 104$) over the 1-month period.

Mean-level stability of anxiety scores across the first (T0) and second wave (T1) was very high (Cohen's $d = 0.10$), and differential stability was high ($r = 0.697$, $p < 0.001$).

Nearly all factors were found to individually predict symptoms of anxiety when fitted separately, except for pursued degree, binge drinking and marijuana use during the past 30 days, and having had symptoms compatible with COVID-19 infection (**Table 3**, Model 1). A significant effect of time was found for anxiety

TABLE 2 | Prevalence of anxiety levels at the first (T0) and second wave (T1).

	T0			T1		
Anxiety level	**Total *n* (%)**	**Men *n* (%)**	**Women *n* (%)**	**Total *n* (%)**	**Men *n* (%)**	**Women *n* (%)**
Minimal	264 (40.2)	75 (49.0)	189 (37.5)	309 (46.1)	84 (52.8)	225 (44.1)
Mild	260 (39.6)	54 (35.3)	206 (40.9)	257 (38.4)	58 (36.5)	199 (39.0)
Moderate	98 (14.9)	18 (11.8)	80 (15.9)	60 (9.0)	9 (5.7)	50 (9.8)
Severe	35 (5.3)	6 (3.9)	29 (5.8)	44 (6.6)	8 (5.0)	36 (7.1)

18 and 6 participants missed the first and second wave, respectively.

TABLE 3 | Estimated fixed effects of individual and contextual predictors of anxiety symptoms.

Variable	**Model 1: all fitted separately**			**Model 2: all fitted jointly**		
	β (SE)	**95% CI**	***p*-value**	**β (SE)**	**95% CI**	***p*-value**
Time	−0.446 (0.132)	−0.706, −0.186	0.001	−0.987 (0.635)	−2.236, 0.262	0.121
Sociodemographic						
Age	0.064 (0.026)	0.012, 0.115	0.016	0.076 (0.025)	0.027, 0.125	0.003
Gender (male)	−0.972 (0.361)	−1.681, −0.264	0.007	−1.048 (0.345)	−1.726, −0.369	0.003
Pursued degree (Master's)	−0.217 (0.445)	−1.090, 0.656	0.626	−0.635 (0.425)	−1.470, 0.200	0.136
Parents' social status	−0.348 (0.101)	−0.548, −0.150	0.001	−0.186 (0.097)	−0.375, 0.004	0.055
Nationality (other than Swiss)	1.616 (0.654)	0.331, 2.900	0.014	1.531 (0.605)	0.343, 2.719	0.012
Psychosocial						
Social support	−0.468 (0.085)	−0.635, −0.301	<0.001	−0.299 (0.083)	−0.463, −0.136	<0.001
Resilient coping	−0.574 (0.067)	−0.705, −0.444	<0.001	−0.373 (0.066)	−0.503, −0.242	<0.001
COVID-19-related						
Worry about completing semester	−0.443 (0.196)	−0.826, −0.059	0.024	−0.374 (0.539)	−1.433, 0.685	0.488
Feeling lonely	1.967 (0.229)	1.517, 2.416	<0.001	1.658 (0.576)	0.527, 2.788	0.004
Health concern	3.170 (0.674)	1.847, 4.493	<0.001	−5.139 (1.996)	−9.058, −1.221	0.010
Health concern for others	1.199 (0.212)	0.782, 1.615	<0.001	0.881 (0.542)	−0.183, 1.944	0.104
Financial concern for others	1.734 (0.303)	1.139, 2.329	<0.001	0.781 (0.674)	−0.543, 2.105	0.247
Binge drinking	0.289 (0.381)	−0.460, 1.038	0.449	0.589 (0.329)	−0.057, 1.236	0.074
Marijuana use	0.661 (0.526)	−0.372, 1.694	0.209	0.352 (0.469)	−0.569, 1.274	0.453
COVID-19 symptoms	0.185 (0.286)	−0.377, 0.747	0.518	−0.416 (0.712)	−1.815, 0.983	0.559
Interactions						
Time * Worry about completing semester	0.272 (0.314)	−0.343, 0.888	0.385	0.251 (0.336)	−0.409, 0.910	0.456
Time * Feeling lonely	0.126 (0.330)	−0.522, 0.773	0.703	0.145 (0.351)	−0.544, 0.833	0.680
Time * Health concern	4.095 (1.015)	2.103, 6.087	<0.001	5.044 (1.267)	2.557, 7.532	<0.001
Time * Health concern for others	0.058 (0.303)	−0.537, 0.652	0.849	−0.056 (0.336)	−0.715, 0.603	0.868
Time * Financial concern for others	−0.124 (0.394)	−0.899, 0.650	0.754	0.335 (0.428)	−0.506, 1.176	0.435
Time * COVID-19 symptoms	0.176 (0.466)	−0.738, 1.091	0.705	0.459 (0.505)	−0.534, 1.452	0.364

SE, standard error; CI, confidence interval.

symptom severity. GAD-7 scores decreased significantly from T0 to T1 (mean change: −0.446, SE = 0.132, 95% CI of the difference: −0.706, −0.186, $t = -3.371$, $df = 659$, $p = 0.001$). Furthermore, the interaction effect of Time * participants' Health concern for their own health was statistically significant. Specifically, **Figure 2A** shows that symptoms of anxiety were stable or decreased slightly in participants with no or some concern about their own health over the 1-month period (M = 6.27, SE = 0.17 at T0; M = 5.75, SE = 0.17 at T1), whereas symptoms of participants who reported high health concern increased (M = 7.49, SE = 0.81 at T0; M = 11.06, SE = 0.86 at T1).

When all factors were then jointly modeled (**Table 3**, Model 2), the effect of time, social status of parents, worry about completing the semester, and participants' health and financial concerns for family members on anxiety symptoms became statistically non-significant. However, social status ($p = 0.055$) and binge drinking ($p = 0.074$) were borderline significant (Bland, 2015), indicating that a higher social status of parents at student age 16 years was associated with lower anxiety scores and that binge drinking was associated with higher anxiety scores. An older age, female gender, nationality other than Swiss, feeling of loneliness, and participants' concern for their own health significantly predicted higher symptoms of anxiety. On the other hand, resilient coping and social support were protective factors for symptoms of anxiety. Finally, the interaction effect of Time * participants' Health concern for their own health remained

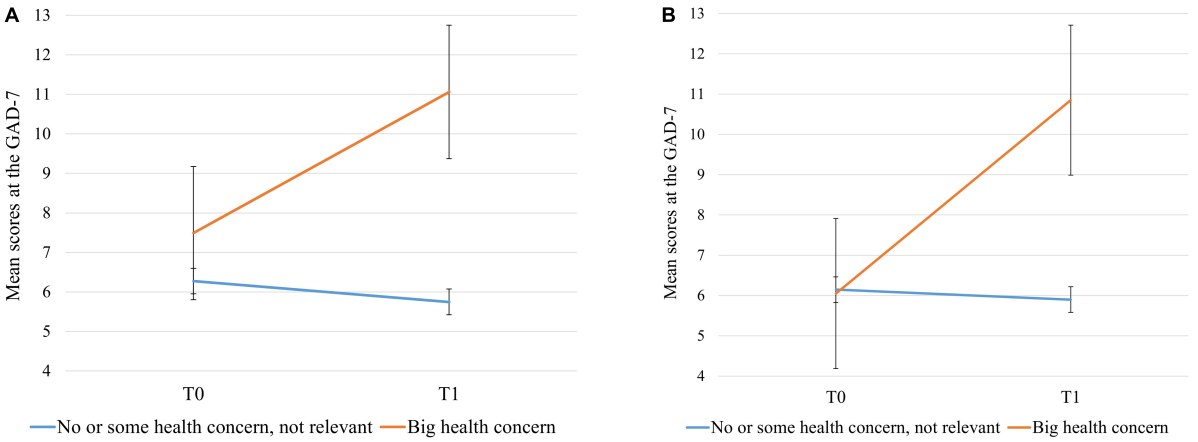

FIGURE 2 | Estimated marginal mean scores at the Generalized Anxiety Scale - 7 as predicted by the interaction term Time * participant's Concern for their own health in: **(A)** Unadjusted Model 1, and **(B)** Adjusted Model 2. Error bars represent the 95% confidence intervals.

statistically significant. Namely, symptoms of anxiety were stable in participants with no or some concern for their own health over the 1-month period (M = 6.15, SE = 0.16 at T0; M = 5.90, SE = 0.16 at T1) and increased in participants with high health concern (M = 6.05, SE = 0.95 at T0; M = 11.85, SE = 1.01 at T1) (**Figure 2B**).

DISCUSSION

Our study, to our knowledge one of few longitudinal studies on anxiety in university students during the COVID-19 pandemic, indicates a decrease in anxiety symptoms with time and decreasing population infection rates. However, we see heterogenous trends in individuals' concern for their own heath in the pandemic.

In the first wave, considering the GAD-7 cut-off, 20.2% of students reported moderate-to-severe anxiety. This result is in line with previous studies (Chi et al., 2020; Naser et al., 2020; Perz et al., 2020; Savitsky et al., 2020; Wang and Zhao, 2020; Zhang et al., 2020) that found high levels of symptoms of anxiety among university students during the COVID-19 pandemic. The prevalence of moderate-to-severe anxiety among our sample of participants decreased to 15.6% at the second wave (i.e., after 1 month).

The findings of this present study reveal a significant effect of time on anxiety symptom severity. Anxiety symptoms decreased 0.45 points according to the GAD-7 mean scores between the first and second wave, which supports our first hypothesis. This finding is consistent with that of a study conducted in China (Li et al., 2020). However, two studies observed an increase in symptoms of anxiety (Elmer et al., 2020; Zimmermann et al., 2020a). The differences in the studies' results could be explained by the timing of the data collection periods and the respective trends of the COVID-19 infection. In particular, Elmer et al. (2020) observed an increase of anxiety during the COVID-19 emergency (i.e., April 2020) compared to pre-emergency levels (i.e., April and September 2019). Zimmermann et al. (2020a) found an increase in anxiety symptoms simultaneously with a consistent daily increase in the number of new infections and deaths from COVID-19 in the United States. In contrast, Li et al. (2020) as well as the present study found a decrease in anxiety symptoms that corresponds with a decline in the number of the newly infected and the number of deaths. These results are in line with the prediction that if the probability of incurring threats to survival increases (i.e., spread of the COVID-19 infection), the severity of anxiety symptoms increases (Bateson et al., 2011).

Importantly, mean GAD-7 scores (at both T0 and T1) among our sample of participants as well as in another Swiss sample (Elmer et al., 2020) were lower than those observed in other two studies using the same measure of anxiety among university and college students during the COVID-19 pandemic (Liu et al., 2020; Perz et al., 2020; Savitsky et al., 2020; Zimmermann et al., 2020a). Biological, psychological, and cultural factors influence the phenomenological presentation and clinical severity of anxiety (Kirmayer et al., 1995; Hettema et al., 2005; Heinrichs et al., 2006; Bergstrom and Meacham, 2016; Fullana et al., 2020; Zimmermann et al., 2020b). The difference in GAD-7 mean scores outlined here may also be related to the country-specific quarantine measures. Cross-cultural studies are needed to further examine this important issue, with its implications for public health measures and health.

From a broader mental health perspective, it would be highly informative to compare our findings with those observed among samples of participants of other countries that were similarly affected by the COVID-19 pandemic. This comparison would improve our understanding of the link between the spread and consequences of the infection in the territory and the changes in psychological health of the population. Findings of a recent study showed that Austria, Switzerland and Portugal experienced a similar low effect of the pandemic on overall deaths between January and May 2020 while a medium-to-high effect was shown for France, Netherlands, Sweden (medium effect), Belgium, Italy, Scotland, Spain, England and Wales (high effect) (Kontis et al., 2020). To date, however, longitudinal studies exploring changes

in symptoms of anxiety or mental health among students or general populations are lacking both in Austria and Portugal.

Linear mixed model analysis highlighted different personal and contextual factors associated with the severity of anxiety symptoms during the spread of COVID-19 in Switzerland. Regarding sociodemographic factors, in line with the findings of Li et al.'s (2020) study, we found that an older age was positively associated with symptoms of anxiety among Swiss university students. However, in contrast to the results highlighted by Li et al., we did not observe an effect of the type of the university degree program attended (i.e., Bachelor's or Master's degree program) on symptoms of anxiety. A possible explanation for our finding is that older university students may be more concerned that the outbreak could delay their academic career and entry into the labor market or negatively affect their own financial situation, regardless the type of the degree pursued. Elmer et al. (2020) found that students' worries about their own future career positively predicted anxiety symptoms.

Female gender was also associated with a higher risk of anxiety. This result is in line with some previous studies conducted during the COVID-19 pandemic (Elmer et al., 2020; Naser et al., 2020; Wang and Zhao, 2020), although other studies did not find a gender effect on anxiety (Cao et al., 2020; Li et al., 2020; Zimmermann et al., 2020a). In particular, women compared to men are more likely to suffer from anxiety due to differences in risk and protective factors and in clinical presentation (Toufexis et al., 2006; Baxter et al., 2013; Christiansen, 2015).

University students of non-Swiss nationality (e.g., international students, students whose parents do not have Swiss citizenship) were also at increased risk of anxiety during the pandemic. However, Savitsky et al. (2020) did not find evidence for this association. One possible explanation for our finding is that non-Swiss students are not together with their family and other close people who can provide security and support. A second possible reason is related to the concepts of familiarity and "non-territory" (Price, 2003). International students, currently living away from home, may perceive greater insecurity that is linked to the unfamiliarity of the surrounding environment. Finally, some students probably had concerns about relatives living in countries with a high incidence of COVID-19 cases and deaths. Our finding suggests that the impact of the COVID-19 emergency on the mental health of students of non-Swiss nationality (e.g., international students) should be monitored and addressed, and it requires additional research.

In this study, COVID-19-related factors, namely, participants' concern for the health and financial situation of family members or friends (in the unadjusted model), feeling of loneliness, and concern for their own health (in the final adjusted model), predicted higher symptoms of anxiety among Swiss university students during the pandemic. Moreover, participants who reported high concern for their own health at T0 scored higher on anxiety at T1 compared to participants who were not worried about their own health. These findings are in line with previous studies (McIntyre et al., 2018; Cao et al., 2020; Li et al., 2020; Liu et al., 2020; Naser et al., 2020). Students were more worried about the health of family members than about their own health, as has been previously suggested (Maaravi and Heller, 2020). Further, students' worry about the health of family members was higher than their concern about family members' financial situation. Our findings have clinical implications; treatment of students' anxiety should consider the role of the pandemic-related concern about health and finances in predicting the severity of anxiety symptoms.

Finally, social support and resilient coping negatively predicted university students' symptoms of anxiety. These findings are consistent with previous studies (Cao et al., 2020; Chi et al., 2020; Liu et al., 2020) and have implications for public health measures during states of emergency. Interventions should be implemented to boost the ability of university students to face stressful situations in an adaptive manner as well as to provide them with social support. It is best to implement the interventions before a crisis occurs, in the sense of preventive measures. As public health and safety measures during pandemics might limit personal meetings with professionals, it is important to ensure that students have the possibility and the infrastructures to take advantage of counseling or psychotherapy interventions.

The findings of this study should be interpreted while keeping some limitations in mind. The use of self-report measures could have increased the risk of social desirability response bias affecting the results. At the same time, the decrease in symptoms of anxiety could be due in part to repeated administration of the self-report measure. Finally, an imbalance between the number of men and women participating in this study was present. Gender imbalance is not uncommon in questionnaire studies. A possible explanation is related to an "interest" bias: students from ZHAW faculties with a high percentage of women (Health Sciences, Psychology and Economics faculties) who were potentially more interested in health-related subjects were more likely to participate (lower response rates from students of Engineering, Life Sciences, Facility Management faculties). Therefore, there are some limitations in the generalizability of the results to the entire ZHAW student population. Further caution must be taken regarding the generalizability of our findings to the broader population of Swiss university students.

Despite these limitations, our study demonstrates the change in symptoms of anxiety and contributes new evidence on the role of individual and contextual factors in predicting anxiety over a 1-month period during the COVID-19 pandemic. These findings can be used to inform both public health measures and psychological treatment supporting psychological well-being of university students during public health emergencies.

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 Local Cantonal Ethics Committee

(BASEC-Nr. Req-2020-00326) and ZHAW data protection officer. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

SA, AW, TV, AZ, MH, and JD contributed to the conceptualization of the study. SA analyzed the data with TV's support and wrote the original draft of the manuscript. All authors discussed the results and commented on the manuscript approving its final version.

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REFERENCES

Anyan, F., Worsley, L., and Hjemdal, O. (2017). Anxiety symptoms mediate the relationship between exposure to stressful negative life events and depressive symptoms: a conditional process modelling of the protective effects of resilience. *Asian J. Psychiatr.* 29, 41–48. doi: 10.1016/j.ajp.2017.04.019

Bateson, M., Brilot, B., and Nettle, D. (2011). Anxiety: an evolutionary approach. *Can. J. Psychiatry* 56, 707–715. doi: 10.1177/070674371105601202

Baxter, A. J., Scott, K. M., Vos, T., and Whiteford, H. A. (2013). Global prevalence of anxiety disorders: a systematic review and meta-regression. *Psychol. Med.* 43, 897–910. doi: 10.1017/S003329171200147X

Bergstrom, C. T., and Meacham, F. (2016). Depression and anxiety: maladaptive byproducts of adaptive mechanisms. *Evol. Med. Public Health* 1, 214–218. doi: 10.1093/emph/eow019

Bland, M. (2015). *An Introduction to Medical Statistics*, 4th Edn. Oxford: Oxford University Press.

Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., et al. (2020). The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Res.* 287:112934. doi: 10.1016/j.psychres.2020.112934

Chi, X., Becker, B., Yu, Q., Willeit, P., Jiao, C., Huang, L., et al. (2020). Prevalence and psychosocial correlates of mental health outcomes among Chinese college students during the coronavirus disease (COVID-19) pandemic. *Front. Psychiatry* 11:803. doi: 10.3389/fpsyt.2020.00803

Christiansen, D. M. (2015). "Examining sex and gender differences in anxiety disorders," in *A Fresh Look at Anxiety Disorders*, ed. F. Durbano (Rijeka: InTech).

Dalgard, O. S. (1996). "Community health profile as tool for psychiatric prevention," in *Promotion of Mental Health*, Vol. 5, eds D. R. Trent and C. Reed (Aldershot: Avebury).

Danneel, S., Geukens, F., Maes, M., Bastin, M., Bijttebier, P., Colpin, H., et al. (2020). Loneliness, social anxiety symptoms, and depressive symptoms in adolescence: longitudinal distinctiveness and correlated change. *J. Youth Adolesc.* 49, 2246–2264. doi: 10.1007/s10964-020-01315-w

Dar, K. A., Iqbal, N., and Mushtaq, A. (2017). Intolerance of uncertainty, depression, and anxiety: examining the indirect and moderating effects of worry. *Asian J. Psychiatr.* 29, 129–133. doi: 10.1016/j.ajp.2017.04.017

Ding, Y., Xu, J., Huang, S., Li, P., Lu, C., and Xie, S. (2020). Risk perception and depression in public health crises: evidence from the COVID-19 crisis in China. *Int. J. Environ. Res. Public Health* 17:5728. doi: 10.3390/ijerph17165728

Dratva, J., Zysset, A., Schlatter, N., von Wyl, A., Huber, M., and Volken, T. (2020). Swiss university students' risk perception and general anxiety during the COVID-19 pandemic. *Int. J. Environ. Res. Public Health* 17:7433. doi: 10.3390/ijerph17207433

Elmer, T., Mepham, K., and Stadtfeld, C. (2020). Students under lockdown: comparisons of students' social networks and mental health before and during the COVID-19 crisis in Switzerland. *PLoS One* 15:e0236337. doi: 10.1371/journal.pone.0236337

Essadek, A., and Rabeyron, T. (2020). Mental health of French students during the Covid-19 pandemic. *J. Affect. Disord.* 277, 392–393. doi: 10.1016/j.jad.2020.08.042

Fancourt, D., Steptoe, A., and Bu, F. (2020). Trajectories of depression and anxiety during enforced isolation due to COVID-19: longitudinal analyses of 59,318 adults in the UK with and without diagnosed mental illness. *medRxiv* [Preprint]. doi: 10.1101/2020.06.03.20120923

Federal Council (2020). *Bundesrat Verschärft Massnahmen gegen das Coronavirus zum Schutz der Gesundheit und unterstützt betroffene Branchen*. Available online at: https://www.admin.ch/gov/de/start/dokumentation/medienmitteilungen.msg-id-78437.html (accessed 31 July 2020).

Fichter, M. M., Quadflieg, N., Fischer, U. C., and Kohlboeck, G. (2010). Twenty-five-year course and outcome in anxiety and depression in the Upper Bavarian Longitudinal Community Study. *Acta Psychiatr. Scand.* 122, 75–85. doi: 10.1111/j.1600-0447.2009.01512.x

Fullana, M. A., Tortella-Feliu, M., Fernández de la Cruz, L., Chamorro, J., Perez-Vigil, A., Ioannidis, J. P. A., et al. (2020). Risk and protective factors for anxiety and obsessive-compulsive disorders: an umbrella review of systematic reviews and meta-analyses. *Psychol. Med.* 50, 1300–1315. doi: 10.1017/S0033291719001247

Giebel, C., Corcoran, R., Goodall, M., Campbell, N., Gabbay, M., Daras, K., et al. (2020). Do people living in disadvantaged circumstances receive different mental health treatments than those from less disadvantaged backgrounds? *BMC Public Health* 20:651. doi: 10.1186/s12889-020-08820-4

Hamm, A. O. (2019). Fear, anxiety, and their disorders from the perspective of psychophysiology. *Psychophysiology* 57:e13474. doi: 10.1111/psyp.13474

Heinrichs, N., Rapee, R. M., Alden, L. A., Bogels, S., Hofmann, S. G., Oh, K. J., et al. (2006). Cultural differences in perceived social norms and social anxiety. *Behav. Res. Ther.* 44, 1187–1197. doi: 10.1016/j.brat.2005.09.006

Hettema, J. M., Prescott, C. A., Myers, J. M., Neale, M. C., and Kendler, K. S. (2005). The structure of genetic and environmental risk factors for anxiety disorders in men and women. *Arch. Gen. Psychiatry* 62, 182–189. doi: 10.1001/archpsyc.62.2.182

Hibell, B., Guttormsson, U., Ahlström, S., Balakireva, O., Bjarnason, T., Kokkevi, A., et al. (2009). *The 2007 ESPAD Report. Substance Use among Students in 35 European Countries*. Stockholm: European School Survey Project on Alcohol and Other Drugs.

Huang, Y., Wang, Y. U., Wang, H., Liu, Z., Yu, X., Yan, J., et al. (2019). Prevalence of mental disorders in China: a cross-sectional epidemiological study. *Lancet Psychiatry* 6, 211–224. doi: 10.1016/S2215-0366(19)30128-2

Jeong, H., Yim, H. W., Song, Y. J., Ki, M., Min, J. A., Cho, J., et al. (2016). Mental health status of people isolated due to Middle East Respiratory Syndrome. *Epidemiol. Health* 38:e2016048. doi: 10.4178/epih.e2016048

Jones, J. H., and Salathé, M. (2009). Early assessment of anxiety and behavioral response to novel swine-origin influenza A(H1N1). *PLoS One* 4:e8032. doi: 10.1371/journal.pone.0008032

Kaparounaki, C. K., Patsali, M. E., Mousa, D. P. V., Papadopoulou, E. V. K., Papadopoulou, K. K. K., and Fountoulakis, K. N. (2020). University students' mental health amidst the COVID-19 quarantine in Greece. *Psychiatry Res.* 290:113111. doi: 10.1016/j.psychres.2020.113111

Kasteenpohja, T., Marttunen, M., Aalto-Setälä, T., Perälä, J., Saarni, S. I., and Suvisaari, J. (2018). Outcome of depressive and anxiety disorders among young adults: results from the Longitudinal Finnish Health 2011 Study. *Nord. J. Psychiatry* 72, 205–213. doi: 10.1080/08039488.2017.1418429

Kirmayer, L. J., Young, A., and Hayton, B. C. (1995). The cultural context of anxiety disorders. *Psychiatr. Clin. North Am.* 18, 503–521. doi: 10.1016/S0193-953X(18)30037-6

Kocalevent, R. D., Berg, L., Beutel, M. E., Hinz, A., Zenger, M., Harter, M., et al. (2018). Social support in the general population: standardization of the Oslo social support scale (OSSS-3). *BMC Psychol.* 6:31. doi: 10.1186/s40359-018-0249-9

Kontis, V., Bennett, J. E., Rashid, T., Parks, R. M., Pearson-Stuttard, J., Guillot, M., et al. (2020). Magnitude, demographics and dynamics of the effect of the first wave of the COVID-19 pandemic on all-cause mortality in 21 industrialized countries. *Nat. Med.* 26, 1919–1928. doi: 10.1038/s41591-020-1112-0

Lauriola, M., Carleton, R. N., Tempesta, D., Calanna, P., Socci, V., Mosca, O., et al. (2019). A correlational analysis of the relationships among intolerance of uncertainty, anxiety sensitivity, subjective sleep quality, and insomnia symptoms. *Int. J. Environ. Res. Public Health* 16:3253. doi: 10.3390/ijerph16183253

Leung, G. M., Ho, L. M., Chan, S. K. K., Ho, S. Y., Bacon-Shone, J., Choy, R. Y. L., et al. (2005). Longitudinal assessment of community psychobehavioral responses during and after the 2003 outbreak of severe acute respiratory syndrome in Hong Kong. *Clin. Infect. Dis.* 40, 1713–1720. doi: 10.1086/429923

Li, H. Y., Cao, H., Leung, D. Y. P., and Mak, Y. W. (2020). The psychological impacts of a COVID-19 outbreak on college students in China: a longitudinal study. *Int. J. Environ. Res. Public Health* 17:3933. doi: 10.3390/ijerph17113933

Liu, C. H., Zhang, E., Wong, G. T. F., Hyun, S., and Hahm, H. C. (2020). Factors associated with depression, anxiety, and PTSD symptomatology during the COVID-19 pandemic: clinical implications for U.S. *young adult mental health*. *Psychiatry Res.* 290:113172. doi: 10.1016/j.psychres.2020.113172

Maaravi, Y., and Heller, B. (2020). Not all worries were created equal: the case of COVID-19 anxiety. *Public Health* 185, 243–245. doi: 10.1016/j.puhe.2020.06.032

McIntyre, J. C., Worsley, J., Corcoran, R., Woods, P. H., and Bentall, R. P. (2018). Academic and non-academic predictors of student psychological distress: the role of social identity and loneliness. *J. Ment. Health* 27, 230–239. doi: 10.1080/09638237.2018.1437608

McLaughlin, K. A., Conron, K. J., Koenen, K. C., and Gilman, S. E. (2010). Childhood adversity, adult stressful life events, and risk of past-year psychiatric disorder: a test of the stress sensitization hypothesis in a population-based sample of adults. *Psychol. Med.* 40, 1647–1658. doi: 10.1017/S0033291709992121

Naser, A. Y., Dahmash, E. Z., Al-Rousan, R., Alwafi, H., Alrawashdeh, H. M., Ghoul, I., et al. (2020)). Mental health status of the general population, healthcare professionals, and university students during 2019 coronavirus disease outbreak in Jordan: a cross−sectional study. *Brain Behav.* 10:e01730. doi: 10.1002/brb3.1730

Perz, C. A., Lang, B. A., and Harrington, R. (2020). Validation of the Fear of COVID-19 Scale in a US college Sample. *Int. J. Ment. Health Addict.* doi: 10.1007/s11469-020-00356-3 [Epub ahead of print].

Price, J. S. (2003). Evolutionary aspects of anxiety disorders. *Dialogues Clin. Neurosci.* 5, 223–236.

Raskind, I. G., Haardörfer, R., and Berg, C. J. (2019). Food insecurity, psychosocial health and academic performance among college and university students in Georgia, USA. *Public Health Nutr.* 22, 476–485. doi: 10.1017/S1368980018003439

Savitsky, B., Findling, Y., Ereli, A., and Hendel, T. (2020). Anxiety and coping strategies among nursing students during the Covid-19 pandemic. *Nurse Educ. Pract.* 46:102809. doi: 10.1016/j.nepr.2020.102809

Schneider, R. L., Long, E. E., Arch, J. J., and Hankin, B. L. (2020). The relationship between stressful events, emotion dysregulation, and anxiety symptoms among youth: longitudinal support for stress causation but not stress generation. *Anxiety Stress Coping* 6, 1–16. doi: 10.1080/10615806.2020.1839730

Sinclair, V. G., and Wallston, K. A. (2004). The development and psychometric evaluation of the Brief Resilient Coping Scale. *Assessment* 11, 94–101. doi: 10.1177/1073191103258144

Sotomo. Corona-Krise: Monitoring der Bevölkerung 24/03/20 (2020). Available online at: https://sotomo.ch/site/corona-krise-monitoring-der-bevoelkerung/ (accessed October 12, 2020).

Spitzer, R. L., Kroenke, K., Williams, J. B. W., and Löwe, B. (2006). A brief measure for assessing generalized anxiety disorder: the GAD-7. *Arch. Intern. Med.* 166:1092. doi: 10.1001/archinte.166.10.1092

Stegmann, Y., Schiele, M. A., Schümann, D., Lonsdorf, T. B., Zwanzger, P., Romanos, M., et al. (2019). Individual differences in human fear generalization-pattern identification and implications for anxiety disorders. *Transl. Psychiatry* 9, 1–11. doi: 10.1038/s41398-019-0646-8

Tartas, M., Walkiewicz, M., Majkowicz, M., and Budzinski, W. (2011). Psychological factors determining success in a medical career: a 10-year longitudinal study. *Med. Teach.* 33:e163-72. doi: 10.3109/0142159X.2011.544795

Toufexis, D. J., Myers, K. M., and Davis, M. (2006). The effect of gonadal hormones and gender on anxiety and emotional learning. *Horm. Behav.* 50, 539–549. doi: 10.1016/j.yhbeh.2006.06.020

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., McIntyre, R. S., et al. (2020). A longitudinal study on the mental health of general population during the COVID-19 epidemic in China. *Brain Behav. Immun.* 87, 40–48. doi: 10.1016/j.bbi.2020.04.028

Wang, C., and Zhao, H. (2020). The impact of COVID-19 on anxiety in Chinese university students. *Front. Psychol.* 11:1168. doi: 10.3389/fpsyg.2020.01168

Wathelet, M., Duhem, S., Vaiva, G., Baubet, T., Habran, E., Veerapa, E., et al. (2020). Factors associated with mental health disorders among university students in france confined during the COVID-19 pandemic. *JAMA Netw. Open* 3:e2025591. doi: 10.1001/jamanetworkopen.2020.25591

Zhang, Y., Zhang, H., Ma, X., and Di, Q. (2020). Mental health problems during the COVID-19 pandemics and the mitigation effects of exercise: a longitudinal study of college students in China. *Int. J. Environ. Res. Public Health* 17:3722. doi: 10.3390/ijerph17103722

Zimmermann, M., Bledsoe, C., and Papa, A. (2020a). The impact of the COVID-19 pandemic on college student mental health: a longitudinal examination of risk and protective factors. *PsyArXiv* [Preprint]. doi: 10.31234/osf.io/2y7hu

Zimmermann, M., Chong, A. K., Vechiu, C., and Papa, A. (2020b). Modifiable risk and protective factors for anxiety disorders among adults: a systematic review. *Psychiatry Res.* 285:112705. doi: 10.1016/j.psychres.2019.112705

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Perceived Stress and Coping Strategies Among Undergraduate Health Science Students of Jimma University Amid the COVID-19 Outbreak: Online Cross-Sectional Survey

Mengist Awoke[1*†], *Girma Mamo*[1†], *Samuel Abdu*[2†] *and Behailu Terefe*[1†]

[1] Department of Clinical Pharmacy, Faculty of Health Science, School of Pharmacy, Institute of Health, Jimma University, Jimma, Ethiopia, [2] Faculty of Health Science, School of Nursing, Institute of Health, Jimma University, Jimma, Ethiopia

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Valentina Lucia La Rosa, University of Catania, Italy

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***Correspondence:**
Mengist Awoke
mengist93@gmail.com

†ORCID:
Mengist Awoke
orcid.org/0000-0002-1140-433X
Girma Mamo
orcid.org/0000-0002-1757-8250
Behailu Terefe
orcid.org/0000-0002-4512-2111
Samuel Abdu
orcid.org/s0000-0002-1962-0360

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Background: The rapid spread of COVID-19 infection has led countries across the globe to take various measures to contain the outbreak, including the closure of Universities. Forcing University students to stay at home has created enormous stress and uncertainty in their daily life.

Objective: This study aimed to assess the perceived stress and coping strategies among undergraduate health science students of Jimma University amid the COVID-19 outbreak.

Materials and methods: An online cross-sectional survey was conducted involving 337 undergraduate health science students from August to September 5, 2020. The perceived stress scale (PSS)-10 and Brief-COPE scale were used to assess the level of stress and coping strategies, respectively. Statistical Package for Social Science (SPSS) Version 22 was employed for data analysis. Logistic regression was conducted to identify predictors of high perceived stress.

Results: The overall mean [±standard deviation (SD)] age of the participants was 22.88 (±1.78) years. The mean (±SD) PSS score was 22.16 (±1.41), and high perceived stress was reported in 121 (35.9%) participants. The overall mean (±SD) coping score was 72.34 (±12.31), and approach coping was the predominantly used strategy for coping with stress. Personal perception of being stressed by the daily number of COVID-19 cases/deaths in Ethiopia (AOR = 4.61, $p < 0.01$), rare online talk/chat with friends (AOR = 4.07, $p = 0.01$), presence of confusion due to the inconsistent strategies developed by the health/government authorities in view of the scientific recommendations (AOR = 2.22, $p = 0.01$), perception of self/family members being at risk of getting sick (AOR = 0.53, $p = 0.03$), decreased household income following the COVID-19 pandemic (AOR = 3.92, $p = 0.01$), practicing denial (AOR = 1.34, $p < 0.01$), self-blame (AOR = 1.23, $p = 0.02$), planning (AOR = 1.28, $p = 0.01$), and religion (AOR = 1.41, $p < 0.01$) as means of coping with stress were associated with high perceived stress.

Conclusion: Over one-third of the participants had a high level of perceived stress, and the majority of them were practicing effective means of coping with stress. The authors recommend that the hosting University in collaboration with the concerned bodies develop innovative strategies to improve the psychological well-being of the students.

Keywords: perceived level of stress, brief-COPE, associated factors, COVID-19 pandemic, students, Ethiopia

INTRODUCTION

As of the second half of January 2021, over 98 million COVID-19 infections were recorded globally claiming the lives of over 2.1 million people (Medicine, 2020). In response to the expeditious increase in the number of COVID-19 infections and the World Health Organization's declaration of the infection as a pandemic (WHO, 2020b), governments across the world implemented early wide-ranging control measures to mitigate its spread and impact. The measures taken included travel/transportation bans from specific locations, closures of selected institutions and borders, quarantine, self-isolation, and social distancing measures (ACAPS, 2020).

Though the measures adopted to contain the COVID-19 infection were justifiable, the measures greatly impacted the psychosocial, economic, and political aspects of the population across the globe (Bank, 2020; WHO, 2020a). The fear of exposure to infection, subsequent risk of infecting family members and loved ones, prolonged quarantine, fear of relative's death, and concerns about educational progression and other fears have grown tremendously. Thus, COVID-19 has the potential to leave a devastating mark on the psyche of the people, including students across the world (Mohammed et al., 2020; WHO, 2020a).

With the spread of the COVID-19 infection, more than 1.5 billion students and young people across the planet were forced to stay at home due to the closure of schools and Universities, leading to enormous anxiety and uncertainty (Husain, 2020; UNESCO, 2020). Social distancing measures and cessation of face-to-face teaching at higher educational institutes put students in an altogether new position without a well-defined estimate of how long it will last, compromising their daily life (IESALC, 2020). University and college students are especially prone to feelings of loneliness, and they experience higher rates of anxiety and depression compared to the general population (Rahman et al., 2012; Diehl et al., 2018). During the era of COVID-19, due to social isolation, uncertainty, and abrupt transitions, students are prone to further worsening of these feelings (Psychiatry, 2020).

Looking at the experiences of the world, the Ethiopian government took multiple measures, such as closure of schools and restricting large gatherings and movements of people. Additionally, the government adopted WHO's basic measures to reduce transmission of COVID-19 including washing hands frequently using soap, maintaining social distancing, staying informed and following advice given by your healthcare provider, and staying at home if you begin to feel sick. These measures were communicated to the general public through various media platforms (Baye, 2020; Hailu, 2020).

Numerous worldwide studies were conducted to assess the level of perceived stress among University students before the COVID-19 pandemic (Shah et al., 2010; Borjalilu et al., 2015; Ahmed and Prashantha, 2018; Gazzaz et al., 2018; Al-Qahtani and Alsubaie, 2020; Karyotaki et al., 2020; Tariq et al., 2020), but only limited studies were conducted on the same issue during the COVID-19 outbreak. The available studies reported a high perceived stress level for students ranging from 12.6 to 30.2% during the current pandemic (AlAteeq et al., 2020; Pedrozo-Pupo et al., 2020; Sheroun et al., 2020). A study from China revealed that ∼25% of the study population experiencing anxiety symptoms, which were positively correlated with increased concerns about academic delays, economic effects of the pandemic, and impacts on daily life (Cao et al., 2020). In Ethiopia, it is estimated that the prevalence of anxiety and depression symptoms has tripled from pre-outbreak estimates (Monitor, 2020). A previous study in Ethiopia revealed that high perceived stress was apparent in more than half of healthcare providers (51.6%) (Chekole et al., 2020), and another study involving University students reported stress in 32.5% of the participants (Aylie et al., 2020).

Medical students experience more stress compared to students of other subjects (Kebede et al., 2019; Olum et al., 2020; Worku et al., 2020). In Ethiopia, age, class, study year, practical attachment, poor/low social support, having stressful life events, financial problems, and thinking about future career expectations were identified as factors related to perceived stress among health science students (Kebede et al., 2019; Worku et al., 2020). On top of pre-existing factors, the unprecedented disruptions in health education and other activities due to the COVID-19 outbreak (Alsoufi et al., 2020) is expected to further affect the mental health of these students. Thus, students had to cope with their own fears, stresses, and insecurity. The way of coping with a stressful event, like the COVID-19 crisis, affects physical health, medical conditions, and emotional well-being either positively or negatively (CDC, 2020). Despite the recent reopening of face-to-face University education, no research has assessed the perceived stress levels and coping strategies of University students during the COVID-19 pandemic in Ethiopia. Therefore, the current study aimed to explore the perceived stress level, associated factors, and stress coping strategies used among health science students of Jimma University amid the COVID 19 outbreak. The hypothesis of this research is that COVID-19-related events

Abbreviations: AOR, adjusted odds ratios; COVID-19, coronavirus infection disease-2019; ETB, Ethiopian Birr; M, mean; PSS, perceived stress scale; SD, standard deviation; SPSS, Statistical Package for Social Science.

increase the risk of high perceived stress level and change stress coping strategies.

MATERIALS AND METHODS

Study Design and Setting

A cross-sectional online surveillance study was conducted at Jimma University from August to September 5, 2020. Jimma University is one of the well-known Universities in Ethiopia, located in the southwest part of the country. It has six colleges and four institutes, one of which is the Institute of Health Sciences (University, 2020), which includes the department of Anesthesia, School of Nursing and Midwifery (Generic Nursing, Generic Midwifery, Operational Theater Nursing, Neonatal Nursing), School of Environmental Health, School of Pharmacy, and School of Laboratory Technology.

Participants

Eligibility Criteria

All undergraduate health science students of Jimma University who were willing and able to respond to online questionnaires were included in the study. A total of 337 health science students participated in the study.

Variables

Independent Variables

Sociodemographic variables (age, sex, residence, living with your parents or family, family size, marital status, field of study, academic year, and household average monthly income), COVID-19-related experience variables, and variables related to measures taken for the prevention of COVID-19.

Dependent Variables

Perceived stress level and coping approaches to stress.

Sample Size and Sampling Technique

The sample size was calculated using Open-Epi version 2 with consideration of a 5% margin of error, 95% confidence interval, a 50% prevalence of perceived stress associated with the COVID-19 outbreak, and a 1,528 population size. Adding a non-response rate of 10%, the final sample size was 337 students. The participants were recruited by a non-probability sampling technique (a combination of purposive and snowball sampling techniques).

Data Collection Instrument and Process

The surveillance questionnaire was developed on Google Forms following the review of different kinds of literature. The questionnaire has five sections; sociodemographic characteristics, COVID-19-related experience, WHO precautionary measures, perceived stress scale (PSS-10), and Brief-COPE scale (see **Supplementary Data** for the collection format).

The perceived stress scale (PSS)-10 (Program, 2020) is the most widely used and validated psychological instrument for measuring the perception of stress and it has also been validated in Ethiopian University students (Manzar et al., 2019). The PSS-10 includes direct queries about current levels of experienced stress. The questions in the PSS ask about the feelings and thoughts of the last month. In each case, respondents are asked how often they felt a certain way. For instance, "In the last month, how often have you been upset because of something that happened unexpectedly?," "In the last month, how often have you felt that you were unable to control the important things in your life?," etc.

Each item provides five response options: (i.e., 0 = never, 1 = almost never, 2 = sometimes, 3 = fairly often, 4 = very often). PSS scores were obtained by reversing responses (0 = 4, 1 = 3, 2 = 2, 3 = 1, & 4 = 0) to the four positively stated items (4, 5, 7, and 8). Total scores were obtained by summing all the scale items with a total score range between 0 and 40. In this study, PSS-10 scores equal to or higher than 25 were deemed as high perceived stress, while scores <25 were considered as low perceived stress associated with COVID-19 (Pedrozo-Pupo et al., 2020).

Brief-COPE Strategy Scale

The Brief-COPE (NovoPsych, 2020) scale is a 28-item self-report questionnaire designed to measure effective and ineffective ways to cope with a stressful life event. To list some, "I've been turning to work or other activities to take my mind off things," "I've been concentrating my efforts on doing something about the situation I'm in," etc. Each question has a 4-point Likert item from "I haven't been doing this at all" to "I've been doing this a lot" (1 = I haven't been doing this at all, 2 = I've been doing this a little bit, 3 = I've been doing this a medium amount, 4 = I've been doing this a lot). The tool has been used in a previous study in Ethiopia (Telake Azale et al., 2018). The term "coping" is defined broadly as an effort used to minimize distress associated with negative life experiences. The coping approaches are broadly categorized as avoidant coping, approach coping, and neither/or, with each category containing subscales.

1. Avoidant coping: characterized by the subscales of denial, substance use, venting, behavioral disengagement, self-distraction, and self-blame. Avoidant coping is associated with poorer physical health among those with medical conditions.
2. Approach coping: characterized by the subscales of active coping, positive reframing, planning, acceptance, seeking emotional support, and seeking informational support. Approach coping is associated with more helpful responses to adversity, including adaptive practical adjustment, better physical health outcomes, and more stable emotional responses.
3. Neither/or: characterized by the subscales of humor and religious ways of coping with stress.

First, each class's representative phone number was accessed from respective departments and we called to them to justify the purpose of the study. Following this, the survey link was then forwarded by Telegram to the representative of each class using their phone numbers. Thereafter, the representative of each class shared the link with the common Telegram address of their class, using a purposive sampling technique. Finally, students who saw the link in the common Telegram address shared the link further to their classmates via Facebook and WhatsApp, using the snowball sampling technique.

In our study, using the Cronbach alpha, the Brief-COPE-28 item (Cronbach alpha equal to 0.844) and the PSS-10 item (Cronbach alpha equal to 0.741) had high and good internal consistencies, respectively. The avoidant coping, approach coping, and neither/or broad categories of coping approaches had good (Cronbach alpha equal to 0.777), high (Cronbach alpha equal to 0.812), and poor (Cronbach alpha equal to 0.455) internal consistencies, respectively.

Data Quality Assurance

The questionnaires were translated from English to two dominant local languages (Amharic and Afan Oromo) and back-translated into English by an independent person to assure its consistency. The tool was pre-tested on private college health science students, before starting the actual data collection and then any necessary adjustment was done. The data were compiled, coded, and checked for consistency before analysis.

Data Analysis

The CSV formatted data from Google Forms were exported to SPSS version 22.0 for analysis. A continuous data normality test was conducted using Shapiro-Wilk's *W*-test. For this purpose, a level of significance of 0.05 was used. Parametric data were reported with mean and standard deviation, whereas non-parametric data were reported with the median. Frequency and percentage were computed for categorical variables and a chi-square test was conducted to check for cell adequacy. Bivariate logistic regression was carried out to investigate the associations between the perceived stress level and independent variables/coping strategies. Then, a backward, stepwise multivariate logistic regression [reported with adjusted odds ratios (AOR) with 95% confidence intervals (95% CI)] was performed including all explanatory variables with a $p < 0.25$ on bivariate logistic regression to evaluate factors independently associated with high perceived stress level. All *p*-values calculated were two-sided, and the statistical significance threshold was <0.05.

RESULTS

Baseline Characteristics

A total of 337 health science students were involved in the study. The overall mean (±SD) age of the participants was 22.88 (±1.78) years, and the participants were comparable in terms of sex (male = 51.6% vs. female = 48.4%). Nearly three-quarters (73.3%) of the participants reported urban residence (**Table 1**).

TABLE 1 | Socio-demographic characteristics of the study participants.

Variables		Frequency (%)
Age (mean ± SD), years		22.88 ± 1.78
Sex	Male	174 (51.6)
	Female	163 (48.4)
Residency	Urban	247 (73.3)
	Rural	90 (26.7)
Live with your parents or family	Yes	323 (95.8)
	No	14 (4.2)
Family size	1–4	42 (12.5)
	5–7	64 (19.0)
	8–9	145 (43.0)
	>9	86 (25.5)
Marital status	Single	297 (88.1)
	Married	39 (11.6)
	Divorced	1 (0.3)
Study field	Anesthesia	22 (6.5)
	Generic nursing	91 (27.0)
	Generic midwifery	55 (16.3)
	Environmental health	21 (6.2)
	Operational theater nursing	8 (2.4)
	Neonatal nursing	55 (17.2)
	Pharmacy	71 (21.1)
	Laboratory technology	11 (3.3)
Academic year	1st year	4 (1.2)
	2nd year	146 (43.3)
	3rd year	72 (21.4)
	4th year	61 (18.1)
	5th year	28 (8.3)
	6th year	26 (7.7)
Family/parents monthly estimated income (ETB) (median)		5,000

SD, standard deviation; ETB, Ethiopian Birr.

COVID-19 Related Experiences

A total of 160 (47.5%) students reported predominant use of social media and mass media as the primary source of COVID-19-related information. Most of the students, 298 (88.4%), believe that COVID-19 will have negative consequences on their education. Furthermore, the majority of the participants, 188 (55.8%), think that their family members are at risk of contracting COVID-19, mainly due to work exposure. Above half of the students, 176 (52.2%), reported frustration from the isolation and quarantine measures imposed by the government. Confusion from the inconsistency of health/government authorities' strategies with the scientific recommendations was reported by 199 (59.1%). Regarding income after the COVID-19 outbreak, 213 (63.2%) participants reported a decrease in household income (**Table 2**).

Measures Taken for the Prevention of COVID-19

In this study, a significantly higher proportion of the participants reported practicing all aspects of the COVID-19 infection prevention modalities as per the WHO recommendations (**Table 3**).

Perceived Stress Scale

The overall mean (±SD) PSS score was 22.16 (±1.41). The item, "in the last month, how often have you been angered because of things that were outside of your control?," achieved the highest PPS score with a mean (±SD) value of 2.44 (±1.26), and the item with the lowest PSS score was, "in the last month, how often have

TABLE 2 | COVID-19-related experience among the participants.

Variables		Frequency (%)
The primary source of COVID-19-related information	Social media and mass media	160 (47.5)
	Social media	110 (32.6)
	Mass media (TV, radio)	77 (22.8)
	Community (family, friends...)	20 (5.9)
Judgment toward accessed information on COVID-19	Correct and balanced	184 (54.6)
	Too alarming	107 (31.8)
	Hides reality so as not to scare	46 (13.6)
Stressed by the daily COVID-19 cases/deaths reported in Ethiopia	Yes	260 (77.2)
	No	77 (22.8)
Stressed by the daily COVID-19 cases/deaths reported worldwide	Yes	278 (82.5)
	No	59 (17.5)
Talk on COVID-19-related updates with parents/friends	Yes	310 (92.0)
	No	27 (8.0)
Frequency of online talk/chat with close friends since the closure of the University	Every day or almost every day	111 (32.9)
	Several times a week	104 (30.9)
	About once a week	59 (17.5)
	Rarely	63 (18.7)
Perception of COVID-19 has negative consequences in education	Yes	298 (88.4)
	No	18 (5.3)
	I don't know	21 (6.3)
Perception of COVID-19-related changes in friendship behavior	Yes	240 (71.2)
	No	69 (20.5)
	I don't know	28 (8.3)
Perception of themselves or family members being at risk of getting sick from the coronavirus	Yes	188 (55.8)
	No	149 (44.2)
Reason for perception of themselves or family members being at risk of getting sick from the coronavirus	Due to existing medical condition	76 (33.3)
	Due to work exposure	115 (50.4)
	Less execution of measures	32 (14.0)
	I don't know	40 (17.5)
Perception of the restrictions (i.e., social distancing, facemask usage) that have been recommended by the local and national government	I think the restrictions are not strict enough	207 (61.4)
	I think the restrictions are too strict	39 (11.6)
	I think the restrictions are appropriate	91 (27.0)
Frustration by the isolation and quarantine measures taken by the government	Yes	176 (52.2)
	No	161 (47.8)
Presence of confusion due to the inconsistent strategies developed by the health/government authorities given the scientific recommendations	Yes	199 (59.1)
	No	138 (40.9)
Presence of change in family behavior following the outbreak of COVID-19	Yes	240 (71.2)
	No	97 (28.8)
Presence of family lifestyle change following the COVID-19 outbreak	Yes	283 (84.0)
	No	54 (16.0)
Directions of family lifestyle change following the COVID-19 outbreak, if any	Positively	218 (76.0)
	Negatively	69 (24.0)
Changes in household income following the COVID-19 outbreak	Decreased	213 (63.2)
	Increased	38 (11.3)
	Not changed	86 (25.5)

you felt that things were going your way?," with a mean (±SD) PSS score of 2.05 (±1.25) (**Table 4**). In this study, high perceived stress levels were reported by 121 (35.5%) of the participants, while low perceived stress was reported by 216 (64.5%) of them.

Coping Strategies

The students have reported various means of coping with COVID-19-related stress experiences. Based on the Brief-COPE strategy, the mean (±SD) of the total coping score was 72.34 (±12.31). Of the broad categories of coping approaches,

TABLE 3 | Measures taken for the prevention of COVID-19 among the participants.

Variables		Frequency (%)
1. Wash your hands regularly using soap and water for at least 20 s	Yes	301 (89.3)
	No	36 (10.7)
2. Avoid touching your eyes, nose, and mouth with your hand/fingers	Yes	286 (84.9)
	No	51 (15.1)
3. Covering mouth and nose when coughing or sneezing, and washing your hands after	Yes	319 (94.7)
	No	18 (5.3)
4. Avoid close contact with anyone who is sick, especially those with flu or cold symptoms such as fever, cough, or sneezing	Yes	313 (92.9)
	No	24 (7.1)
5. Clean and disinfect frequently touched objects and surfaces	Yes	271 (80.4)
	No	66 (19.6)
6. Stay at home, except to get emergency needs	Yes	272 (80.7)
	No	65 (19.3)
7. Avoid shaking hands with others	Yes	316 (93.8)
	No	21 (6.2)
8. Wearing a face mask while going out of your home	Yes	314 (93.2)
	No	23 (6.8)
9. Avoiding crowds	Yes	318 (93.5)
	No	22 (6.5)

TABLE 4 | Perceived stress scale (PSS) among the participants.

PSS items	Average score (mean ± SD)
1. In the last month, how often have you been upset because of something that happened unexpectedly?	2.16 ± 1.32
2. In the last month, how often have you felt that you were unable to control the important things in your life?	2.21 ± 1.27
3. In the last month, how often have you felt nervous and "stressed"?	2.25 ± 1.24
4. In the last month, how often have you felt confident about your ability to handle your problems?	2.37 ± 1.18
5. In the last month, how often have you felt that things were going your way?	2.05 ± 1.25
6. In the last month, how often have you found that you could not cope with all the things that you had to do?	2.10 ± 1.25
7. In the last month, how often have you been able to control irritations in your life?	2.27 ± 1.15
8. In the last month, how often have you felt that you were on top of things?	2.12 ± 1.25
9. In the last month, how often have you been angered because of things that were outside of your control?	2.44 ± 1.26
10. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?	2.20 ± 1.22
Total PSS score (M ± SD)	22.17 ± 6.82

PSS, perceived stress scale; SD, standard deviation.

approach coping achieved the highest mean (±SD) score, 33.76 (±6.64). Among subscales of coping strategies, religion achieved the highest mean (±SD) score accounting for 6.35 (±1.60), while substance use was the least stress coping strategy reported with a score of 3.41 (±1.91) (**Table 5**).

TABLE 5 | Brief coping scale among participants.

Coping styles		Coping score (mean ± SD)
Avoidant coping	Self-distraction, items 1 and 19	5.87 ± 1.42
	Denial, items 3 and 8	4.45 ± 1.86
	Substance use, items 4 and 11	3.41 ± 1.94
	Behavioral disengagement, items 6 and 16	4.80 ± 1.74
	Venting, items 9 and 21	4.85 ± 1.55
	Self-blame, items 13 and 26	4.40 ± 1.83
	Total avoidant coping score	27.78 ± 6.72
Approach coping	Active coping, items 2 and 7	5.80 ± 1.61
	Emotional support, items 5 and 15	5.10 ± 1.62
	Use of informational support, items 10 and 23	5.35 ± 1.71
	Positive reframing, items 12 and 17	5.63 ± 1.51
	Planning, items 14 and 25	5.91 ± 1.53
	Acceptance, items 20 and 24	5.96 ± 1.52
	Total approach coping	33.76 ± 6.64
Neither/or	Humor, items 18 and 28	4.45 ± 1.78
	Religion, items 22 and 27	6.35 ± 1.60
	Total	10.80 ± 2.43
Total coping score	72.34 ± 12.31	

SD, standard deviation.

Factors Associated With the Perceived Stress Level

In bivariate logistic regression, 29 variables achieved a $p < 0.25$ and were recruited for multivariate analysis. Of the 29 candidate variables, family size of 8–9 ($p = 0.02$), personal perception of being stressed by the daily number of COVID-19 cases/deaths in Ethiopia ($p < 0.001$), perception of COVID-19-related changes in friendship behavior ($p = 0.02$), perception of family members at risk of getting sick from the coronavirus ($p < 0.001$), frustration due to the isolation and quarantine measures taken by the government ($p = 0.01$), presence of confusion due to the inconsistent strategies developed by health/government authorities in view of scientific recommendations ($p < 0.001$), presence of a change in family behavior following the outbreak of COVID-19 ($p < 0.001$), presence of family lifestyle change following the COVID-19 outbreak (p =0.025), inconsistency of the household income following the COVID-19 outbreak (decreased, $p = 0.002$ and increased, $p = 0.004$), self-distraction, items 1 and 19 ($p = 0.19$), denial, items 3 and 8 ($p < 0.01$), substance use, items 4 and 11 ($p = 0.01$), behavioral disengagement, items 6 and 16 (p<0.01), venting, items 9 and 21 ($p < 0.01$), self-blame, items 13 and 26 ($p < 0.01$), active coping, items 2 and 7 ($p = 0.03$), emotional support, items 5 and 15 ($p = 0.04$), use of informational support, items 10 and 23 ($p < 0.01$), positive reframing, items 12 and 17 ($p < 0.01$), planning, items 14 and 25 ($p < 0.01$), and religion, items 22 and 27 ($p < 0.01$) were significantly associated with perceived stress level on the bivariate logistic regression analysis.

TABLE 6 | Bivariate and multivariate analysis to identify factors associated with perceived stress level.

Variables		Perceived stress level		COR [95%CI]	*p*-value	AOR [95%CI]	*p*-value
		Low ($n = 216$)	High ($n = 121$)				
Sex	Female	110 (32.6)	53 (15.7)	0.75 [0.48–1.17]	0.21	–	
	Male	106 (31.5)	68 (20.2)	1			
Age (years)		22.9 ± 2.81	22.7 ± 2.73	0.97 [0.90–1.06]	0.59		
Residency	Rural	52 (15.4)	38 (11.3)	1.44 [0.88–2.36]	0.14	0.55 [0.28–1.08]	0.08
	Urban	164 (48.7)	83 (24.6)	1			
Family size	>9	59 (17.5)	27 (8.0)	0.45 [0.21–0.97]	0.04	–	
	8–9	101 (30.0)	44 (13.1)	0.43 [0.21–0.87]	0.02	–	
	5–7	35 (10.4)	29 (8.6)	0.82 [0.38–1.80]	0.63	–	
	1–4	21 (6.2)	21 (6.2)	1			
Stressed by the no. of COVID-19 cases/deaths in Ethiopia	Yes	155 (46.0)	105 (31.2)	0.38 [0.21–0.70]	<0.01	4.61 [1.57–13.50]	<0.01
	No	61 (18.1)	16(4.7)				
Stressed by the no. of COVID-19 cases/deaths worldwide	Yes	174 (51.6)	104 (30.9)	0.67 [0.36–1.25]	0.21	3.01 [0.94–9.61]	0.06
	No	42 (12.5)	17 (5.0)	1		1	
Frequency of online talk/chat with friends	Rarely	34 (10.1)	29 (8.6)	1.51 [0.80–2.84]	0.19	4.07	0.01
	About once a week	36 (10.7)	23 (6.8)	1.13 [0.59–2.17]	0.70	2.82 [1.19–6.70]	0.01
	Several times a week	75 (22.3)	29 (8.6)	0.68 [0.38–1.22]	0.20	1.23 [0.60–2.51]	0.56
	Every day or almost every day	71 (21.1)	40 (11.9)	1		1	
Perception of COVID-19 has negative consequences in education	Yes	186 (55.2)	112 (33.2)	0.51 [0.18–1.45]	0.21	–	
	I don't know	16 (4.7%)	5 (1.5)	0.47 [0.15–1.47]	0.19	–	
	No	14 (4.2)	4 (1.2)	1			
Perception of COVID-19-related changes friendship behavior	Yes	146 (43.3)	94 (27.9)	0.86 [0.38–1.95]	0.72	–	
	No	52 (15.4)	17 (5.0)	0.50 [0.27–0.93]	0.02	–	
	I don't know	18 (5.3)	10 (3.0)	1			
Perception of themselves or family members being at risk of getting sick from the coronavirus	Yes	106 (31.5)	82 (24.3)	0.45 [0.28–0.73]	<0.01	0.53 [0.29–0.95]	0.03
	No	110 (32.6)	39 (11.6)	1			
Frustration by the isolation and quarantine measures taken by the government	Yes	102 (30.3)	74 (22.0)	0.56 [0.36–0.89]	0.01	–	
	No	114 (33.8)	47 (13.9)	1			
Presence of confusion due to the inconsistent strategies developed by the health/government authorities given the scientific recommendations	Yes	112 (33.2)	87 (25.8)	2.37 [1.47–3.83]	<0.01	2.22 [1.19–4.14]	0.01
	No	104 (30.9)	34 (10.1)	1		1	
Presence of change in family behavior following the outbreak of COVID-19	Yes	143 (42.4)	97 (28.8)	0.48 [0.28–0.82]	<0.01	–	
	No	73 (21.7)	24 (7.1)	1			
Presence of family lifestyle change following the COVID-19 outbreak	Yes	174 (51.6)	109 (32.3)	0.45 [0.23–0.90]	0.02	–	
	No	42 (12.5)	12 (3.6)	1			
Changes in household income following the COVID-19 outbreak	Decreased	128 (38.0)	85 (25.2)	2.50 [1.39–4.51]	<0.01	3.92 [1.36–11.33]	0.01
	Increased	20 (5.9)	18 (5.3)	3.40 [1.49–7.73]	<0.01	1.35 [0.66–2.74]	0.40
	Not changed	68 (20.2)	18 (5.3)	1		1	
Practice of avoiding close contact with anyone who is sick	Yes	197 (58.5)	116 [34.4]	2.23 [0.81–6.15]	0.11	–	
	No	19 (5.6)	5 (1.5)	1			
Practice of avoiding shaking hands with others	Yes	199 (59.1)	117 (34.7)	0.40 [0.13–1.21]	0.10	0.24 [0.06–1.02]	0.05
	No	17 (5.0)	4 (1.2)	1		–	
Avoidant coping	Self-distraction, items 1 and 19*	5.80 ± 1.429	6.01 ± 1.417	1.11 [0.94–1.30]	0.19	–	
	Denial, items 3 and 8*	4.04 ± 1.690	5.18 ± 1.932	1.41 [1.24–1.61]	<0.01	1.34 [1.11–1.62]	<0.01

(Continued)

TABLE 6 | Continued

Variables		Perceived stress level		COR [95%CI]	*p*-value	AOR [95%CI]	*p*-value
		Low ($n = 216$)	High ($n = 121$)				
	Substance use, items 4 and 11*	3.21 ± 1.749	3.78 ± 2.223	1.15 [1.03–1.29]	0.01	–	
	Behavioral disengagement, items 6 and 16*	4.52 ± 1.773	5.30 ± 1.590	1.30 [1.13–1.49]	<0.01	–	
	Venting, items 9 and 21*	4.51 ± 1.494	5.46 ± 1.478	1.53 [1.30–1.80]	<0.01	1.22 [0.98–1.51]	0.06
	Self-blame, items 13 and 26*	4.00 ± 1.719	5.10 ± 1.828	1.40 [1.23–1.60]	<0.01	1.23 [1.02–1.49]	0.02
Approach coping	Active coping, items 2 and 7*	5.66 ± 1.646	6.05 ± 1.527	1.16 [1.01–1.34]	0.03	–	
	Emotional support, items 5 and 15*	4.96 ± 1.698	5.34 ± 1.464	1.15 [1.00–1.32]	0.04	–	
	Use of informational support, items 10 and 23*	5.07 ± 1.688	5.84 ± 1.658	1.31 [1.14–1.51]	<0.01	–	
	Positive reframing, items 12 and 17*	5.39 ± 1.566	6.06 ± 1.318	1.35 [1.16–1.59]	<0.01	–	
	Planning, items 14 and 25*	5.68 ± 1.630	6.33 ± 1.261	1.33 [1.14–1.56]	<0.01	1.28 [1.04–1.58]	0.01
	Acceptance, items 20 and 24*	5.89 ± 1.598	6.09 ± 1.384	1.09 [0.94–1.26]	0.24	–	
Neither/or coping	Humor, items 18 and 28*	4.36 ± 1.770	4.62 ± 1.795	1.08 [0.95–1.23]	0.19	0.84 [0.70–1.00]	0.06
	Religion, items 22 and 27*	6.13 ± 1.717	6.75 ± 1.306	1.30 [1.11–1.51]	<0.01	1.41 [1.14–1.75]	<0.01

*SD, standard deviation; * reported in mean ± standard deviation.*

On multivariate logistic regression analysis, personal perception of being stressed by the daily number of COVID-19 cases/deaths in Ethiopia [AOR = 4.61, 95% CI (1.57–13.50), $P < 0.01$], rare online talk/chat with friends [AOR = 4.07, 95% CI (1.77–9.35), $p = 0.01$], presence of confusion due to the inconsistent strategies developed by health/government authorities in view of the scientific recommendations [AOR = 2.22, 95% CI (1.19–4.14), $p = 0.01$], perception of self/family members being at risk of getting sick [AOR = 0.53, 95%CI (0.29–0.95), $p = 0.03$], and decreased household income following the COVID-19 pandemic [AOR = 3.92, 95% CI (1.36–11.33), $p = 0.01$] were independently associated with perceived stress level. Among subscales of coping strategy, denial, items 3 and 8 [AOR = 1.34, 95% CI (1.11–1.62), $p < 0.01$], self-blame, items 13 and 26 [AOR = 1.23, 95% CI (1.02–1.49), $p = 0.02$], planning, items 14 and 25 [AOR = 1.28, 95% CI (1.04–1.58), $p = 0.01$], and religion, items 22 and 27 [AOR = 1.41, 95% CI (1.14–1.75), $p < 0.01$] means of coping were associated with perceived stress (**Table 6**).

DISCUSSION

This cross-sectional surveillance study was undertaken involving 337 undergraduate health science students to assess the perceived stress level and coping strategies amid the COVID-19 pandemic. More than one-third (35.9%) of participants experienced high perceived stress. The overall mean PSS score was 22.17 (±6.82), whereas the total mean of the stress coping score was 72.34 (±12.31).

The prevalence of high perceived stress was relatively higher in the current study than in other previous studies. In Colombia, Pedrozo-Pupo et al. (2020) found that 14.3% of the participants reported high perceived distress during the COVID-19 pandemic. In another study, Sheroun et al. (2020) reported that 13.3% of Bachelor science of nursing students suffered from high perceived stress. This difference might be explained by the difference in the study population; unlike the current study, the Pedrozo et al. study recruited professors, students, and health professionals, while, Sheroun et al. enrolled only Bachelor science nursing students. Which might reflect the significant difference in perceived stress level across different populations and, additionally, it may show cross-country discrepancies of the PSS amid the COVID-19 pandemic.

During a crisis, such as the outbreak of COVID-19, effective coping strategies play a vital role in managing distress and developing resilience. The type of stress coping employed in such circumstances is believed to impact health differently resulting in either poor or better health outcomes (NovoPsych,

2020; Polizzi et al., 2020). In our study, among subscales of coping, religion as a means of coping with stress achieved the highest mean score followed by planning and acceptance. On the contrary, substance use was the lowest means reported for coping with stress. Similarly, a study on medical students from Qatar reported religion, planning, and acceptance as the three most frequent means of coping with stress. Moreover, the Qatar study corroborates our finding of substance use as the lowest used means of coping with stress (Slah Eddine and Adawi, 2020). Overall, of a broad categories of coping, our study participants reported approach coping as a major means of coping with stress. This implies that the majority of the students were practicing effective means of coping with stress, which is associated with better physical health outcomes (NovoPsych, 2020).

Students who perceived being stressed by the daily number of COVID-19 cases/deaths in Ethiopia were four times more likely to have a high perceived stress level. This might be explained by an increment in alarming information that led to a drastic increase in stress-related conditions and mental health issues (Fernandes, 2020; Vinkers et al., 2020). Consistent with a study report from Colombia (Pedrozo-Pupo et al., 2020), our study also identified an association between confusion due to the inconsistent strategies developed by the health/government authorities in view of scientific recommendations and high perceived stress level. Inconsistent recommendations and messaging by health/government authorities leads to confusion or omitting steps or making other errors which can result in an increased risk of contamination and infection, which ultimately distress the individual (Peters et al., 2020). There is evidence that social media exposure is associated with psychological distress among college students (Hong et al., 2020) and similarly, poor social interaction (less sharing of ideas with friends, families, and community) influenced students' perceptions of stress (Stoliker and Lafreniere, 2015). In the current study, students who rarely talk/chat with their friends online were at a more than four-fold higher risk of having high perceived stress compared with those who talk/chat every day in the current pandemic. In the present study, decreased household income following the COVID-19 outbreak increased the risk of high perceived stress. This finding is consistent with a study report from Italy (Flesia et al., 2020). The emergency of the COVID-19 pandemic has caused a multitude of crises, one of which is economic (Bank, 2020). Decreased household income results in the inability to execute daily demands; this challenge will increase personal stress level.

Among subscales of coping strategies reported by the students, denial, self-blame, planning, and religion significantly increased the risk for high perceived stress. Denial and self-blame are part of the avoidance coping strategies of trying to avoid stressors instead of dealing with them. They are maladaptive (or unhealthy) ways of coping with stress because they often exacerbate stress without helping a person deal with the things that are causing them stress (Dijkstra and Homan, 2016). The increased risk of high perceived stress by using religion and planning as stress coping strategies could be an unfortunate finding or could be related to the unprecedented impact of COVID-19 on activities like religious practices and planning.

The present study has some limitations. Selection bias due to the sampling techniques employed dictates the cautious interpretation of the findings. Additionally, the authors adopted an existing scale to measure perceived stress and coping strategies associated with COVID-19. Furthermore, the study only enrolled health science students from a single institution, which might limit inference to health science students throughout Ethiopia as well as students of other subjects in the same institution.

CONCLUSION

More than one-third of the participants had a high level of perceived stress, and the majority of them were practicing effective means of coping with stress. Personal perception of being stressed by the daily number of COVID-19 cases/deaths in Ethiopia, rare online talk/chat with friends, presence of confusion due to the inconsistent strategies developed by the health/government authorities in view of scientific recommendations, and decreased household income following the COVID-19 pandemic were the predicting factors of high perceived stress level. Among the subscales of coping strategies, denial, self-blame, planning, and religious means of coping with stress were associated with high perceived stress. The authors recommend that the hosting University in collaboration with the concerned bodies develop innovative strategies to improve the psychological well-being of the students in parallel with class courses using online platforms as well as expanding the existing student counseling facilities. The health/government authorities have to develop consistent strategies in view of the scientific recommendations to contain the pandemic. Besides, longitudinal studies have to be conducted to assess the long-term psychological/psychiatric impact of the COVID-19 pandemic as well as the cognitive and academic performance impact of it. Moreover, research with large sample sizes and identifying the sources of stress among the students are warranted.

DATA AVAILABILITY STATEMENT

The original data presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Institutional review board (IRB) of Jimma University, Ethiopia. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

MA, BT, SA, and GM conceptualized and designed the study. MA and BT analyzed the data, interpreted the findings, and wrote the manuscript. All authors read and approved the final manuscript.

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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.2021.639955/full#supplementary-material

REFERENCES

ACAPS (2020). *COVID-19 Governments' Measures: Report #1–19 March 2020.* Retrieved from https://reliefweb.int/report/world/covid-19-governments-measures-report-1-19-march-2020 (accessed October 12, 2020).

Ahmed, M., and Prashantha, B. (2018). Perceived stress and source of stress among undergraduate medical students of government medical college, Mysore. *Int. J. Community Med. Public* 5, 3513–3518. doi: 10.18203/2394-6040.ijcmph20183090

AlAteeq, D. A., Aljhani, S., and AlEesa, D. (2020). Perceived stress among students in virtual classrooms during the COVID-19 outbreak in KSA. *J. Taibah Univ. Med. Sci.* 15, 398–403. doi: 10.1016/j.jtumed.2020.07.004

Al-Qahtani, M. F., and Alsubaie, A. S. R. (2020). Investigating stress and sources of stress among female health profession students in a Saudi University. *J. Multidiscip. Healthc.* 13, 477–484. doi: 10.2147/JMDH.S255781

Alsoufi, A., Alsuyihili, A., Msherghi, A., Elhadi, A., Atiyah, H., Ashini, A., et al. (2020). Impact of the COVID-19 pandemic on medical education: Medical students' knowledge, attitudes, and practices regarding electronic learning. *PLoS ONE* 15:e0242905. doi: 10.1371/journal.pone.0242905

Aylie, N. S., Mekonen, M. A., and Mekuria, R. M. (2020). The psychological impacts of COVID-19 pandemic among University students in bench-sheko zone, south-west Ethiopia: a community-based cross-sectional study. *Psychol. Res. Behav. Manag.* 13, 813–821. doi: 10.2147/PRBM.S275593

Bank, W. (2020). *The Global Economic Outlook During the COVID-19 Pandemic: A Changed World.* Retrieved from https://www.worldbank.org/en/news/feature/2020/06/08/the-global-economic-outlook-during-the-covid-19-pandemic-a-changed-world (accessed January 23, 2021).

Baye, K. (2020). *COVID-19 Prevention Measures in Ethiopia: Current Realities and Prospects, Vol. 141.* Washington, DC; Addis Ababa: International Food Policy Research Institue. doi: 10.2499/p15738coll2.133729

Borjalilu, S., Mohammadi, A., and Mojtahedzadeh, R. (2015). Sources and severity of perceived stress among Iranian medical students. *Iran. Red Crescent Med. J.* 17, 1–6. doi: 10.5812/ircmj.17767

Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., et al. (2020). The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Res.* 287:112934. doi: 10.1016/j.psychres.2020.112934

CDC (2020). *Coping With Stress.* Retrieved from https://www.cdc.gov/violenceprevention/publichealthissue/copingwith-stresstips.html (accessed November 28, 2020).

Chekole, Y. A., Yimer Minaye, S., Mekonnen Abate, S., and Mekuriaw, B. (2020). Perceived stress and its associated factors during COVID-19 among healthcare providers in Ethiopia: a cross-sectional study. *Adv. Public Health* 2020:5036861. doi: 10.1155/2020/5036861

Diehl, K., Jansen, C., Ishchanova, K., and Hilger-Kolb, J. (2018). Loneliness at Universities: determinants of emotional and social loneliness among students. *Int. J. Environ. Res. Public Health* 15:1865. doi: 10.3390/ijerph15091865

Dijkstra, M., and Homan, A. C. (2016). Engaging in rather than disengaging from stress: effective coping and perceived control. *Front. Psychol.* 7:1415. doi: 10.3389/fpsyg.2016.01415

Fernandes, N. (2020). *Economic Effects of Coronavirus Outbreak (COVID-19) on the World Economy*. IESE Business School Working Paper No. WP-1240-E. doi: 10.2139/ssrn.3557504

Flesia, L., Monaro, M., Mazza, C., Fietta, V., Colicino, E., Segatto, B., et al. (2020). Predicting perceived stress related to the covid-19 outbreak through stable psychological traits and machine learning models. *J. Clin. Med.* 9:3350. doi: 10.3390/jcm9103350

Gazzaz, Z. J., Baig, M., Al Alhendi, B. S. M., Al Suliman, M. M. O., Al Alhendi, A. S., Al-Grad, M. S. H., et al. (2018). Perceived stress, reasons for and sources of stress among medical students at rabigh medical College, king abdulaziz University, Jeddah, Saudi Arabia. *BMC Med. Educ.* 18:29. doi: 10.1186/s12909-018-1133-2

Hailu, B. H. (2020). *Education Response to COVID-19: How Can Basic Education be Implemented in Ethiopia?* Retrieved from https://www.ukfiet.org/2020/education-response-to-covid-19-how-can-basic-education-be-implemented-in-ethiopia/ (accessed October 21, 2020).

Hong, W., Liu, R.-D., Ding, Y., Fu, X., Zhen, R., and Sheng, X. (2020). Social media exposure and college students' mental health during the outbreak of CoViD-19: the mediating role of rumination and the moderating role of mindfulness. *Cyberpsychol. Behav. Soc. Netw.* 1–6. doi: 10.1089/cyber.2020.0387

Husain, N. (2020). *Impact of COVID-19 on Higher Education: Challenges,Opportunities and Road Ahead.* Retrieved from https://www.researchgate.net/publication/341203464_Impact_of_COVID-19_on_Higher_Education_Challenges_Opportunities_and_Road_Ahead (accessed October 12, 2020).

IESALC, U. (2020). *Report "COVID-19 and Higher Education: Today and Tomorrow. Impact Analysis, Policy Responses and Recommendations".* Retrieved from http://www.guninetwork.org/publication/report-covid-19-and-higher-education-today-and-tomorrow-impact-analysis-policy-responses#main-content (accessed October 12, 2020).

Karyotaki, E., Cuijpers, P., Albor, Y., Alonso, J., Auerbach, R. P., Bantjes, J., et al. (2020). Sources of stress and their associations with mental disorders among college students: results of the world health organization world mental health surveys international college student initiative. *Front. Psychol.* 11:1759. doi: 10.3389/fpsyg.2020.01759

Kebede, M. A., Anbessie, B., and Ayano, G. (2019). Prevalence and predictors of depression and anxiety among medical students in Addis Ababa, Ethiopia. *Int. J. Ment. Health Syst.* 13:30. doi: 10.1186/s13033-019-0287-6

Manzar, M. D., Salahuddin, M., Peter, S., Alghadir, A., Anwer, S., Bahammam, A. S., et al. (2019). Psychometric properties of the perceived stress scale in Ethiopian University students. *BMC Public Health* 19:41. doi: 10.1186/s12889-018-6310-z

Medicine, J. H. U. (2020). *COVID-19 Dashboard by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University (JHU).* Retrieved from https://coronavirus.jhu.edu/map.html (accessed anuary 23, 2020).

Mohammed, A. A., Uddin, M. S., and Saidi, A. M. (2020). Covid-19 and movement control order: stress and coping strategies of students observing self-quarantine. *Int. J. Acad. Res. Busin. Soc. Sci.* 10, 788–802. doi: 10.6007/IJARBSS/v10-i5/7249

Monitor, E. (2020). *Depression & Anxiety Increase Three-Fold in Ethiopia After COVID-19.* Retrieved from https://ethiopianmonitor.com/2020/05/14/depression-anxiety-increase-three-fold-in-ethiopia-after-covid-19/ (accessed October 12, 2020).

NovoPsych (2020). *Brief-COPE.* Retrieved from https://novopsych.com.au/assessments/brief-cope/ (accessed June 1, 2020).

Olum, R., Nakwagala, F. N., and Odokonyero, R. (2020). Prevalence and factors associated with depression among medical students at makerere University, Uganda. *Adv. Med. Educ. Pract.* 11, 853–860. doi: 10.2147/AMEP.S278841

Pedrozo-Pupo, J. C., Pedrozo-Cortés, M. J., and Campo-Arias, A. (2020). Perceived stress associated with COVID-19 epidemic in Colombia: an online survey. *Cader. Saúde Púb.* 36, 1–6. doi: 10.1590/0102-311x00090520

Peters, M. D., Marnie, C., and Butler, A. (2020). Policies and procedures for personal protective equipment: does inconsistency increase risk of contamination and infection? *Int. J. Nurs. Stud.* 109:103653. doi: 10.1016/j.ijnurstu.2020.103653

Polizzi, C., Lynn, S. J., and Perry, A. (2020). Stress and coping in the time of COVID-19: Pathways to resilience and recovery. *Clin. Neuropsychiatry* 17, 59–62. doi: 10.36131/CN20200204

Program, S. O. N. H. E. A. (2020). *Perceived Stress Scale.* Retrieved from https://das.nh.gov/wellness/docs/percieved%20stress%20scale.pdf (accessed June 1, 2020).

Psychiatry, D. O. (2020). *Coping With the COVID-19 Pandemic as a College Student.* Retrieved from https://medicine.umich.edu/dept/psychiatry/michigan-psychiatry-resources-covid-19/adults-specific-resources/coping-covid-19-pandemic-college-student (accessed October 23, 2020)

Rahman, A., Bairagi, A., Dey, B. K., and Nahar, L. (2012). Loneliness and depression in University students. *Chittag. Univ. J. Biol. Sci.* 7, 175–189.

Shah, M., Hasan, S., Malik, S., and Sreeramareddy, C. T. (2010). Perceived stress, sources and severity of stress among medical undergraduates in a Pakistani medical school. *BMC Med. Educ.* 10:2. doi: 10.1186/1472-6920-10-2

Sheroun, D., Wankhar, D. D., Devrani, A., Lissamma, P. V., Gita, S., and Chatterjee, K. (2020). A study to assess the perceived stress and coping strategies among B. Sc. nursing students of selected colleges in pune during COVID-19 pandemic lockdown. *Int. J. Sci. Healthc. Res.* 5, 280–288.

Slah Eddine, B. F., and Adawi, T. R. T. (2020). Perceived stress and coping strategies among University students. *Eur. J. Res. Med. Sci.* 8, 19–25.

Stoliker, B. E., and Lafreniere, K. D. (2015). The influence of perceived stress, loneliness, and learning burnout on University students' educational experience. *Coll. Stud. J.* 49, 146–160.

Tariq, S., Tariq, S., Tariq, S., and Jawed, S. (2020). Perceived stress, severity and sources of stress among female medical students in a private medical college in Pakistan. *JPMA* 2019, 162–167. doi: 10.5455/JPMA.2153

Telake Azale, A. F., Girmay, M., and Charlotte, H. (2018). Coping strategies of women with postpartum depression symptoms in rural Ethiopia: a cross-sectional community study. *BMC Psychiatry* 18, 1–13. doi: 10.1186/s12888-018-1624-z

UNESCO (2020). *Global Education Coalition.* Retrieved from https://en.unesco.org/covid19/educationresponse/globalcoalition (accessed October 12, 2020).

University, J. (2020). Retrieved from https://ju.edu.et/ (accessed November 23, 2020).

Vinkers, C. H., van Amelsvoort, T., Bisson, J. I., Branchi, I., Cryan, J. F., Domschke, K., et al. (2020). Stress resilience during the coronavirus pandemic. *Eur. Neuropsychopharmacol.* 35, 12–16. doi: 10.1016/j.euroneuro.2020.05.003

WHO (2020a). *Mental Health and COVID-19.* Retrieved from https://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/technical-guidance/mental-health-and-covid-19 (accessed October 29, 2020).

WHO (2020b). *WHO Announces COVID-19 Outbreak a Pandemic.* Retrieved from https://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/news/news/2020/3/who-announces-covid-19-outbreak-a-pandemic (accessed October 12, 2020).

Worku, D., Dirriba, A. B., Wordofa, B., and Getahun, F. (2020). Perceived stress, depression, and associated factors among undergraduate health science students at arsi University in 2019 in Oromia, Ethiopia. *Psychiatry J.* 2020, 1–8. doi: 10.1155/2020/4956234

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The Influence of Post-Traumatic Growth on College Students' Creativity During the COVID-19 Pandemic: The Mediating Role of General Self-Efficacy and the Moderating Role of Deliberate Rumination

Wei Zeng[1], Yuqing Zeng[1], Yanhua Xu[2], Dongtao Huang[1], Jinlian Shao[1], Jiamin Wu[1] and Xingrou Wu[1]*

[1]School of Geography, South China Normal University, Guangzhou, China, [2]College of Resource Environment and Tourism, Capital Normal University, Beijing, China

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Maria Anna Coniglio, University of Catania, Italy

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***Correspondence:**
Yanhua Xu
yanhuaxuedu@foxmail.com

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Purpose: This study used a moderated mediation model to test the mediating effect of general self-efficacy on the relationship between post-traumatic growth (PTG) and creativity and the moderating effect of deliberate rumination in the second path of the indirect mediation path during the COVID-19 pandemic.

Methods: A sample of 881 university students from Guangdong Province, China, was surveyed with the Posttraumatic Growth Inventory, the Runco Ideational Behavior Scale, the General Self-Efficacy Scale, and the Deliberate Rumination Inventory. SPSS (23 version) and PROCESS (3.3 version) were used for correlation analyses, mediation analysis, and moderated mediation analysis.

Results: (1) PTG was positively correlated with creativity, self-efficacy, and deliberate rumination. Creativity was positively correlated with self-efficacy and deliberate rumination. Deliberate rumination was positively correlated with self-efficacy. (2) Self-efficacy mediated the relationship between PTG and creativity. (3) Deliberate rumination moderated the second half of the path of "PTG → self-efficacy → creativity."

Conclusions: PTG affected creativity directly and also indirectly through self-efficacy. In particular, deliberate rumination moderated the relationship between self-efficacy and creativity, such that the association was stronger when the incidence of deliberate rumination was low. These results provide a more comprehensive understanding of the positive link between PTG and creativity.

Keywords: post-traumatic growth, creativity, deliberate rumination, general self-efficacy, mediated effect, moderated mediation model, COVID-19

INTRODUCTION

The coronavirus disease 2019 (COVID-19) spread rapidly and widely worldwide, which had a significant impact on people's lives (Zhao et al., 2020). For example, a sample survey and analysis of 17,865 posts of active Weibo users found that people's sensitivity to social risks increased and their life satisfaction decreased during the pandemic (Li et al., 2020). Pandemics and government-mandated measures of quarantine and isolation defined as lockdown have an impact on mental health of general population (Brooks et al., 2020). People suffered from depression, anxiety, insomnia, stress, addiction symptoms, and the persistence of avoidance behaviors due to infection fears, reduced social activities, loss of accessibility to basic necessities, and financial loss during the pandemics (Brooks et al., 2020; Rossi et al., 2020; Grignoli et al., 2021). During the COVID-19 pandemic, a study of 1,210 respondents in China showed that 84.7% spent 20–24 h per day at home and experienced the rates of moderate to severe depression and anxiety of 16.5 and 28.8%, respectively (Wang et al., 2020). In addition, the relatives of COVID-19 patients suffered from high levels of anxiety due to feelings of insecurity and loss of a sense of control (Dorman-Ilan et al., 2020). Most Italian residents had higher levels of distress because of positive cases nearby, the prolonged lockdown and having to relocate (Di Giuseppe et al., 2020). At the same time, people face enormous stressors and spend more time fantasizing, which is an addictive mental behavior associated with psychological dysfunctions (Somer et al., 2020). In summary, individuals have been exposed to varying degrees of threat of injury or death, resulting in numerous psychological problems and instances of post-traumatic stress disorder (PTSD) during the pandemic (Yehuda, 2002; Sun et al., 2020). Therefore, it is essential to understand people's automatic coping mechanisms in order to respond effectively to the intense stress caused by a pandemic (Di Giuseppe et al., 2020).

The COVID-19 pandemic has also posed a threat to the physical and mental health of Chinese college students, and this has attracted extensive attention from society and academia. Many universities have taken precautionary measures such as closing campuses, postponing internships, and changing to e-learning. College students have generally been anxious because of multiple pressures from the pandemic, their studies and their employment (Cao et al., 2020). For example, a cross-sectional study showed that 50.09% of college students from Guangdong Province, China, reported symptoms of stress (Li X. et al., 2020). A similar study found that the prevalence of mental disorders among 11,954 Chinese college students was as high as 22.8%, and that the stress caused by uncertainty was a risk factor for mental disorders during the pandemic (Wu et al., 2020). In the face of such a devastating public health event, it is necessary to attend to the mental health status of college students and to intervene effectively to improve their ability to avoid mental disorders.

A number of empirical studies have examined the positive effects that traumatic events can have on people (Linley and Joseph, 2004). Tedeschi and Calhoun (1996), in their scientific measurement of the phenomenon of psychological growth after traumatic events, proposed the term *post-traumatic growth* (PTG) to describe the process by which people re-evaluate traumatic events in order to better understand themselves, others, and the world as they actively adapt to challenging circumstances.

Although some college students from China suffered from PTSD, anxiety, and depressive symptoms during the COVID-19 pandemic, they also sought effective ways to adapt to trauma and adversity (Chi et al., 2020). Researchers have pointed out that PTG is positively correlated with PTSD symptoms (Shakespeare-Finch and Lurie-Beck, 2014; Liu et al., 2016) and that both positive and negative outcomes of traumatic events may occur simultaneously. In the short and long post-traumatic period, PTG can be used as a strategy to alleviate PTSD or as an outcome to be transformed by PTSD (Wu et al., 2018). Furthermore, negative emotions and cognitive deficits caused by traumatic events may impair an individual's creativity development (Benedek et al., 2014). However, a study that focused on 92 outstanding literary scholars from the Tang and Song dynasties in China showed that an adverse environment can be an important factor in the achievement of highly successful creatives (Yi et al., 2017). Trauma and adversity are conceptually similar in that both involve experiences that are destructive or antagonistic to the individual (American Psychiatric Association, 2013). When individuals use various strategies to solve problems in the face of adversity, cognitive flexibility is likely to increase and provide motivation and opportunities for the development of creativity. Then individuals who experience PTG are able to face traumatic events and life challenges with more positive moods, which will foster creative ideas (Han et al., 2019). Thus, trauma is closely linked to creativity, but until now there exists little empirical research examining this association (Liang et al., 2020). In addition, previous studies focused on only outstanding individuals (Simonton, 1994; Niu and Kaufman, 2005), but few studies have investigated the general population. The relationship between ordinary people's trauma and creativity is also an important issue.

Research shows that the positive changes generated by PTG include interpersonal relationship, personal strength, mental state, attitude toward life, etc. (Tedeschi and Calhoun, 2004). These positive changes can help individuals to adopt more proactive thinking and coping styles when they experience new negative events. Therefore, we speculate that individuals who experience PTG can improve their general self-efficacy. Though the development of creativity may be a manifestation of PTG, it is also influenced by other factors. Studies have demonstrated that individual self-efficacy is a positive predictor of creativity (Jaiswal and Dhar, 2016; Newman et al., 2018). However, it is worth exploring whether self-efficacy can have a positive impact on the creativity of college students in the face of the immense mental stress caused by their social isolation during the COVID-19 outbreak (Chi et al., 2020).

Furthermore, stressors associated with COVID-19 activated individuals' rumination mechanisms, which may have an impact on individual creativity. It has been shown that a higher frequency of rumination during the pandemic resulted in more

negative emotions and decreased cognitive function (Newman et al., 2018; Ye et al., 2020), which is detrimental to the development of creative thinking. However, individuals can also increase their self-confidence by recalling positive examples through rumination (Bandura, 1997). At the same time, creative ideas and material from life can be obtained through rumination (Forgeard et al., 2020). It has been shown that intrusive rumination is positively correlated with creativity (Wang et al., 2021) and that intrusive rumination may promote deliberate rumination (Kamijo and Yukawa, 2018). Deliberate rumination indicates that individuals cognitively revisit events, reframe and recover their core beliefs, and feel positive changes in several aspects of their lives (Cann et al., 2011). When individuals face traumatic events, high self-efficacy can promote individuals to be more likely to actively recognize and reflect on the problem under the influence of the consciousness of "I can," that is, to realize deliberate rumination (Andersson et al., 2014). However, there are few researches on the influence of deliberate rumination on the relationship between general self-efficacy and creativity (Binnewies et al., 2009). Thus, deliberate rumination deserves attention as an important factor influencing individual mental health and cognitive development.

In order to enhance the understanding of the changes in creativity of college students during the COVID-19 pandemic, this study explored the relationship between PTG and creativity among college students during that period as well as the mediating role of self-efficacy and the moderating role of deliberate rumination. In the following section, the definitions of these four variables and the relationships between them are presented.

THEORETICAL BASIS AND HYPOTHESIS

Relationship Between PTG and Creativity

PTG refers to the positive psychological changes brought about by an individual's struggle with traumatic events, which does not mean a reduction in the level of psychological distress; rather, the two often coexist (Tedeschi and Calhoun, 2004). It is commonly assessed using indicators such as "new possibilities, relating to others, personal strength, spiritual change, and appreciation of life" (Tedeschi and Calhoun, 1996). Recently, many studies have focused on the predictors of and influences on PTG. For example, it has been shown that optimism, social support, and appropriate cognitive strategies contribute to PTG (Baillie et al., 2014; Pérez-San-Gregorio et al., 2017; Sun et al., 2020). In addition, a number of scholars and practitioners have empirically confirmed the mechanisms of action when different traumatic events have a positive impact on people such as cancer (Sharp et al., 2018), burns (Wiechman Askay and Magyar-Russell, 2009), sexual assault (Frazier et al., 2001), earthquakes (Alamdar et al., 2020), and the death of a loved one (Büchi et al., 2007). Although the possible positive effects of traumatic events have been demonstrated in practice, the exact nature of the predictors and consequences of PTG remain inconclusive (Blackie and Jayawickreme, 2014; Groarke et al., 2017).

Guilford (1950) defined the term *creativity* as a process of thought and action that produces new and original works, emphasizing the originality and effectiveness of creativity (Runco and Jaeger, 2012). Rhodes (1961) proposed the *4Ps creativity model*, which integrates the different aspects of creativity, including person, process, product and process. In the field of social psychological research, Amabile (1988) developed a model of the components of creativity that comprised cognitive, personality, motivational, and social factors including domain-relevant skills, creativity-relevant skills and task motivation. Later, Amabile (1996) revised the model to take into account the working environment. Sternberg and Lubart (1991) developed *creativity investment theory*, which states that creativity is related to six factors associated with the individual's psychological mechanisms and environment: intellectual abilities, knowledge, thinking styles, personality, motivation, and environment. Plucker et al. (2004, p. 90), after reviewing 90 articles from high-impact journals, suggested that "creativity is the interaction among aptitude, process, and environment by which an individual or group produces a perceptible product that is both novel and useful as defined within a social context." However, there is currently no agreed definition of creativity (Treffinger, 2009).

Creativity is an important part of cognitive, social, and emotional activity, and it is often defined in terms of creative products, but creative ideas can also be quantified as creative products, and focusing on the ideas people generate is particularly useful for understanding "everyday creativity" (Runco et al., 2000). The Runco Ideational Behavior Scale, for example, measures creative potential by asking individuals to rate the frequency with which they generate ideas in their everyday experiences (Runco et al., 2000).

A number of studies have examined the influences on an individual's creativity such as environment, emotions, cognition, stress, goals and motivation (Peterson et al., 2008; Edl et al., 2014; Hu et al., 2015; Du et al., 2020). Peterson et al. (2008) found that the character strength of creativity correlated significantly with PTG (Peterson et al., 2008). It is a pity that creativity was only one of many character strengths included as outcomes in their study, the precise nature of the association between PTG and creativity was not investigated further or explained.

Creative processes involve cognition and self-control (Edl et al., 2014). Traumatic events may impair cognitive processes and cognitive functioning, thus negatively affecting creativity (Paulus et al., 2010). Conversely, an examination of the experiences of 722 Chinese writers in the twentieth century found that those who suffered personal tragedy or political persecution were more likely to win creative awards in their later years (Niu and Kaufman, 2005). Thus, the effects of trauma can be both negative and positive.

PTG can be accompanied by positive psychological changes, i.e., in personal attitudes, awareness, and health behaviors associated with growth (Siegel and Schrimshaw, 2000; Barskova and Oesterreich, 2009). It has been shown that increased creativity may constitute a manifestation of PTG (Forgeard, 2013).

During the COVID-19 outbreak, Chinese university students have shown the ability to respond effectively to challenges and experience PTG (Chi et al., 2020). However, the positive changes in the behavior and the cognition of college students experiencing PTG need to be further explored through empirical studies (Liang et al., 2020). In summary, we believe that PTG can have a positive effect on the creativity of college students and propose the following hypothesis:

H1: PTG has a positive correlation with creativity.

The Mediating Role of Self-Efficacy

Self-efficacy is a central concept in social cognitive theory (Bandura, 1978), which refers to an individual's perceptions or beliefs about whether they are able to adopt appropriate behavior when faced with challenging circumstances. As a perception of "can do," self-efficacy reflects a sense of control over the environment and may be thought of as the ability of individuals to handle certain life stressors with greater confidence (Schwarzer et al., 1997). According to the theory of self-efficacy, the sense of the individual of control over the environment and subjective evaluation of their own ability will affect their psychological status and behavioral choices. These include what behavioral choices to make, how much effort to put in and how long to persist in the face of difficulties, and the emotional state of the person facing the situation (Bandura, 1990). Self-efficacy is not static (Ng and Lucianetti, 2015), and it is influenced by a variety of internal and external factors such as achievement goals (Du et al., 2020), creativity training (Mathisen and Brønnick, 2009), and social support (Mathisen, 2011).

Previous research has shown that PTG is positively correlated with self-efficacy in both patient and survivor groups that have experienced a traumatic event (Barskova and Oesterreich, 2009). Self-efficacy manages people's perceptions of the environment and their assessment of personal competence in the face of traumatic and stressful events (Bandura, 2011). People with high self-efficacy are more open to challenges thus are more likely to experience growth-related changes. PTG, both as a process and as an outcome, also can impact positively on an individual's personality (Blackie and Jayawickreme, 2014). Therefore, we speculate that individuals who experience traumatic events and achieve growth can improve their general self-efficacy. Thus, it is proposed that individuals who experience PTG are more confident in themselves and, in their lives, then experience greater general self-efficacy in the face of stressful events (Tedeschi and Calhoun, 2004; Jia et al., 2017). It leads to the second hypothesis of the study:

H2a: PTG has a positive correlation with self-efficacy.

A number of studies have investigated the relationship between self-efficacy and creativity. In the field of creativity research, the positive correlation between an individual's self-efficacy and an individual's creativity is well recognized (Jaiswal and Dhar, 2016; Newman et al., 2018). In addition, some studies have explored the mediating role of self-efficacy in the relationship between creativity and other factors such as achievement goals (Du et al., 2020), motivation-enhancing practices (Ma et al., 2017), and active procrastination (Liu et al., 2017). The predictive effect of self-efficacy on creativity is also influenced by internal and external factors. For example, self-efficacy had a differential effect due to individual differences in creativity, and that it was negatively correlated with individual creativity for employees who were more promotion-oriented (Li C.-R. et al., 2020). In addition, researchers have empirically shown that college students' award experience influences the degree of effect of their self-efficacy on creativity (Chang et al., 2016). Given so much overlap between self-efficacy and creativity, we propose the third hypothesis:

H2b: Self-efficacy has a positive correlation with creativity.

From a health behavior perspective, self-efficacy affects people's health behaviors (Strecher et al., 1986). For example, the person who has high sense of self-efficacy is more likely to increase motivation to act, leading to greater achievement and better health (Zalewska-Puchala et al., 2007). This means that individuals who have increased self-efficacy during a traumatic event are likely to experience more positive changes. Thus, they are able to confidently cope with illness risks and implement positive and healthy behaviors, thereby promoting creative behaviors. In addition, self-efficacy mediates knowledge and behavior and facilitates the knowledge-behavior relations (Rimal, 2000). It has also been shown that self-efficacy mediates perceived efficacy of the government health measures and compliance during the pandemic, and that people with high self-efficacy are better able to have higher scores in behavioral compliance (Roma et al., 2020). It follows that self-efficacy as a factor that enables individuals to face life stresses with confidence is often presented as a mediating role in research.

Individuals who have experienced PTG may develop confidence in their own abilities and in their capacity to face the future, which may facilitate their achievement of more challenging and creative tasks. The COVID-19 has forced college student to study at home for long periods of time, resulting in students facing multiple stressors and suffering from general anxiety about their physical health, academics, and socialization (Cao et al., 2020; Li X. et al., 2020). Thus, COVID-19 has been a substantial stressor that can lead to psychological distress among college students (Lahav, 2020). Exposure to stressors leads to the secretion of cortisol in the body (Dickerson and Kemeny, 2004). It has been shown that physiological activity in humans is influenced by self-efficacy and that cortisol secretion is lower at when self-efficacy is high (Wiedenfeld et al., 1990, Nierop et al., 2008), thereby reducing the increase in cortisol that may result from traumatic events and mitigating the potentially damaging effects on neuronal and cognitive mechanisms (Schönfeld et al., 2013). This physiological mechanism reveals that an individual's self-efficacy may have an effect on creative cognition by influencing the secretion of cortisol. Thus, the increase in self-efficacy, as an important aspect of PTG, protects psychological health, which facilitates the generation of creative ideas. On the other hand,

changes in self-efficacy, an important judgment factor in the choice of challenging tasks and problem-solving, may have an impact on creativity. Then, we propose the fourth hypothesis.

H2: Self-efficacy mediates PTG and creativity.

The Moderating Role of Deliberate Rumination

There are two main types of definitions of rumination in current research. Nolen-Hoeksema et al. (2008) defined *rumination* as an individual's repeated, passive attention to the details of a stressful event, the possible causes and consequences of its symptoms, and the details of the course of the event. However, to assess contemplation objectively and neutrally, it is important to distinguish two main types of rumination: intrusive and deliberate (Tedeschi and Calhoun, 2004; Cann et al., 2011). *Intrusive rumination* refers to the individual's passive repetition of the traumatic event in a negative manner, which is a non-constructive cognitive approach, whereas *deliberate rumination* refers to the individual's active re-examination of the traumatic events and related information: they face the dilemma openly and solve the problem (Cann et al., 2011). Deliberate rumination represents the positive aspect of contemplation, whereby individuals actively reflect on and re-evaluate cognitive processes and ways of thinking to choose a more compatible worldview and lifestyle, shifting their personal attention to positive aspects (Joseph and Linley, 2005). Deliberate rumination allows individuals to achieve positive meaning construction of the stressful event (Cann et al., 2010b), which may lead to PTG of the individual (Wu et al., 2015). What's more, deliberate rumination can lead to a more purposeful cognitive process and metacognition of the stressful event, which aims to solve problems and foreshadows the possibility of PTG (Cann et al., 2011), reducing the damage of the stressful event (Tedeschi and Calhoun, 2004). For example, in a study of PTG following cancer, it was found that enhanced deliberate rumination can facilitate individuals to achieve PTG (Rider Mundey et al., 2018). Studies have found a significant positive correlation between deliberate rumination and PTG (Andrades et al., 2017; Xu et al., 2019). From above, we can infer that, to some extent, deliberate rumination seems to be an important factor in the individual's perception of a potentially negative stressor. In summary, we propose a fifth hypothesis:

H3a: Deliberate rumination has a positive correlation with PTG.

Studies examining the effects of rumination on creativity have shown that different types of rumination affect creativity differently. An increase in creative thinking may stem from the development of a post-traumatic cognitive process (Liang et al., 2020), which involves cognitive and attentional control. Iterative rumination on individuals and events is also an important factor in the development of creativity (Verhaeghen et al., 2005). For example, it has been suggested that rumination contributes to the development of higher-value creative ideas (Forgeard et al., 2020). Self-reflective rumination stimulates interest in creative behavior (Verhaeghen et al., 2005, 2014). In light of the above, we believe it is worthwhile to further explore how deliberate rumination can contribute to the development of creativity in college students. Therefore, we hypothesize that.

H3b: Deliberate rumination has a positive correlation with creativity.

The relationship between self-efficacy and rumination has been explored from different perspectives. Researchers have shown that rumination has a negative impact. For example, an empirical study with undergraduate nursing students showed that rumination can lead to depression and reduce self-efficacy, and that self-efficacy does not alleviate depression (Takagishi et al., 2013).

Conversely, higher levels of self-efficacy contribute to an individual's ability to adapt and develop. Individuals with PTSD and possessing higher self-efficacy chose to extract memories that promoted an increase in self-efficacy when recalling experiences (Brown et al., 2016). In other words, self-efficacy had a positive impact on deliberate rumination. It is generally accepted that rumination is likely to trigger negative emotions and thoughts in individuals, but the facilitative role of rumination with positive beliefs in problem-solving has been overlooked (Dunn and Sensky, 2018). Furthermore, finding support for one's view of oneself by reviewing the past and constructing future events is often beneficial in establishing and maintaining self-efficacy (Bandura, 1997). Therefore, we suggest that there is an association between self-efficacy, deliberate rumination and creativity, and that, due to its plasticity (Ng and Lucianetti, 2015), self-efficacy has different effects on creativity at different levels of deliberate rumination. In summary, we hypothesize that.

H3c: Deliberate rumination has a positive correlation with self-efficacy.

Based on existing research and the hypotheses above, we further propose that

H3: Deliberate rumination moderates the second half of the path of "PTG → self-efficacy → creativity."

MATERIALS AND METHODS

Participants and Procedures

The study was conducted at a polytechnic in Guangdong Province, China, that serves more than 20,000 full-time students. A total of 918 students completed the survey questionnaire. After data collection, 37 participants who were not from Guangdong were excluded from the study, and so the actual number of valid questionnaires was 881. Among the interviewees, 317 (35.982%) were male and 564 (64.018%) were female. Before the research design was finalized, the researchers conducted exploratory focus-group interviews with students at the school to understand their emotional profile and psychological state. The majority of the interviewees indicated that they had been depressed during the COVID-19 pandemic.

The present study followed a correlational design and used a web-based questionnaire as the data collection method. The questionnaires were completed between April 10 and June 15, 2020. A QR code for completing the questionnaire was sent to students electronically during the time college students were studying online because their in-person classes were canceled because of the COVID-19 outbreak. Participants simply had to scan the QR code, go to the on-screen questionnaire, answer the questions and then click on Submit (QR refers to *quick response*, a readable barcode that contains a large amount of information. Devices, such as mobile phones and tablets, use cameras to scan the QR code and recognize the binary data in it, which takes them to a specific linked website). In China, QR codes are widely used as a means of accessing specific webpages and for other tasks, such as making financial payments, providing identification and searching for information. It should be emphasized that the purpose of the study was explained in detail before the QR code was scanned and that all participants completed the questionnaire on a voluntary basis.

Materials

The questionnaire used in this study consisted of 64 items divided into five sections: (a) demographic information, (b) Posttraumatic Growth Inventory, (c) Runco Ideational Behavior Scale, (d) General Self-Efficacy Scale, and (e) Deliberate Rumination Inventory. The demographic information included gender, home address, and profession. Runco Ideational Behavior Scale, General Self-Efficacy Scale, and Deliberate Rumination Inventory above-mentioned scales were originally developed in English and translated into Chinese for this study. In order to improve the quality of the translations, a back-translation method was used (Brislin, 1970); that is, the first researcher translated the English version into Chinese, then a second researcher back-translated the translated English into Chinese, and a third researcher compared the original, translated, and back-translated versions of the scales to assess the accuracy of the translations. The translations were corrected and optimized prior to finalizing the questionnaire to ensure the equivalence of the scales.

Posttraumatic Growth Inventory

The study used the Chinese version of the Posttraumatic Growth Scale, originally proposed by Tedeschi and Calhoun (1996) and later translated by Geng et al. (2011). The scale consists of 21 items that cover five dimensions: interpersonal relationships (e.g., "Putting effort into my relationships"), new possibilities (e.g., "I'm more likely to try to change things which need changing"), personal strengths (e.g., "I discovered that I'm stronger than I thought I was"), spiritual changes (e.g., "A better understanding of spiritual matters"), and the appreciation of life (e.g., "Appreciating each day"). The scale has six points that measure feelings, reactions, and agreement (1 = no change to 6 = very high degree of change). In the present study, the Cronbach's alpha coefficient of the scale was 0.958.

Runco Ideational Behavior Scale

The Runco Ideational Behavior Scale, developed by Runco et al. (2000), was used in this study. It consists of 23 self-report items (e.g., "I think about ideas more often than most people" and "I am able to think up answers to problems that have not already been figured out") that measure the level of creative behavior in everyday life on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). In the present study, the Cronbach's alpha coefficient of the scale was 0.938.

General Self-Efficacy Scale

The General Self-Efficacy Scale (Schwarzer et al., 1997), which consists of 10 items, was used in this study. After discussion, the last three items of the original scale were removed so as to take into account the specific situation of participants and research needs, reducing the total to seven (e.g., "I can always manage to solve difficult problems if I try hard enough" and "I am confident that I could deal efficiently with unexpected events"). The scale has four points (1 = not at all true to 4 = very true). In this study, the Cronbach's alpha coefficient of the scale was 0.875.

Deliberate Rumination Inventory

The Deliberate Rumination Inventory, part of the Event-Related Rumination Inventory, developed by Cann et al. (2011), was used in this study. The inventory, consisting of 10 items (e.g., "I thought about whether I could find meaning from my experience" and "I thought about the event and tried to understand what happened"), assesses the frequency of deliberate rumination in injured people. The scale rated on a 4-point Likert scale (1 = not at all and 4 = always). In this study, the Cronbach's alpha coefficient for the inventory was 0.913.

Data Analysis

Version 23.0 of SPSS was used to perform the analysis. Since self-report data were collected for this study, common method biases were tested to ensure its validity by using the Harman single factor test before data processing (Podsakoff et al., 2003). The 74 items in the questionnaire related to the four variables were tested. The results showed that nine factors had eigenvalues greater than 1. These factors contributed 63.876% of the total variance. The first factor explained only 31.878% of the variance, which did not reach the critical criterion of 40% (Zhou and Long, 2004), indicating that there is no significant common methodological bias in this study.

After common-method-bias evaluation, we carried out descriptive analysis, correlation analysis, and model testing of the data based on the research hypotheses. First, we examined trends in concentration and dispersion of the data. Then, we tested the relationships between the independent, mediating, dependent, and moderating variables by calculating Pearson's correlation coefficients. A model was constructed based on the results of the correlation analysis, and the hypotheses proposed were tested, and the PROCESS (version 3.3) plug-in in SPSS was used to test the mediating effect of self-efficacy and the moderating effect of deliberate rumination. [The PROCESS plug-in was developed by Hayes (2013) specifically for path analysis-based regulation and mediator analysis and their combinations].

RESULTS

Descriptive Statistics and Correlations Analyses

Means, standard deviations, and correlations of the study variables were calculated. As shown in **Table 1**, the PTG of participating college students was significantly and positively correlated with general self-efficacy (r = 0.466, p < 0.01) and creativity (r = 0.434, p < 0.01). Their general self-efficacy was positively correlated with creativity (r = 0.475, p < 0.01) and deliberate rumination (r = 0.216, p < 0.01). In addition, deliberate rumination was positively correlated with creativity (r = 0.288, p < 0.01). Thus, the results of the correlation analysis provided preliminary support for the subsequent mediated-effects test. In addition, gender was used as a control variable in the current study. And, it was dummy coded (1, female and 0, male).

Mediation Analysis of Self-Efficacy

Multiple regression analysis was performed using Model 4 of the PROCESS component of SPSS, with PTG as the independent variable, creativity as the dependent variable and general self-efficacy as the mediating variable. As shown in **Table 2**, PTG positively predicted creativity (β = 0.150, SE = 0.018, p < 0.001). As well, PTG was positively correlated to self-efficacy (β = 0.248, SE = 0.016, p < 0.001), and self-efficacy was positively correlated to creativity (β = 0.375, SE = 0.035, p < 0.001).

In addition, we used the bootstrap method to test the confidence interval (CI) estimates, which showed that the 95% confidence intervals for the direct and indirect effects of PTG on creativity did not include 0. Thus, the partial mediator equation model of general self-efficacy held, and self-efficacy was the mediating variable in the relationship between PTG and creativity. The direct effect (0.150) and the mediating effect (0.093) accounted for 61.728 and 38.272% of the total effect, respectively (see **Table 3**).

Moderated Mediation Effects

To test H3, the second half of the mediated model was analyzed by adding the moderating variable deliberate rumination. Then we used SPSS PROCESS Model 14 to test the model. The results showed that deliberate rumination was positively correlated to creativity (β = 0.178, p < 0.001) with a 95% CI [0.111, 0.244]. The interaction term of self-efficacy and deliberate rumination reached a significant level for creativity (β = −0.186, p < 0.001) with a 95% confidence interval of [−0.282, −0.090] (see **Table 4**). The model is shown in **Figure 1**.

In order to further analyze the moderating effect of deliberate rumination, the study divided deliberate rumination into low (M − 1SD) and high (M + 1SD) groups and performed a simple slope analysis. The results showed that 95% of the CIs did not include zero and that deliberate rumination influenced the strength of the relationship between self-efficacy and creativity (see **Table 5**). Self-efficacy was a stronger predictor of creativity with low (i.e., M − 1 SD) levels of deliberate rumination (see **Figure 2**).

DISCUSSION

Discussion of the Results

First, the present study shows that PTG significantly predicts creativity in college students, which was relatively consistent with H1 and previous studies on the positive effects of traumatic events, which have the potential to increase creativity (Forgeard, 2013; Liang et al., 2020). According to the PTG model proposed by Tedeschi and Calhoun (2004), traumatic events change an individual's worldview, and PTG is the result of reconstruction

TABLE 1 | Descriptive statistics and correlations among variables.

Variables	Mean	SD	1	2	3	4
(1) PTG	3.300	1.003	—			
(2) Creativity	3.249	0.563	0.434**	—		
(3) GES	2.318	0.537	0.466**	0.475**	—	
(4) DR	2.012	0.520	0.353**	0.288**	0.216**	—

*N = 881. PTG, post-traumatic growth; GES, general self-efficacy; and DR, deliberate rumination. **p < 0.01; ***p < 0.001.*

TABLE 3 | Total effect, direct effect and indirect effect among the variables.

	Effect size	Boot SE	Boot CI lower limit	Boot CI upper limit	Relative effect size
Total effect	0.243	0.017	0.210	0.277	
Direct effect	0.150	0.018	0.115	0.186	61.728%
Indirect effect	0.093	0.012	0.070	0.118	38.272%

TABLE 2 | Testing the mediating effect of PTG on creativity.

Predictors	On GSE				On creativity			
	β	SE	t	95% CI	β	SE	t	95% CI
Gender	−0.199	0.033	−6.096***	[−0.264, −0.135]	0.044	0.034	1.283	[−0.023,0.111]
PTG	0.248	0.016	15.820***	[0.217,0.279]	0.150	0.018	8.270***	[0.115,0.186]
GES					0.375	0.035	10.843***	[0.307,0.443]
R^2	0.249				0.285			
F	149.807***				116.346***			

*Analyses conducted using PROCESS model 4. N = 881. PTG, post-traumatic growth and GES, general self-efficacy. **p < 0.01; ***p < 0.001.*

TABLE 4 | Testing the moderated mediating effect of PTG on creativity.

Predictors	On GSE				On creativity			
	β	SE	*t*	95% CI	*β*	SE	*t*	95% CI
Gender	−0.199	0.033	−6.096***	[−0.264, −0.135]	0.021	0.034	0.613	[−0.046,0.087]
PTG	0.248	0.016	15.820 ***	[0.217,0.279]	0.122	0.019	6.553***	[0.086,0.159]
GES					0.362	0.034	10.626***	[0.295,0.429]
DR					0.178	0.034	5.222***	[0.111,0.244]
GSE*DR					−0.186	0.049	−3.814***	[−0.282,-0.090]
R^2	0.249				0.311			
F	145.807***				79.000***			

*Analyses conducted using PROCESS model 14. N = 881. PTG, post-traumatic growth; GES, general self-efficacy; and DR, deliberate rumination. **p < 0.01; ***p < 0.001.*

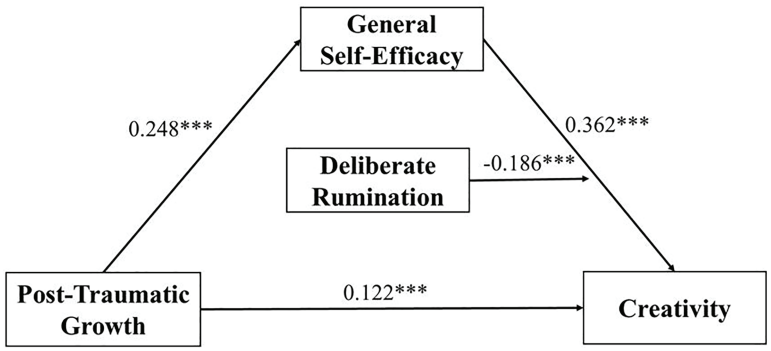

FIGURE 1 | The moderated mediation model.

and integration of cognitive assessments of traumatic events. The cognitive assessment process may involve cognitive neurological and psychological rehabilitation, prompting reflection and return to a way of life more in line with their values, thus changing their behavior and thinking (Baseotto et al., 2020). At the same time, from a mental and behavioral developmental perspective, negative experiences can have an impact on an individual's cognitive and behavioral structure (Yi et al., 2017). When faced with difficulties and distress, they think deeply and explore ways to find a way out of the situation. In the process, they choose new ways of thinking and make an effort to adopt behaviors that build new cognitive structures and behavioral systems (Helson and Roberts, 1994). By using a variety of strategies to solve problems and readjust to a new life, they successfully embrace new ways of making sense of the world and develop new cognitive structures that promote cognitive flexibility and innovative behavior (Cann et al., 2010a). As a result, individuals who have experienced PTG have a more objective and positive perception of the traumatic event and on the challenges of everyday life. This positive emotional state is conducive to creative development (Han et al., 2019). So, measuring levels of PTG can predict an individual's perception of their increased level of creativity.

Second, the findings validate H2a, H2b, and H2. The results show that PTG positively predicts an individual's self-efficacy, which aligns with previous findings that individuals who have experienced PTG may be able to develop greater confidence in themselves (Joseph et al., 1993; Arpawong et al., 2013; Glad et al., 2013). This finding supports the PTG model, which posits positive changes in self-perception (Tedeschi and Calhoun, 2004). In other words, the positive impact of a traumatic event may also be reflected in the individual's reassessment of their ability to face and resolve past or possible future traumatic events in a more confidently and courageously. In addition, individuals with high self-efficacy are more likely to experience PTG (Benight and Bandura, 2004; Prati and Pietrantoni, 2009; Jurišová, 2016). Thus, PTG and self-efficacy are closely related.

The results also validate the positive predictive effect of self-efficacy on creativity, which also aligns with the results of previous studies. According to social cognitive theory, people with high self-efficacy tend to be more open to challenges, put a higher level of effort into an activity and pay more sustained attention to it (Bandura, 1978, 1982). Therefore, with regard to creativity, self-efficacy affects the individual's abilities to engage in the creative process: persons with low self-efficacy may cease their efforts when faced with challenges and dilemmas, and so fail to produce a product of creative value. In addition, the component model of creativity points by Amabile (1988) to internal motivation as one of the most important factors influencing creativity. Individuals with high self-efficacy, which is a source of motivation, tend to set creative goals and are confident of reaching them (Intasao and Hao, 2018). However, those with doubts about their own abilities tend to avoid situations and tasks that are beyond their creative reach,

which can make it difficult for them to develop and demonstrate practical skills and abilities (Locke and Latham, 2006). During the COVID-19 pandemic, college students who experienced PTG may have increase their level of self-efficacy, which had a protective effect on cognitive (Wang et al., 2014). As a result, they have been able to gather materials and ideas from life in a more positive frame of mind and stimulate their creative behavior. In summary, it is logical that self-efficacy plays a mediating role between PTG and creativity.

Third, the results are also consistent with H3a, H3b, H3c, and the results of other studies. To begin, deliberate rumination by college students had a positive impact on PTG, which validates previous research that showed that deliberate rumination has a constructive effect on human development. Therefore, in mental health counseling and interventions for college students, it is important to help them to transform cathartic negative thoughts and emotions into positive perceptions of the traumatic event in order to facilitate the occurrence of PTG. Further, deliberate rumination had a positive effect on college students' creativity (Verhaeghen et al., 2005, 2014; Forgeard et al., 2020). In past studies, self-efficacy and rumination were considered as important factors influencing individual physical and mental growth, with the former often representing a positive influence and the latter being associated with mental illness (Takagishi et al., 2013; Karabati et al., 2017; Nota and Coles, 2018), However, the two dimensions of rumination have not been comprehensively discussed. Deliberate rumination, which involves active self-reflection and reflection, can help individuals to better cope with difficult situations (Dunn and Sensky, 2018). Finally, deliberate rumination had a positive correlation with students' self-efficacy, which is consistent with the findings of previous studies (Bandura, 1997; Brown et al., 2016). The frequency of rumination among college students influenced their level of creativity and deliberate rumination, which means individual have positive beliefs stimulates creative interests and behaviors.

Fourth, the present study found that deliberate rumination plays a moderating role in the influence of college students' self-efficacy on creativity, which confirms H3. The present study found that the positive effect of self-efficacy on creativity was more significant for college students with lower levels of deliberate rumination compared to those with high levels of deliberate rumination. According to Cann et al. (2011), deliberate rumination enables people to positively understand negative events in order to solve problems. As mentioned above, deliberate rumination has been found to be an important predictor of PTG. For example, it has been shown that deliberate rumination motivates individuals to rethink the world, others, and self and to take the initiative to obtain social support to reduce stress and grow (Xu et al., 2019). Therefore, college students with higher levels of deliberate rumination have the ability and means to solve problems and rate their level of creativity higher. In contrast, students with low levels of deliberate rumination inhibit the development of creativity due to a lack of proactive and constructive thinking about events and problems (Cohen and Ferrari, 2010; Vahle-Hinz et al., 2017).

However, it does not mean that higher levels of deliberate rumination are better, because students with low levels of deliberate rumination were more likely to be influenced by self-efficacy as a factor. As the frequency of deliberate rumination decreased, the effect of self-efficacy on creativity increased. While deliberate rumination assists individuals in finding meaning in stressful events, this meaning may involve negative beliefs, worldviews, and self-concepts (Kamijo and Yukawa, 2018), which may lead to negative emotions, which reveals that when suffer a stressful event, individuals who possess strong deliberate rumination may reinforce the recurrence of negative emotions to the extent that they reduce their self-efficacy in dealing with the stressful event, thus weakening the development of creativity. The high levels of deliberate rumination are more likely lead to negative emotions due to the fact that during the COVID-19 outbreak, students studied at home for long periods of time and were unable to

TABLE 5 | Conditional indirect effect at specific levels of deliberate rumination when mediated by general self-efficacy.

Conditional effect of DR	Effect	Boot SE	95%CI
Low (M – 1 SD)	0.114	0.016	[0.081,0.147]
Medium (M)	0.090	0.012	[0.066,0.114]
High (M + 1 SD)	0.066	0.015	[0.036,0.094]

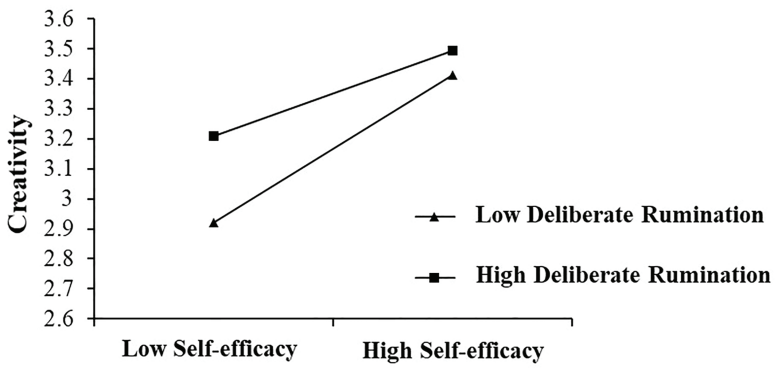

FIGURE 2 | The relationship between self-efficacy and creativity for high and low levels of deliberate rumination.

communicate with others and so resolve their confusion. Then changes in self-efficacy have less impact on the effect of creativity under the effect of negative emotions such as anxiety and helplessness (Hu et al., 2015). Dispersed thinking is a core component of creative thinking (Runco and Acar, 2012). When deliberate rumination levels are lower, individuals with high levels of self-efficacy are able to positively think and solve problems from multiple perspectives due to reduced frequency of repetitive thinking about events and constant self-focusing. Then the influence of self-efficacy on creativity is subsequently enhanced.

Implications

In a theoretical sense, our study links PTG and creativity, a new learning that deepens understanding of the positive impact of traumatic events on the mechanisms of creativity. In addition, the researchers analyzed mediating and moderating effects. Using self-efficacy as a mediating variable, they found that the PTG of college students increased their self-efficacy and ultimately had a positive effect on their creativity, while deliberate rumination had a moderating effect on self-efficacy and creativity.

In a practical sense, this study has described the relationship between the four variables presented in this study, which may help researchers to better understand the mechanisms by which creativity develops after trauma. Therefore, the negative impact of major public health events, such as the COVID-19 pandemic, can be alleviated through positive psychological interventions with the college student population. This theory has a great guiding role in reality. After college students experience traumatic events, effective measures can be taken to promote their PTG, improving their self-efficacy and avoiding them having too high frequency of deliberate rumination so as to develop their creativity. During the outbreak confinement, The Ministry of Education of the People's Republic of China asked universities to set up psychological support hotlines and online counseling services to mitigate the psychological damage caused to students. For instance, several universities provided psychological counseling services for students, offering them access to psychological problems, timely follow-up by professionals, and regular visits thus providing better attention to students' PTG (The Ministry of Education of the People's Republic of China, 2020). Second, news media should also focus on promoting healthy lifestyles and new forms of activities that emerge during the COVID-19 pandemic, such as online supermarkets, video consultations, and live home activities, which will help the public to build confidence in their lives and avoid excessive attention of epidemic-related information. Meanwhile, the mutual assistance of epidemic prevention resources and the timely response of staff to residents' needs in the community will enhance individuals' sense of security and alleviate the negative feelings associated with isolation and excessive rumination. Such interventions can help the students to reconstruct their perception of adversity and enable them to develop positive self-beliefs and so promote the creative process.

Limitations and Future Directions

This study has certain limitations. First, the cross-sectional study used in this study, while revealing correlations between the variables, does not allow for inference of causality between the variables tested. Future researchers could conduct longitudinal studies to determine whether the scores measured effectively represent an actual increase in creativity. Second, this study was conducted with college students from the same college, and due to the limitations of sampling at that time, gender balance of the samples was not achieved. In the future, the external validity of the results of this study can be tested by selecting subjects from a wider range of sources and more balanced gender. Third, this study only focused on the moderating effect of deliberate rumination between self-efficacy and creativity. Future research could further expand on the effects of other dimensions of rumination on creativity after a traumatic event. Finally, the effects of other factors, such as major discipline and gender on the four variables, have not been explored in this study, and future research could include control variables to further clarify the relationship between the four variables.

CONCLUSION

This study tested a moderated mediation model to examine the relationship between PTG and creativity, and the mediating role of self-efficacy between the two and the moderating role of deliberate rumination in college students during the COVID-19 pandemic. The results showed that PTG positively predicted creativity while self-efficacy mediated the relationship between the two. Furthermore, deliberate rumination moderated self-efficacy in the second half of the mediating pathway between PTG and creativity. More specifically, the positive predictive effect of self-efficacy on creativity was more pronounced at low levels of deliberate rumination.

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 Institutional Ethics Committee of School of Geography, South China Normal University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

WZ and YX designed the research and reviewed and edited the paper. YZ, WZ, YX, and DH carried out the literature search and data analysis. WZ, YZ, YX, JS, XW, JW, and DH wrote the paper. All authors have read and agreed to the published version of the manuscript.

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REFERENCES

Alamdar, S., Lv, Y., Guo, J., Lu, J., and Zhang, Y. (2020). Attentional bias effect on post-traumatic outcomes in children after earthquake: mediation role of rumination. *Psych J.* 9, 738–748. doi: 10.1002/pchj.360

Amabile, T. (1988). A model of creativity and innovation in organizations. *Res. Organ. Behav.* 10, 123–167.

Amabile, T. (1996). *Creativity in context: Update to "The social psychology of creativity"*. Boulder, CO: Westview Press.

American Psychiatric Association (2013). *Diagnostic and statistical manual of mental disorders: Fifth edition (DSM-5)*. Washington, DC: American Psychiatric Publishing.

Andersson, L. M. C., Moore, C. D., Hensing, G., Krantz, G., and Staland-Nyman, C. (2014). General self-efficacy and its relationship to self-reported mental illness and barriers to care: a general population study. *Community Ment. Health J.* 50, 721–728. doi: 10.1007/s10597-014-9722-y

Andrades, M., García, F. E., Calonge, I., and Martínez-Arias, R. (2017). Posttraumatic growth in children and adolescents exposed to the 2010 earthquake in Chile and its relationship with rumination and posttraumatic stress symptoms. *J. Happiness Stud.* 19, 1505–1517. doi: 10.1007/s10902-017-9885-7.4

Arpawong, T. E., Oland, A., Milam, J. E., Ruccione, K., and Meeske, K. A. (2013). Post-traumatic growth among an ethnically diverse sample of adolescent and young adult cancer survivors. *Psychooncology* 22, 2235–2244. doi: 10.1002/pon.3286

Baillie, S. E., Sellwood, W., and Wisely, J. A. (2014). Post-traumatic growth in adults following a burn. *Burns* 40, 1089–1096. doi: 10.1016/j.burns.2014.04.007

Bandura, A. (1978). Self-efficacy: toward a unifying theory of behavioral change. *Adv. Behav. Res. Ther.* 1, 139–161. doi: 10.1016/0146-6402(78)90002-4

Bandura, A. (1982). Self-efficacy mechanism in human agency. *Am. Psychol.* 37, 122–147. doi: 10.1037/0003-066X.37.2.122

Bandura, A. (1990). Perceived self-efficacy in the exercise of control over AIDS infection. *Eval. Program Plann.* 13, 9–17. doi: 10.1016/0149-7189(90)90004-G

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W. H. Freeman.

Bandura, A. (2011). On the functional properties of perceived self-efficacy revisited. *J. Manag.* 38, 9–44. doi: 10.1177/0149206311410606

Barskova, T., and Oesterreich, R. (2009). Post-traumatic growth in people living with a serious medical condition and its relations to physical and mental health: a systematic review. *Disabil. Rehabil.* 31, 1709–1733. doi: 10.1080/09638280902738441

Baseotto, M. C., Morris, P. G., Gillespie, D. C., and Trevethan, C. T. (2020). Post-traumatic growth and value-directed living after acquired brain injury. *Neuropsychol. Rehabil.* 3, 1–20. doi: 10.1080/09602011.2020.1798254

Benedek, M., Jauk, E., Sommer, M., Arendasy, M., and Neubauer, A. C. (2014). Intelligence, creativity, and cognitive control: the common and differential involvement of executive functions in intelligence and creativity. *Dermatol. Int.* 46, 73–83. doi: 10.1016/j.intell.2014.05.007

Benight, C. C., and Bandura, A. (2004). Social cognitive theory of posttraumatic recovery: the role of perceived self-efficacy. *Behav. Res. Ther.* 42, 1129–1148. doi: 10.1016/j.brat.2003.08.008

Binnewies, C., Sonnentag, S., and Mojza, E. J. (2009). Feeling recovered and thinking about the good sides of one's work. *J. Occup. Health Psychol.* 14, 243–256. doi: 10.1037/a0014933

Blackie, L., and Jayawickreme, E. (2014). Promoting change in post-traumatic growth research: response to commentaries. *Eur. J. Pers.* 28, 351–361. doi: 10.1002/per.1970

Brislin, R. (1970). Back-translation for cross-cultural research. *J. Cross-Cult. Psychol.* 1, 185–216. doi: 10.1177/135910457000100301

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., et al. (2020). The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet* 395, 912–920. doi: 10.1016/S0140-6736(20)30460-8

Brown, A. D., Kouri, N. A., Rahman, N., Joscelyne, A., Bryant, R. A., and Marmar, C. R. (2016). Enhancing self-efficacy improves episodic future thinking and social-decision making in combat veterans with posttraumatic stress disorder. *Psychiatry Res.* 242, 19–25. doi: 10.1016/j.psychres.2016.05.026

Büchi, S., Mörgeli, H., Schnyder, U., Jenewein, J., Hepp, U., Jina, E., et al. (2007). Grief and post-traumatic growth in parents 2–6 years after the death of their extremely premature baby. *Psychother. Psychosom.* 76, 106–114. doi: 10.1159/000097969

Cann, A., Calhoun, L. G., Tedeschi, R. G., Kilmer, R. P., Gil-Rivas, V., Vishnevsky, T., et al. (2010a). The Core Beliefs Inventory: a brief measure of disruption in the assumptive world. *Anxiety Stress Coping* 23, 19–34. doi: 10.1080/10615800802573013

Cann, A., Calhoun, L. G., Tedeschi, R. G., and Solomon, D. T. (2010b). Posttraumatic growth and depreciation as independent experiences and predictors of well-being. *J. Loss Trauma* 15, 151–166. doi: 10.1080/15325020903375826

Cann, A., Calhoun, L. G., Tedeschi, R. G., Triplett, K. N., Vishnevsky, T., and Lindstrom, C. M. (2011). Assessing posttraumatic cognitive processes: The Event Related Rumination Inventory. *Anxiety Stress Coping* 24, 137–1156. doi: 10.1080/10615806.2010.529901

Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., et al. (2020). The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Res.* 287:112934. doi: 10.1016/j.psychres.2020.112934

Chang, S.-H., Wang, C.-L., and Lee, J.-C. (2016). Do award-winning experiences benefit students' creative self-efficacy and creativity? The moderated mediation effects of perceived school support for creativity. *Learn. Individ. Differ.* 51, 291–298. doi: 10.1016/j.lindif.2016.09.011

Chi, X., Becker, B., Yu, Q., Willeit, P., Jiao, C., Huang, L., et al. (2020). Prevalence and psychosocial correlates of mental health outcomes among Chinese college students during the coronavirus disease (COVID-19) pandemic. *Front. Psych.* 11:803. doi: 10.3389/fpsyt.2020.00803

Cohen, J. R., and Ferrari, J. R. (2010). Take some time to think this over: the relation between rumination, indecision, and creativity. *Creat. Res. J.* 22, 68–73. doi: 10.1080/10400410903579601

Di Giuseppe, M., Zilcha-Mano, S., Prout, T. A., Perry, J. C., Orru, G., and Conversano, C. (2020). Psychological impact of coronavirus disease 2019 among italians during the first week of lockdown. *Front. Psych.* 11:576597. doi: 10.3389/fpsyt.2020.576597

Dickerson, S. S., and Kemeny, M. E. (2004). Acute stressors and cortisol responses: a theoretical integration and synthesis of laboratory research. *Psychol. Bull.* 130, 355–391. doi: 10.1037/0033-2909.130.3.355

Dorman-Ilan, S., Hertz-Palmor, N., Brand-Gothelf, A., Hasson-Ohayon, I., Matalon, N., Gross, R., et al. (2020). Anxiety and depression symptoms in COVID-19 isolated patients and in their relatives. *Front. Psych.* 11:581598. doi: 10.3389/fpsyt.2020.581598

Du, K., Wang, Y., Ma, X., Luo, Z., Wang, L., and Shi, B. (2020). Achievement goals and creativity: the mediating role of creative self-efficacy. *Educ. Psychol.* 40, 1249–1269. doi: 10.1080/01443410.2020.1806210

Dunn, J. M., and Sensky, T. (2018). Psychological processes in chronic embitterment: the potential contribution of rumination. *Psychol. Trauma* 10, 7–13. doi: 10.1037/tra0000291

Edl, S., Benedek, M., Papousek, I., Weiss, E., and Fink, A. (2014). Creativity and the Stroop interference effect. *Personal. Individ. Differ.* 69, 38–42. doi: 10.1016/j.paid.2014.05.009

Forgeard, M. J. C. (2013). Perceiving benefits after adversity: the relationship between self-reported posttraumatic growth and creativity. *Psychol. Aesthet. Creat. Arts* 7, 245–264. doi: 10.1037/a0031223

Forgeard, M., Corcoran, E., Beard, C., and Bjorgvinsson, T. (2020). Relationships between depression, self-reflection, brooding, and creative thinking in a psychiatric sample. *Psychol. Aesthet. Creat. Arts* 14, 325–333. doi: 10.1037/aca0000206

Frazier, P., Conlon, A., and Glaser, T. (2001). Positive and negative life changes following sexual assault. *J. Consult. Clin. Psychol.* 69, 1048–1055. doi: 10.1037/0022-006X.69.6.1048

Geng, Y., Xu, Q., Liu, H., and Xu, X. (2011). Reliability and validity analysis of the Chinese Post-traumatic Growth Scale in multiple trauma survivors. *Chin. J. Nurs.* 46, 1003–1005. doi: 10.3761/j.issn.0254-1769.2011.10.023

Glad, K. A., Jensen, T. K., Holt, T., and Ormhaug, S. M. (2013). Exploring self-perceived growth in a clinical sample of severely traumatized youth. *Child Abuse Negl.* 37, 331–342. doi: 10.1016/j.chiabu.2013.02.007

Grignoli, N., Petrocchi, S., Bernardi, S., Massari, I., Traber, R., Malacrida, R., et al. (2021). Influence of empathy disposition and risk perception on the psychological impact of lockdown during the coronavirus disease pandemic outbreak. *Front. Public Health* 8:567337. doi: 10.3389/fpubh.2020.567337

Groarke, A., Curtis, R., Groarke, J. M., Hogan, M. J., Gibbons, A., and Kerin, K. (2017). Post-traumatic growth in breast cancer: how and when do distress and stress contribute? *Psychooncology* 26, 967–974. doi: 10.1002/pon.4243

Guilford, J. P. (1950). Creativity. *Am. Psychol.* 5, 444–454. doi: 10.1037/h0063487

Han, W., Feng, X., Zhang, M., Peng, K. P., and Zhang, D. (2019). Mood states and everyday creativity: employing an experience sampling method and a day reconstruction method. *Front. Psychol.* 10:1698. doi: 10.3389/fpsyg.2019.01698

Hayes, A. F. (2013). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. New York, NY: Guilford Press.

Helson, R., and Roberts, B. (1994). Ego development and personality change in adulthood. *J. Pers. Soc. Psychol.* 66, 911–920. doi: 10.1037/0022-3514.66.5.911

Hu, W., Wang, B., Duan, H., Cheng, L., Zhou, H., and Li, J. (2015). Neural mechanism of creative cognitive process influenced by emotion. *Adv. Psychol. Sci.* 23, 1869–1878. doi: 10.3724/SP.J.1042.2015.01869

Intasao, N., and Hao, N. (2018). Beliefs about creativity influence creative performance: the mediation effects of flexibility and positive affect. *Front. Psychol.* 9:1810. doi: 10.3389/fpsyg.2018.01810

Jaiswal, N. K., and Dhar, R. L. (2016). Fostering employee creativity through transformational leadership: moderating role of creative self-efficacy. *Creat. Res. J.* 28, 367–371. doi: 10.1080/10400419.2016.1195631

Jia, X., Liu, X., Ying, L., and Lin, C. (2017). Longitudinal relationships between social support and posttraumatic growth among adolescent survivors of the wenchuan earthquake. *Front. Psychol.* 8:1275. doi: 10.3389/fpsyg.2017.01275

Joseph, S., and Linley, P. A. (2005). Positive adjustment to threatening events: an organismic valuing theory of growth through adversity. *Rev. Gen. Psychol.* 9, 262–280. doi: 10.1037/1089-2680.9.3.262

Joseph, S., Williams, R., and Yule, W. (1993). Changes in outlook following disaster: the preliminary development of a measure to assess positive and negative responses. *J. Trauma. Stress.* 6, 271–279. doi: 10.1002/jts.2490060209

Jurišová, E. (2016). Coping strategies and post-traumatic growth in paramedics: moderating effect of specific self-efficacy and positive/negative affectivity. *Stud. Psychol.* 58, 259–275. doi: 10.21909/sp.2016.04.722

Kamijo, N., and Yukawa, S. (2018). The role of rumination and negative affect in meaning making following stressful experiences in a Japanese sample. *Front. Psychol.* 9:2404. doi: 10.3389/fpsyg.2018.02404

Karabati, S., Ensari, N., and Fiorentino, D. (2017). Job satisfaction, rumination, and subjective well-being: a moderated mediational model. *J. Happiness Stud.* 20, 251–268. doi: 10.1007/s10902-017-9947-x

Lahav, Y. (2020). Psychological distress related to COVID-19—The contribution of continuous traumatic stress. *J. Affect. Disord.* 277, 129–137. doi: 10.1016/j.jad.2020.07.141

Li, X., Lv, S., Liu, L., Chen, R., Chen, J., Liang, S., et al. (2020). COVID-19 in Guangdong: immediate perceptions and psychological impact on 304,167 college students. *Front. Psychol.* 11:2024. doi: 10.3389/fpsyg.2020.02024

Li, S., Wang, Y., Xue, J., Zhao, N., and Zhu, T. (2020). The impact of COVID-19 epidemic declaration on psychological consequences: a study on active Weibo users. *Int. J. Environ. Res. Public Health* 17:2032. doi: 10.3390/ijerph17062032

Li, C.-R., Yang, Y., Lin, C.-J., and Xu, Y. (2020). Within-person relationship between creative self-efficacy and individual creativity: the mediator of creative process engagement and the moderator of regulatory focus. *J. Creat. Behav.* 55, 63–78. doi: 10.1002/jocb.435

Liang, Y., Zheng, H., Cheng, J., Zhou, Y., and Liu, Z. (2020). Associations between posttraumatic stress symptoms, creative thinking, and trait resilience among Chinese adolescents exposed to the Lushan earthquake. *J. Creat. Behav.* 1–12. doi: 10.1002/jocb.460

Linley, P. A., and Joseph, S. (2004). Positive change following trauma and adversity: a review. *J. Trauma. Stress* 17, 11–21. doi: 10.1023/B:JOTS.0000014671.27856.7e

Liu, W., Pan, Y., Luo, X., Wang, L., and Pang, W. (2017). Active procrastination and creative ideation: the mediating role of creative self-efficacy. *Personal. Individ. Differ.* 119, 227–229. doi: 10.1016/j.paid.2017.07.033

Liu, A.-N., Wang, L.-L., Li, H.-P., Gong, J., and Liu, X.-H. (2016). Correlation between posttraumatic growth and posttraumatic stress disorder symptoms based on Pearson correlation coefficient: a meta-analysis. *J. Nerv. Ment. Dis.* 205, 380–389. doi: 10.1097/NMD.0000000000000605

Locke, E. A., and Latham, G. P. (2006). New directions in goal-setting theory. *Curr. Dir. Psychol. Sci.* 15, 265–268. doi: 10.1111/j.1467-8721.2006.00449.x

Ma, Z., Long, L., Zhang, Y., Zhang, J., and Lam, C. K. (2017). Why do high-performance human resource practices matter for team creativity? The mediating role of collective efficacy and knowledge sharing. *Asia Pac. J. Manag.* 34, 565–586. doi: 10.1007/s10490-017-9508-1

Mathisen, G. E. (2011). Organizational antecedents of creative self-efficacy. *Creat. Innov. Manag.* 20, 185–195. doi: 10.1111/j.1467-8691.2011.00606.x

Mathisen, G., and Brønnick, K. (2009). Creative self-efficacy: an intervention study. *Int. J. Educ. Res.* 48, 21–29. doi: 10.1016/j.ijer.2009.02.009

Newman, A., Tse, H. H. M., Schwarz, G., and Nielsen, I. (2018). The effects of employees' creative self-efficacy on innovative behavior: the role of entrepreneurial leadership. *J. Bus. Res.* 89, 1–9. doi: 10.1016/j.jbusres.2018.04.001

Ng, T., and Lucianetti, L. (2015). Within-individual increases in innovative behavior and creative, persuasion, and change self-efficacy over time: a social-cognitive theory perspective. *J. Appl. Psychol.* 101, 14–34. doi: 10.1037/apl0000029

Nierop, A., Wirtz, P. H., Aliki Bratsikas, A., Zimmermann, R., and Ehlert, U. (2008). Stress-buffering effects of psychosocial resources on physiological and psychological stress response in pregnant women. *Biol. Psychol.* 78, 261–268. doi: 10.1016/j.biopsycho.2008.03.012

Niu, W., and Kaufman, J. (2005). Creativity in troubled times: factors associated with recognitions of Chinese literary creativity in the 20th century. *J. Creat. Behav.* 39, 57–67. doi: 10.1002/j.2162-6057.2005.tb01249.x

Nolen-Hoeksema, S., Wisco, B., and Lyubomirsky, S. (2008). Rethinking rumination. *Perspect. Psychol. Sci.* 3, 400–424. doi: 10.1111/j.1745-6924.2008.00088.x

Nota, J. A., and Coles, M. E. (2018). Shorter sleep duration and longer sleep onset latency are related to difficulty disengaging attention from negative emotional images in individuals with elevated transdiagnostic repetitive negative thinking. *J. Behav. Ther. Exp. Psychiatry* 58, 114–122. doi: 10.1016/j.jbtep.2017.10.003

Paulus, P. B., Levine, D. S., Brown, V., Minai, A. A., and Doboli, S. (2010). Modeling ideational creativity in groups: connecting cognitive, neural, and computational approaches. *Small Group Res.* 41, 688–724. doi: 10.1177/1046496410369561

Pérez-San-Gregorio, M. Á., Martín-Rodríguez, A., Borda-Mas, M., Avargues-Navarro, M. L., Pérez-Bernal, J., and Gómez-Bravo, M. A. (2017). Coping strategies in liver transplant recipients and caregivers according to patient posttraumatic growth. *Front. Psychol.* 8:18. doi: 10.3389/fpsyg.2017.00018

Peterson, C., Park, N., Pole, N., D'Andrea, W., and Seligman, M. E. P. (2008). Strengths of character and posttraumatic growth. *J. Trauma. Stress.* 21, 214–217. doi: 10.1002/jts.20332

Plucker, J. A., Beghetto, R. A., and Dow, G. T. (2004). Why isn't creativity more important to educational psychologists? Potentials, pitfalls, and future directions in creativity research. *Educ. Psychol.* 39, 83–96. doi: 10.1207/s15326985ep3902_1

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., and Podsakoff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *J. Appl. Psychol.* 88, 879–903. doi: 10.1037/0021-9010.88.5.879

Prati, G., and Pietrantoni, L. (2009). Optimism, social support, and coping strategies as factors contributing to posttraumatic growth: a meta-analysis. *J. Loss Trauma* 14, 364–388. doi: 10.1080/15325020902724271

Rhodes, M. (1961). An analysis of creativity. *Phi Delta Kappan* 42, 305–310.

Rider Mundey, K., Nicholas, D., Kruczek, T., Tschopp, M., and Bolin, J. (2018). Posttraumatic growth following cancer: The influence of emotional intelligence, management of intrusive rumination, and goal disengagement as mediated by deliberate rumination. *J. Psychosoc. Oncol.* 37, 1–22. doi: 10.1080/07347332.2018.1514449

Rimal, R. N. (2000). Closing the knowledge-behavior gap in health promotion: the mediating role of self-efficacy. *Health Commun.* 12, 219–237. doi: 10.1207/S15327027HC1203_01

Roma, P., Monaro, M., Muzi, L., Colasanti, M., Ricci, E., Biondi, S., et al. (2020). How to improve compliance with protective health measures during the COVID-19 outbreak: testing a moderated mediation model and machine learning algorithms. *Int. J. Environ. Res. Public Health* 17:7252. doi: 10.3390/ijerph17197252

Rossi, R., Socci, V., Talevi, D., Mensi, S., Niolu, C., Pacitti, F., et al. (2020). COVID-19 pandemic and lockdown measures impact on mental health among the general population in Italy. *Front. Psych.* 11:790. doi: 10.3389/fpsyt.2020.00790

Runco, M. A., and Acar, S. (2012). Divergent thinking as an indicator of creative potential. *Creat. Res. J.* 24, 66–75. doi: 10.1080/10400419.2012.652929

Runco, M. A., and Jaeger, G. J. (2012). The standard definition of creativity. *Creat. Res. J.* 24, 92–96. doi: 10.1080/10400419.2012.650092

Runco, M. A., Plucker, J. A., and Lim, W. (2000). Development and psychometric integrity of a measure of ideational behavior. *Creat. Res. J.* 13, 393–400. doi: 10.1207/S15326934CRJ1334_16

Schönfeld, P., Ackermann, K., and Schwabe, L. (2013). Remembering under stress: different roles of autonomic arousal and glucocorticoids in memory retrieval. *Psychoneuroendocrinology* 39, 249–256. doi: 10.1016/j.psyneuen.2013.09.020

Schwarzer, R., Bäßler, J., Kwiatek, P., Schröder, K., and Zhang, J. X. (1997). The assessment of optimistic self-beliefs: comparison of the German, Spanish, and Chinese versions of the General Self-Efficacy Scale. *Appl. Psychol.* 46, 69–88. doi: 10.1111/j.1464-0597.1997.tb01096.x

Shakespeare-Finch, J., and Lurie-Beck, J. (2014). A meta-analytic clarification of the relationship between posttraumatic growth and symptoms of posttraumatic distress disorder. *J. Anxiety Disord.* 28, 223–229. doi: 10.1016/j.janxdis.2013.10.005

Sharp, L., Redfearn, D., Timmons, A., Balfe, M., and Patterson, J. (2018). Posttraumatic growth in head and neck cancer survivors: is it possible and what are the correlates? *Psychooncology* 27, 1517–1523. doi: 10.1002/pon.4682

Siegel, K., and Schrimshaw, E. (2000). Perceiving benefits in adversity: stress-related growth in women living with HIV/AIDS. *Soc. Sci. Med.* 51, 1543–1554. doi: 10.1016/S0277-9536(00)00144-1

Simonton, D. K. (1994). *Greatness: Who makes history and why*. New York: Guilford Press.

Somer, E., Abu-Rayya, H. M., Schimmenti, A., Metin, B., Brenner, R., Ferrante, E., et al. (2020). Heightened levels of maladaptive daydreaming are associated with COVID-19 lockdown, pre-existing psychiatric diagnoses, and intensified psychological dysfunctions: a multi-country study. *Front. Psych.* 11:587455. doi: 10.3389/fpsyt.2020.587455

Sternberg, R., and Lubart, T. I. (1991). An investment theory of creativity and its development. *Hum. Dev.* 34, 1–31. doi: 10.1159/000277029

Strecher, V. J., DeVellis, B. M., Becker, M. H., and Rosenstock, I. M. (1986). The role of self-efficacy in achieving health behavior change. *Health Educ. Q.* 13, 73–92. doi: 10.1177/109019818601300108

Sun, X., Li, X., Huang, J., and An, Y. (2020). Prevalence and predictors of PTSD, depression and posttraumatic growth among Chinese firefighters. *Arch. Psychiatr. Nurs.* 34, 4–18. doi: 10.1016/j.apnu.2019.12.007

Takagishi, Y., Sakata, M., and Kitamura, T. (2013). Influence of rumination and self-efficacy on depression in Japanese undergraduate nursing students. *Asian J. Soc. Psychol.* 16, 163–168. doi: 10.1111/ajsp.12000

Tedeschi, R. G., and Calhoun, L. G. (1996). The Posttraumatic Growth Inventory: measuring the positive legacy of trauma. *J. Trauma. Stress.* 9, 455–471. doi: 10.1002/jts.2490090305

Tedeschi, R. G., and Calhoun, L. G. (2004). Posttraumatic growth: conceptual foundations and empirical evidence. *Psychol. Inq.* 15, 1–18. doi: 10.1207/s15327965pli1501_01

The Ministry of Education of the People's Republic of China (2020). Principles of opening psychological support hotlines and network counseling services for the new coronavirus pneumonia in the education system. Available at: http://www.gov.cn/xinwen/2020-01/28/content_5472681.htm (Accessed July 18, 2020).

Treffinger, D. J. (2009). Myth 5: creativity is too difficult to measure. *Gift. Child Q.* 53, 245–247. doi: 10.1177/0016986209346829

Vahle-Hinz, T., Mauno, S., de Bloom, J., and Kinnunen, U. (2017). Rumination for innovation? Analysing the longitudinal effects of work-related rumination on creativity at work and off-job recovery. *Work Stress* 31, 315–337. doi: 10.1080/02678373.2017.1303761

Verhaeghen, P., Joorman, J., and Khan, R. (2005). Why we sing the blues: the relation between self-reflective rumination, mood, and creativity. *Emotion* 5, 226–232. doi: 10.1037/1528-3542.5.2.226

Verhaeghen, P., Joormann, J., and Aikman, S. N. (2014). Creativity, mood, and the examined life: self-reflective rumination boosts creativity, brooding breeds dysphoria. *Psychol. Aesthet. Creat. Arts* 8, 211–218. doi: 10.1037/a0035594

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C. S., et al. (2020). Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *Int. J. Environ. Res. Public Health* 17:1729. doi: 10.3390/ijerph17051729

Wang, Y., Yao, L., Liu, L., Yang, X., Wu, H., Wang, J., et al. (2014). The mediating role of self-efficacy in the relationship between big five personality and depressive symptoms among Chinese unemployed population: a cross-sectional study. *BMC Psychiatry* 14:61. doi: 10.1186/1471-244X-14-61

Wang, Q., Zhao, X., Yuan, Y., and Shi, B. (2021). The relationship between creativity and intrusive rumination among chinese teenagers during the COVID-19 pandemic: emotional resilience as a moderator. *Front. Psychol.* 11:601104. doi: 10.3389/fpsyg.2020.601104

Wiechman Askay, S., and Magyar-Russell, G. (2009). Post-traumatic growth and spirituality in burn recovery. *Int. Rev. Psychiatry* 21, 570–579. doi: 10.3109/09540260903344107

Wiedenfeld, S. A., O'Leary, A., Bandura, A., Brown, S., Seymour, L., and Raska, K. (1990). Impact of perceived self-efficacy in coping with stressors on components of the immune system. *J. Pers. Soc. Psychol.* 59, 1082–1094. doi: 10.1037/0022-3514.59.5.1082

Wu, D., Yu, L., Yang, T., Cottrell, R., Peng, S., Guo, W., et al. (2020). The impacts of uncertainty stress on mental disorders of Chinese college students: evidence from a nationwide study. *Front. Psychol.* 11:243. doi: 10.3389/fpsyg.2020.00243

Wu, X., Zhou, X., Wang, W., and Tian, Y. (2018). Dialectical understanding posttraumatic stress disorder and posttraumatic growth: a perspective of integration and comparison. *J. Beij. Nor. Univ. (Soc. Sci.)* 266, 41–50.

Wu, X., Zhou, X., Wu, Y., and An, Y. (2015). The role of rumination in posttraumatic stress disorder and posttraumatic growth among adolescents after the Wenchuan earthquake. *Front. Psychol.* 6:1335. doi: 10.3389/fpsyg.2015.01335

Xu, W., Jiang, H., Zhou, Y., Zhou, L., and Fu, H. (2019). Intrusive rumination, deliberate rumination, and posttraumatic growth among adolescents after a Tornado: the role of social support. *J. Nerv. Ment. Dis.* 207, 152–156. doi: 10.1097/NMD.0000000000000926

Ye, B., Wu, D., Im, H., Liu, M., Wang, X., and Yang, Q. (2020). Stressors of COVID-19 and stress consequences: the mediating role of rumination and the moderating role of psychological support. *Child Youth Serv. Rev.* 118:105466. doi: 10.1016/j.childyouth.2020.105466

Yehuda, R. (2002). Post-traumatic stress disorder. *N. Engl. J. Med.* 346, 108–114. doi: 10.1056/NEJMra012941

Yi, X., Chen, P., and Zhao, W. (2017). Creative achievements and affecters of eminent writers in Tang and Song dynasties: a historiometric account. *J. Beij. Nor. Univ. (Soc. Sci.)* 262, 33–40. doi: 10.3969/j.issn.1002-0209.2017.04.004

Zalewska-Puchala, J., Majda, A., Galuszka, A., and Kolonko, J. (2007). Health behaviour of students versus a sense of self-efficacy. *Adv. Med. Sci.* 52, 73–77.

Zhao, H., He, X., Fan, G., Li, L., Huang, Q., Qiu, Q., et al. (2020). COVID-19 infection outbreak increases anxiety level of general public in China: involved mechanisms and influencing factors. *J. Affect. Disord.* 276, 446–452. doi: 10.1016/j.jad.2020.07.085

Zhou, H., and Long, L. (2004). Statistical remedies for common method biases. *Adv. Psychol. Sci.* 12, 942–950. doi: 10.3969/j.issn.1671-3710.2004.06.018

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How Does Digital Competence Preserve University Students' Psychological Well-Being During the Pandemic? An Investigation From Self-Determined Theory

Xinghua Wang[1], Ruixue Zhang[2], Zhuo Wang[1] and Tiantian Li[1]*

[1] Normal College, Qingdao University, Qingdao, China, [2] School of Mathematics and Statistics, Qingdao University, Qingdao, China

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****Correspondence:***
Ruixue Zhang
ruixuezhang9@gmail.com

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Wang X, Zhang R, Wang Z and Li T (2021) How Does Digital Competence Preserve University Students' Psychological Well-Being During the Pandemic? An Investigation From Self-Determined Theory. Front. Psychol. 12:652594. doi: 10.3389/fpsyg.2021.652594

This study conceptualized digital competence in line with self-determined theory (SDT) and investigated how it alongside help-seeking and learning agency collectively preserved university students' psychological well-being by assisting them to manage cognitive load and academic burnout, as well as increasing their engagement in online learning during the coronavirus disease 2019 (COVID-19) pandemic. Moreover, students' socioeconomic status and demographic variables were examined. Partial least square modeling and cluster analysis were performed on the survey data collected from 695 students. The findings show that mental load and mental effort were positively related to academic burnout, which was significantly negatively associated with student engagement in online learning. Digital competence did not directly affect academic burnout, but indirectly via its counteracting effect on cognitive load. However, help-seeking and agency were not found to be significantly negatively related to cognitive load. Among the three SDT constructs, digital competence demonstrated the greatest positive influence on student engagement. In addition, female students from humanities and social sciences disciplines and lower-income families seemed to demonstrate the weakest digital competence, lowest learning agency, and least help-seeking behaviors. Consequently, they were more vulnerable to high cognitive load and academic burnout, leading to the lowest learning engagement. This study contributes to the ongoing arguments related to the psychological impact of the COVID-19 pandemic and informs the development of efficient interventions that preserve university students' psychological well-being in online learning.

Keywords: digital competence, psychological wellbeing, university students, pandemic, socioeconomic status

INTRODUCTION

Digital competence is related to the knowledge, capacities, and attitudes of using digital technologies to consume, evaluate, and create learning information and to collaborate and communicate with others for learning purposes (Janssen et al., 2013; European Commission, 2019; He and Li, 2019). Developing university students' digital competence is vital for their

success in higher education (López-Meneses et al., 2020). Those with high digital competence can easily interpret and understand online learning materials and perform well in online learning (López-Meneses et al., 2020), whereas those suffering from digital deficiencies may find themselves struggling in or averse to online learning and consequently experiencing high cognitive load and academic burnout, which could eventually lead to the intention of quitting online learning (Bergdahl et al., 2020; Silamut and Petsangsri, 2020).

The unprecedented challenges caused by coronavirus disease 2019 (COVID-19) have disrupted virtually all educational institutions worldwide. As universities across nations struggle to provide continued schooling for their students, deficiencies are exposed in the large-scale remote teaching and online learning, such as complex home environments for learning, digital gap due to socioeconomic disparities, ineffective online learning systems, and inexperienced teachers (Ali, 2020; Hasan and Bao, 2020). Consequently, a series of issues arose in online learning during this pandemic, among which are high cognitive load, academic burnout, and disengagement that have been raised frequently and can impair students' capability to learn and wreak havoc on their psychological well-being (Cao et al., 2020; Islam et al., 2020; Pohan, 2020). Under this circumstance, it calls for more digital competence on the part of students now than ever to adjust to and cope with the uncertainties.

However, there have been a limited number of empirical studies investigating students' digital competence, particularly that of university students (Maderick et al., 2016; He and Li, 2019). Moreover, although the importance of digital competence has been widely recognized and highlighted in school settings (Hatlevik et al., 2015; López-Meneses et al., 2020), there has been limited empirical knowledge regarding how digital competence empowers students to cope with challenges in online learning and maintain psychological and emotional health, which is desperately needed for learning during this pandemic, as well as for re-entering conventional learning settings in the post-pandemic era (Cao et al., 2020; Hasan and Bao, 2020).

Nevertheless, even though digitally competent learners have potentials to perform productively and responsibly in online learning, they may not have adequate motivation for full engagement when experiencing insufficient agency and perceiving little support and help from others in online environments (Chen and Jang, 2010; Vanslambrouck et al., 2018). Therefore, to better examine how digital competence enables students to navigate through challenges in online learning, particularly during this pandemic, this study seeks to conceptualize digital competence in the framework of self-determined theory (SDT) and to examine how digital competence along with help-seeking (relatedness) and learning agency (autonomy) collectively tackles cognitive load and academic burnout and influences student engagement in online learning.

In addition, as the effects of learners' socioeconomic status (SES) and demographic backgrounds (e.g., gender and academic disciplines) on their digital competence and responses to online learning have been much disputed in prior studies (Hatlevik et al., 2015; Mannerström et al., 2018), the present study continues to examine this topic by investigating the distribution of students according to these factors.

Specifically, this study aims to answer the following research questions:

1. How do university students' digital competence together with their help-seeking behaviors and learning agency collectively preserve their psychological well-being by coping with cognitive load and academic burnout and enhancing their engagement in online learning?
2. How are students clustered based on their SES and demographic factors, as well as their digital competence and psychological responses to online learning?

THEORETICAL FRAMEWORK

A Review of Digital Competence for Online Learning

Digital technologies are playing an increasingly important role in present days, so does digital competence, the naming of which has been controversial, some calling it Internet skills, whereas others calling it computer/digital literacy (Janssen et al., 2013; Hatlevik et al., 2015). As digital technologies are becoming smarter and user-friendlier in recent years, its naming shifts from the focus on technical skills of operating technologies in the early days to higher-order skills such as collaboration, creativity, and knowledge building (Janssen et al., 2013). Digital competence is seen as one of the crucial competences for lifelong learning by the European Union (2018), and one of the fundamental skills as writing and reading (Røkenes and Krumsvik, 2016).

Research on digital competence in the educational field has increased gradually in recent years. Most of the research was related to teacher education and sought to uncover the components forming digital competence. For instance, Alarcón et al. (2020) developed a tool to evaluate educators' digital competence, which covered eight areas such as professional engagement, digital resources, and digital environment. Falloon (2020) presented a conceptual framework explicating a comprehensive view of teacher digital competence, which went beyond technical and literacy conceptualizations and argued for a holistic understanding that involved complex knowledge and skills needed to be productive and responsible in digital environments. Gudmundsdottir et al. (2020) examined preservice teachers' digital competence in terms of the responsible use of digital technologies, which included topics of privacy issues, cyberbullying, and the ability to evaluate digital content.

Contrastingly, there are a few studies investigating students' digital competence, mostly in primary and secondary schools. The topics involve the measurement of digital competence and its impacting factors. For example, Aesaert et al. (2014) developed a scale using item response theory to measure primary school students' digital competence. The scale contained 27 items covering topics related to retrieving and processing digital information and communication with a computer. Calvani et al. (2012) investigated secondary school students' digital

competence and found that they demonstrated inadequate digital competence regarding cognitive skills and socioethical knowledge. Hatlevik et al. (2015) explored predictors of digital competence among primary school students and found that students' motivational beliefs and family backgrounds were predictors of their digital competence levels.

However, there has been a dearth of studies examining the digital competence of university students in online learning (Maderick et al., 2016; López-Meneses et al., 2020). This may be due to the misconception about the digital competence of university students who are often assumed to be tech-savvy, growing up with the pervasive presence of digital technologies (Jena, 2015). Nonetheless, this perspective may apply to their use of technologies for entertainment or personal hobbies (Qi, 2019). When digital technologies are used intensively for educational purposes, it may be a different scenario, which entails constant cognitive and affective investment and consequently may be less appealing to the students than using technologies for recreational activities (Maderick et al., 2016; Qi, 2019).

Digital Competence's Importance for University Students' Psychological Well-Being

Psychological well-being has been a frequently raised topic in this pandemic. For instance, Cao et al. (2020) investigated the psychological impact of the COVID-19 pandemic on university students and found that they experienced anxiety and worry of varying degrees. Parola et al. (2020) also found that young adults showed increased anxiety, stress, and depression during the pandemic.

The COVID-19 pandemic has changed the academic landscape and presented daunting challenges to how students take courses (Huntington-Klein and Gill, 2020). Because of the lockdowns caused by the pandemic, students are forced to study remotely at home supported by a variety of digital tools. To enable effective and productive online learning to happen, it requires the efforts of universities and teachers in the provision of digital learning resources, properly designed pedagogy, and academic support, on the one hand. On the other, it also requires the cognitive, affective, and behavioral inputs from students and particularly their digital competence to capitalize on online learning (Janssen et al., 2013; Hasan and Bao, 2020; Rasheed et al., 2020). However, students with insufficient digital competence or holding a negative perception of online learning might experience psychological distress when online learning becomes the sole means for education (Hasan and Bao, 2020).

Conceptualizing Digital Competence in the Framework of Self-Determination Theory

Self-determined theory is a macro theory of motivation, which posits that individuals have an innate need to be self-determining or autonomous, to be competent, and to be connected to others (Deci and Ryan, 2008). SDT is considered particularly useful for examining motivation in online learning given its characteristics of flexibility and the situated and multifaceted nature of motivation (Hartnett et al., 2011; Vanslambrouck et al., 2018).

According to Deci and Ryan (2008), SDT comprises three psychological needs: autonomy (the sense of agency and volition), competence (feeling effective in attaining expected outcomes), and relatedness (interactivity and connectedness). The collective fulfillment of the three psychological needs can lead to the development of intrinsic motivation, which can keep students persistent in tackling challenges and achieving higher qualifications (Deci and Ryan, 2008; Vanslambrouck et al., 2018). Nonetheless, the deficiencies in either one of the three psychological needs may result in amotivation or external motivation. During this pandemic, when students were forced to study at home owing to the lockdowns and social distancing policies, the lack of interpersonal interactions could cause feelings of social disconnectedness and isolation, which could be magnified in virtual spaces (Evans et al., 2020; Horesh et al., 2020), consequently discouraging students from further engaging in online learning.

In this study, digital competence was used to represent "competence" according to SDT. Help-seeking behaviors were chosen as the proxy for "relatedness" because help-seeking is a social and collective process and reflects students' sense of belongingness to a learning community based on which they cope for challenges and difficulties in online learning (Järvelä, 2011; Qayyum, 2018). Learning agency was used to represent "autonomy" as it is related to students' self-directedness and perceived control in online learning (Kearney et al., 2015; Juhaňák et al., 2019).

Hypotheses Development

Cognitive load refers to the amount of working memory for processing and encoding new information (Paas et al., 2003). According to Hwang et al. (2013) and Paas et al. (2003), cognitive load is assessed from two important dimensions: mental load, which is defined as the cognitive load arising from the interaction between tasks and individual characteristics; and mental effort, which is related to the cognitive capacity used for accommodating the demands imposed by learning tasks.

Admittedly, certain levels of difficulty are beneficial for learning. However, if the cognitive load is perceived high or if students deem their cognitive capacities as insufficient to achieve learning success, they tend to experience burnout, which refers to emotional exhaustion and reduced efficacy beliefs resulting from overtaxing learning tasks (Asikainen et al., 2020). Academic burnout is negatively associated with students' psychological well-being and is closely linked to a variety of health problems, such as heavy stress, chronic fatigue, and depression (Kuittinen and Meriläinen, 2011; Salmela-Aro et al., 2019; Asikainen et al., 2020). Consequently, the students may suffer deteriorated performance and opt to give up their learning efforts (Feldon et al., 2019). This phenomenon may appear more frequently in online learning during this pandemic when students were forced to stay online for long hours to finish their coursework at home with limited resources and support available (Islam et al., 2020; Pohan, 2020). Based on the aforementioned analyses, the following hypotheses are proposed:

H1. Mental load is positively related to academic burnout.
H2. Mental effort is positively related to academic burnout.
H3. Academic burnout is negatively related to student learning engagement.

In line with SDT, individuals pursue three psychological needs (digital competence, help-seeking, and learning agency in the context of this study) in their interactions with online environments. When the three psychological needs are met and intertwined, individual students likely evaluate their behaviors as self-determined and develop intrinsic motivation (Deci and Ryan, 2008; Hartnett, 2015). Intrinsically motivated students tend to demonstrate stronger persistence in achieving expected outcomes and are less likely to be discouraged and frustrated by setbacks and challenges arising in online learning than those who are less or externally motivated (Hartnett, 2015; Vanslambrouck et al., 2018). Thus, informed by this line of reasoning, the following hypotheses are developed:

H4a-4d. Digital competence is negatively associated with mental load (H4a), mental effort (H4b), academic burnout (H4c), and learning engagement (H4d).
H5a-5d. Help-seeking is negatively associated with mental load (H5a), mental effort (H5b), academic burnout (H5c), and learning engagement (H5d).
H6a-6d. Learning agency is negatively associated with mental load (H6a), mental effort (H6b), academic burnout (H6c), and learning engagement (H6d).

In addition, help-seeking behaviors are perceived as valuable for the development of digital competence as they increase the chances of exchanging learning experiences and jointly coping with problems emerging in online environments (Røkenes and Krumsvik, 2016). Furthermore, students with high learning agency tend to perceive ownership of learning in virtual spaces and initiate actions to achieve expected learning goals, thereby gradually strengthening their digital competence of addressing challenges emerging in the learning process (Deci and Ryan, 2008; Juhaňák et al., 2019). Therefore, the following hypotheses are developed:

H7. Help-seeking is positively related to digital competence.
H8. Learning agency is positively associated with digital competence.

According to the hypotheses above, the theoretical research model is illustrated in **Figure 1**.

METHODOLOGY

Research Context and Participants

The sample of this study comprised students enrolled in two public universities in China. This study was conducted at the end of the semester when they had finished online courses at home due to the lockdown policy and were about to return to campus the coming semester. Before data collection, the ethical clearance of the two universities and the informed consent of all participants were obtained. The data were collected through an online survey platform using a convenience sampling approach. We approached around 900 university students with the help of their instructors and eventually obtained valid responses from 695 of them. There were 449 female students and 246 males, aged between 18 and 21 years. Among the participants, 471 students came from the disciplines of humanities and social sciences (e.g., education, psychology, and sociology), whereas 224 students from the disciplines of natural sciences and engineering (e.g., mathematics, physics, and computer sciences). To investigate the participants' SES, they were asked to rate their family income based on a five-point scale, ranging from "0" representing the lowest-income family and "4" the highest-income family. All responses were anonymous so as to protect the participants' privacy. Those who rated the first two points were grouped together and were labeled as "lower-income families" (n = 205), whereas the remaining students were labeled as "middle- and higher-income families" (n = 490).

Instrumentation

The survey instrument comprised seven variables with 32 items (Appendix A), besides the items measuring students' SES and demographic information. The items were measured using a five-point Likert scale, ranging from "1" "strongly disagree" to "5" "strongly agree," except for help-seeking, which was scored with "1" indicating "never" and "5" "always."

The survey was developed based on previous relevant studies. The items of digital competence were developed based on Alarcón et al. (2020); Janssen et al. (2013), and López-Meneses et al. (2020), with a Cronbach α value of 0.87. The construct of help-seeking was adapted from Qayyum (2018), with a Cronbach α value of 0.79. The items measuring learning agency were adapted from Kearney et al. (2015), with a Cronbach α value of 0.82. The items measuring mental load and mental effort were adjusted from Hwang et al. (2013), with the Cronbach α values of 0.82 and 0.85, respectively. The construct of academic burnout was adapted from Kristensen et al. (2005), and its value of Cronbach α was 0.92. Finally, the items measuring online engagement were developed based on Bergdahl et al. (2020), with a Cronbach α value of 0.94.

Considering the original instrument was in English, we followed a back-translation procedure to minimize possible differences between the English and the Chinese versions. Before administering the surveys to the participants, we invited two experts in learning sciences and two experts in psychological research to provide feedback on the survey design, based on which the survey was refined. Subsequently, the survey was tested on eight university students to examine its clarity. Items that caused confusion were reworded to convey clearer information. In addition, as this study used self-report data, Harman's single factor test was performed to investigate possible common method bias (Podsakoff et al., 2012). We entered all variables into an exploratory factor analysis to examine the unrotated factor solution. The single largest factor explained 39.1% of the variances, which is lower than the threshold of 50%, implying that this study's validity was not compromised by this issue.

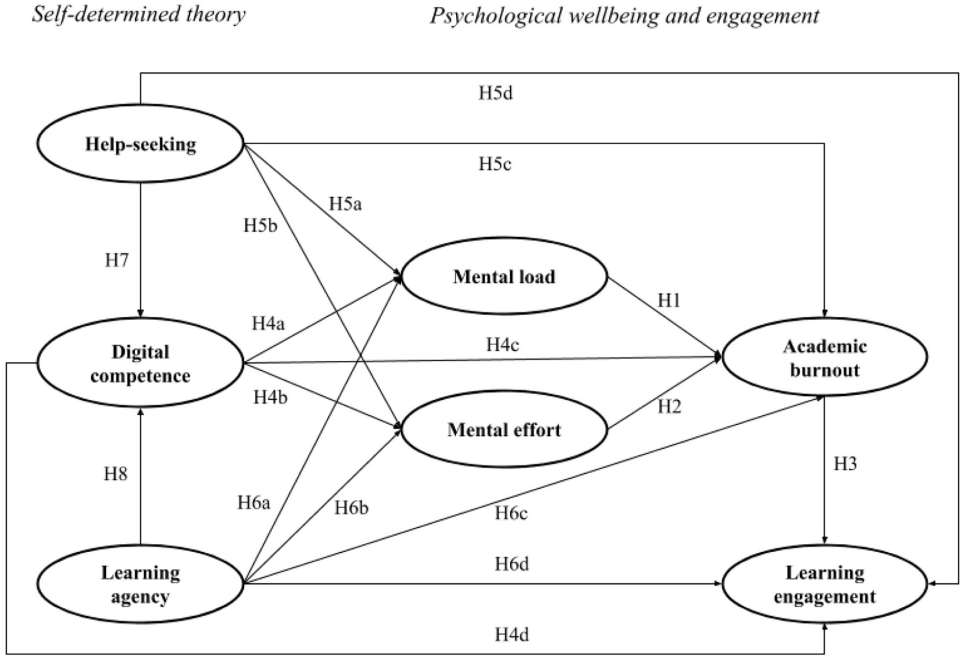


FIGURE 1 | Conceptualization of digital competence in SDT and its relevance with students' psychological well-being.

Analysis Methods

To validate the research model of university students' digital competence and psychological well-being, partial least squares structural equation modeling (PLS-SEM) was used as PLS-SEM is prediction-oriented and excels at maximizing the variance explained for the dependent variables (Chin, 1998; Hair et al., 2014). To examine how the students were distributed based on their SES and demographic variables, as well as their digital competence and mental and emotional responses to online learning, a two-step cluster analysis was performed. Compared with conventional clustering techniques, the two-step cluster analysis has advantages in handling both categorical and continuous variables simultaneously, automatically determining the optimal number of clusters by comparing the values of clustering criteria across different model clustering solutions rather than arbitrary choices, and dealing with large data files (Kent et al., 2014; Benassi et al., 2020). It has been considered one of the most reliable analysis approaches for classifying individual cases into subgroups (Gelbard et al., 2007; Kent et al., 2014).

RESULTS

This section comprises results from PLS-SEM and the two-step cluster analysis. As for PLS-SEM, the measurement model was first examined followed by the structural model (Hair et al., 2014).

Measurement Model

The measurement model was assessed through item reliability, convergent validity, and discriminant validity. Item reliability was attained by evaluating the item loadings with their associated latent factors, which should exceed 0.70 (Hair et al., 2014). As shown in **Table 1**, the loading coefficients of all items were greater than 0.70. Convergent validity was assessed through two aspects: (a) composite reliability, which should be greater than 0.70; and (b) average variance extracted (AVE), the minimum value of which should be higher than 0.50 (Fornell and Larcker, 1981; Hair et al., 2011). As indicated in **Table 1**, the latent constructs' composite reliability and AVEs met the prescribed criteria. Discriminant validity was examined by comparing the square root of each latent construct's AVE with the correlations between that and other latent constructs (Chin et al., 2003). As manifested in **Table 2**, all constructs' AVEs were higher than the correlations between them and other constructs, thus substantiating the discriminant validity of the research model.

In addition, **Table 2** shows that student engagement in online learning was significantly negatively correlated with their mental load ($r = -0.37$, $p < 0.00$, CI = −0.45 to −0.27), mental effort ($r = -0.50$, $p < 0.00$, CI = −0.57 to −0.41), and academic burnout ($r = -0.58$, $p < 0.00$, CI = −0.64 to −0.49). Moreover, significant negative correlations were also observed between the three components of SDT (digital competence, help-seeking, and learning agency) and mental load, mental effort, and academic burnout, with the correlation coefficients ranging from $r = -0.24$ ($p < 0.00$, CI = −0.28 to −0.11) to $r = -0.42$ ($p < 0.00$, CI = −0.47 to −0.32), and digital competence demonstrating the most salient negative correlations with them. All these correlation outcomes highlighted the possible detrimental effects related to high cognitive load and academic burnout in online learning during the pandemic as well as the potential counteracting effect of digital competence on them.

TABLE 1 | Variable reliability, average variance extracted (AVE), and item loadings and means.

Constructs	Cronbach's α	Composite reliability	AVE	Indicators	Factor loadings	Mean (SD)
Digital competence (DC)	0.87	0.90	0.61	DC1	0.71	3.75 (0.92)
				DC2	0.70	3.46 (1.05)
				DC3	0.77	3.39 (1.03)
				DC4	0.85	3.75 (0.93)
				DC5	0.85	3.44 (0.97)
				DC6	0.79	3.27 (1.01)
Help-seeking (HS)	0.79	0.87	0.62	HS1	0.77	3.06 (0.98)
				HS2	0.83	3.26 (0.99)
				HS3	0.80	3.28 (0.95)
				HS4	0.74	2.93 (0.95)
Learning agency (LA)	0.82	0.88	0.65	LA1	0.77	3.70 (0.98)
				LA2	0.88	3.58 (0.98)
				LA3	0.83	3.71 (0.92)
				LA4	0.73	3.93 (0.86)
Mental load (ML)	0.82	0.89	0.74	ML1	0.84	2.91 (1.13)
				ML2	0.87	2.49 (1.05)
				ML3	0.86	2.52 (1.05)
Mental effort (ME)	0.85	0.91	0.77	ME1	0.89	2.64 (1.13)
				ME2	0.85	3.06 (1.15)
				ME3	0.90	2.55 (1.11)
Academic burnout (ABN)	0.92	0.94	0.71	ABN1	0.76	2.92 (1.18)
				ABN2	0.90	2.42 (1.12)
				ABN3	0.89	1.99 (0.97)
				ABN4	0.79	2.41 (1.15)
				ABN5	0.88	1.89 (1.01)
				ABN6	0.81	1.91 (0.98)
Learning engagement (ENG)	0.94	0.95	0.75	ENG1	0.87	3.52 (0.99)
				ENG2	0.82	3.65 (0.94)
				ENG3	0.86	2.90 (1.02)
				ENG4	0.89	3.09 (1.05)
				ENG5	0.90	2.91 (1.02)
				ENG6	0.88	3.15 (1.00)
				ENG7	0.83	3.02 (1.14)

Structural Model

To assess the structural model, we examined both the significance levels of the path coefficients in the proposed research model and the explanatory power (R^2) of the endogenous constructs. Considering that parametric approaches are not suggested to evaluate the path coefficients' significance levels as PLS-SEM does not depend on distributional assumptions, bootstrapping analysis is recommended (Sanchez, 2013; Hair et al., 2014). **Table 3** presents the bootstrap results, which are illustrated in **Figure 2**.

According to **Table 3** and **Figure 2**, mental load and mental effort were positively related to students' academic burnout in online learning, which further negatively predicted their learning engagement, thereby substantiating H1, H2, and H3, and underscoring the potentially negative consequences associated with high cognitive load and academic burnout. Significantly negative correlations were observed between digital competence and mental load and mental effort; hence, H4a and H4b were supported. Help-seeking behaviors and learning agency were not negatively related to mental load and mental effort; thus, H5a, H5b, H6a, and H6b were not substantiated. However, digital competence and help-seeking behaviors did not negatively predict academic burnout, whereas learning agency did, therefore supporting H6c but not H4c and H5c. The three components of SDT (digital competence, help-seeking behaviors, and learning

TABLE 2 | Correlations between different constructs and the square root of their AVEs.

Constructs	1	2	3	4	5	6	7
1. Digital competence	**0.78**						
2. Help-seeking	0.52	**0.79**					
3. Learning agency	0.66	0.40	**0.80**				
4. Mental load	−0.32	−0.24	−0.26	**0.86**			
5. Mental effort	−0.37	−0.24	−0.29	0.71	**0.88**		
6. Academic burnout	−0.41	−0.27	−0.42	0.56	0.65	**0.84**	
7. Learning engagement	0.67	0.50	0.59	−0.37	−0.50	−0.58	**0.86**

The bold values in the diagonal row are the square roots of the AVE of the variables.

TABLE 3 | Bootstrap outcomes of the path coefficients.

Hypotheses		Path coefficients	Standard error	Percentile 0.025	Percentile 0.975	Results
H1	Mental load - > academic burnout	0.18***	0.05	0.09	0.26	Support
H2	Mental effort - > academic burnout	0.45***	0.04	0.38	0.52	Support
H3	Academic burnout - > learning engagement	−0.32***	0.04	−0.39	−0.25	Support
H4a	Digital competence - > mental load	−0.22***	0.06	−0.32	−0.12	Support
H4b	Digital competence - > mental effort	−0.29***	0.06	−0.38	−0.18	Support
H4c	Digital competence - > academic burnout	−0.04 ns	0.04	−0.11	0.03	Not support
H4d	Digital competence - > learning engagement	0.34***	0.04	0.27	0.41	Support
H5a	Help-seeking - > mental load	−0.09 ns	0.05	−0.20	0.001	Not support
H5b	Help-seeking - > mental effort	−0.06 ns	0.05	−0.16	0.05	Not support
H5c	Help-seeking - > academic burnout	−0.006 ns	0.04	−0.07	0.07	Not support
H5d	Help-seeking - > learning engagement	0.18***	0.03	0.12	0.24	Support
H6a	Learning agency - > mental load	−0.07 ns	0.05	−0.16	0.02	Not support
H6b	Learning agency - > mental effort	−0.07 ns	0.05	−0.18	0.03	Not support
H6c	Learning agency - > academic burnout	−0.22***	0.04	−0.30	−0.15	Support
H6d	Learning agency - > learning engagement	0.16***	0.04	0.08	0.23	Support
H7	Help-seeking - > digital competence	0.31***	0.03	0.25	0.37	Support
H8	Learning agency - > digital competence	0.54***	0.05	−0.19	−0.02	Support

****p < 0.001. ns, non-significant.*

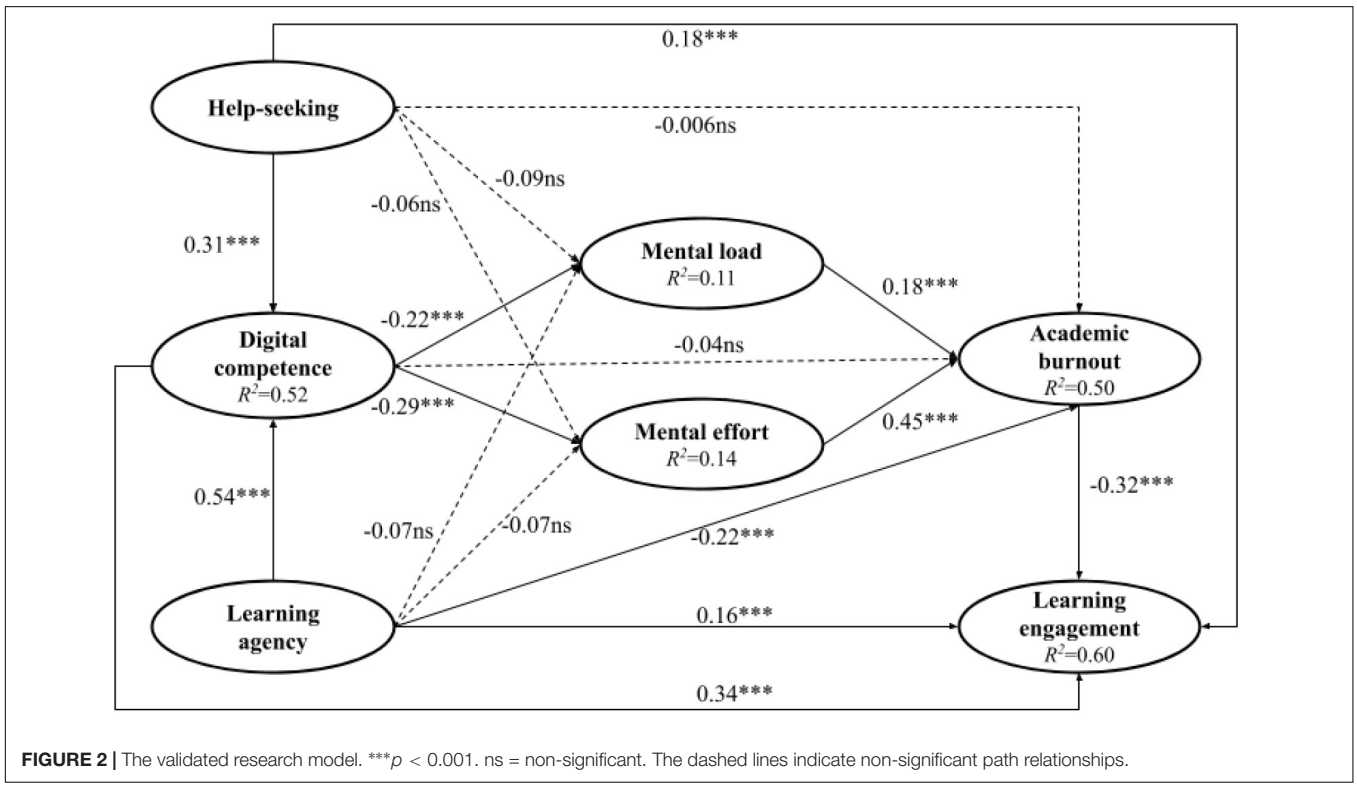


FIGURE 2 | The validated research model. ***p < 0.001. ns = non-significant. The dashed lines indicate non-significant path relationships.

agency) all positively predicted student engagement in online learning, thereby supporting H4d, H5d, and H6d. Finally, students' help-seeking behaviors and agency in online learning were positively related to their digital competence; thus, H7 and H8 were supported.

As PLS-SEM seeks to maximize the variance explained in the endogenous constructs of the theoretical model, their R^2 values are used as crucial criteria to determine the quality of the structural model (Henseler et al., 2009). **Figure 2** shows that the R^2 values of digital competence, mental load, mental effort, academic burnout, and learning engagement were 0.52, 0.11, 0.14, 0.50, and 0.60, respectively, suggesting medium to large effect sizes (Cohen, 1988) and thus high explanatory power of the research model. In addition, according to the global criterion of goodness-of-fit ($0 < GoF < 1$) that is proposed by Tenenhaus et al. (2004) to determine the overall quality of PLS-SEM, the

GoF indices of 0.10, 0.25, and 0.36 indicate small, medium, and large fit, respectively. The GoF value of the PLS-SEM analysis in the present study was 0.51, implying a substantially good fit for the research model and thereby providing further supportive information about the research model.

Two-Step Cluster Analysis

The Bayesian information criterion (BIC) was used as the clustering criterion for computing the potential numbers of clusters. Smaller BIC values suggest better models (Vrieze, 2012). Nonetheless, in the scenario where the BIC values continue to decrease while the number of clusters increases, gradually complicating the cluster model, the changes in BIC values and those in the distance measure are examined to determine the optimal cluster solution so as to balance the tradeoff between the complexity of the cluster model and the BIC values.

As shown in **Table 4**, the two-step cluster analysis reported a three-cluster classification as the optimal solution, with lower BIC values (5,433.58), the biggest BIC changes (0.653), and changes in distance measure (1.656). **Figure 3** presents the supportive information about the three-cluster classification as the distribution of the cluster sizes was reasonable with no clusters featuring the majority of the spare parts.

Table 5 displays the composition of each cluster of students examined in this study. Overall, the comparison between the three clusters implies that family income might be negatively associated with cognitive load and academic burnout. Students from lower-income families likely experience higher cognitive load and academic burnout in online learning during the pandemic. Consequently, their online engagement might be undermined.

Specifically, the female students from the disciplines of humanities and social sciences and middle- and higher-income families (Cluster 2) were likely to be most motivated in the virtual classroom, demonstrating the strongest digital competence (mean = 3.81, SD = 0.69), highest learning agency (mean = 4.03, SD = 0.70), and most help-seeking behaviors (mean = 3.42, SD = 0.75). This cluster of female students tended to experience the lowest cognitive load (mental load, mean = 2.28, SD = 0.84; mental effort, mean = 2.37, SD = 0.95) and burnout (mean = 1.92, SD = 0.74) and consequently demonstrate the highest engagement (mean = 3.52, SD = 0.76) in online learning.

Contrastingly, the female students from the disciplines of humanities and social sciences and lower-income families (Cluster 3) might be the least motivated in online learning, manifesting the weakest digital competence (mean = 3.02, SD = 0.65), lowest learning agency (mean = 3.36, SD = 0.71), and least help-seeking behaviors (mean = 2.79, SD = 0.75). They were likely to experience the highest cognitive load (mental load, mean = 3.07, SD = 0.75; mental effort, mean = 3.22, SD = 0.83) and burnout (mean = 2.77, SD = 0.84) and resultantly demonstrate the lowest engagement (mean = 2.58, SD = 0.76) in online learning.

In comparison with the previous two clusters of students, the male students from the disciplines of natural sciences and engineering and middle- and higher-income families (Cluster 1) likely stand in the middle ground, demonstrating intermediate levels of digital competence, motivation, cognitive load, burnout, and learning engagement.

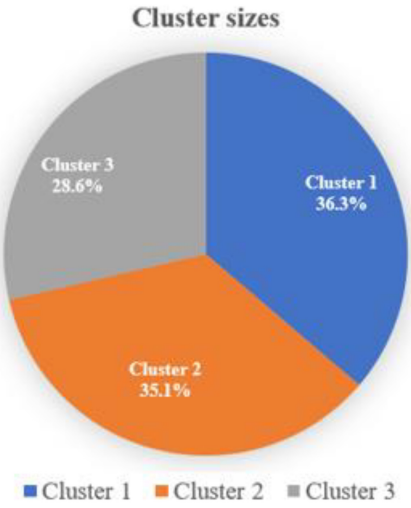
DISCUSSION

This study conceptualized digital competence in the SDT framework and investigated how it alongside help-seeking and learning agency collectively preserved university students' psychological well-being by assisting them to manage cognitive load and academic burnout and increase their engagement in online learning, which is essential for students' academic

TABLE 4 | Full information of the clusters generated by the two-step cluster analysis.

No. of clusters	Bayesian information criterion (BIC)	BIC change[a]	Ratio of BIC changes[b]	Ratio of distance measures[c]
1	6,736.609			
2	5,948.317	−788.292	1.000	1.432
3	5,433.585	−514.732	0.653	1.656
4	5,169.327	−264.258	0.335	1.170
5	4,960.608	−208.719	0.265	1.212
6	4,809.070	−151.539	0.192	1.160
7	4,694.626	−114.444	0.145	1.005
8	4,581.267	−113.358	0.144	1.389
9	4,532.593	−48.675	0.062	1.201
10	4,511.753	−20.839	0.026	1.027
11	4,494.543	−17.210	0.022	1.086
12	4,488.059	−6.484	0.008	1.000
13	4,481.625	−6.434	0.008	1.141
14	4,490.504	8.878	−0.011	1.170
15	4,515.242	24.739	−0.031	1.138

[a]The changes are from the previous number of clusters in the table. [b]The ratios of changes are relative to the change for the two cluster solutions. [c]The ratios of distance measures are based on the current number of clusters against the previous number of clusters.



Size of smallest cluster	199 (28.6%)
Size of largest cluster	252 (36.3%)

FIGURE 3 | Cluster sizes for the three-cluster solution.

success in this challenging time (Ali, 2020). In addition, the roles played by students' SES and demographic factors in this process were examined.

Digital Competence, Help-Seeking, Learning Agency, and Challenges to Psychological Well-Being in Online Learning

As hypothesized, mental load and mental effort were positively associated with academic burnout, which further negatively affected student learning engagement. These findings are consistent with prior studies, such as those by Asikainen et al. (2020) and Chang et al. (2017), which found that high cognitive load tended to interrupt students' learning, causing exhaustion, and frustrating experience for them and leading to disengagement and undesirable learning performance.

Contrary to the hypotheses, digital competence did not directly affect academic burnout, but indirectly through its alleviating effect on mental load and mental effort. This finding is reasonable. According to Arguel et al. (2019) and López-Meneses et al. (2020), students with higher digital competence may be in a better position to solve cognitive disequilibrium as they can make sense of digital learning materials and deal with learning requirements more effectively, thereby being more capable of addressing challenges in online learning and less likely suffering from frustrating feelings and emotional distresses.

The finding of the significant negative relationship between learning agency and academic burnout is congruent with prior studies. When students engage in online learning in a forced and unwilling way, they are more likely to have negative experiences than those who perceive control and self-directedness (Selwyn, 2016; Juhaňák et al., 2019). And when the lack of learning agency is combined with digital incompetence, the negative experience may be intensified (Selwyn, 2016).

However, help-seeking and learning agency were not significantly negatively associated with mental load and mental effort. This may be due to that mental load and effort are essentially related to digital learning materials and their instructional designs, respectively (Hwang et al., 2013). Even though seeking help when facing challenges and empowering students to exercise autonomy may contribute to easing students' cognitive load in online learning (Qayyum, 2018; Schneider et al., 2018), it is individuals' capabilities of processing information that largely determine the quality of interpreting and mastering the online learning materials (López-Meneses et al., 2020).

Among the three constructs used to conceptualize self-determined motivation, digital competence demonstrated the biggest influence on students' engagement in online learning. This finding seems to be at odds with Deci and Ryan (2008) in which they argued for the element of autonomy as the core of intrinsic motivation of learning engagement. But instead, it reinforces the argument raised at the beginning of this study that students' digital competence is greatly needed to cope with the uncertainties in online learning during this pandemic, which presents an unfamiliar context to the students (Pohan, 2020). When university courses are shifted online completely, albeit with some being unsuitable for the online instructional mode, student engagement could suffer (Huntington-Klein and Gill, 2020). The students who are more capable of capitalizing on digital resources and holding responsible attitudes toward the use of digital technologies for learning could be more prepared to tackle the challenges in uncertain times (Janssen et al., 2013).

Overall, the effect size values of digital competence, mental load, mental effort, academic burnout, and learning engagement ranged from 0.11 to 0.60 (**Figure 2**), implying moderate to strong effect sizes (Cohen, 1988). These results may highlight the special context caused by the pandemic when the students were forced to study online alone at home and faced with a variety of distractions and uncertainties (Cao et al., 2020). Under this context, online learning became the only means for schooling. Nonetheless, long-hour exposure to online learning could incur heavy cognitive load (Pohan, 2020). Consequently, the students tended to easily feel exhausted and overwhelmed, leading to decreased engagement and even the intention of dropping out (Bergdahl et al., 2020; Hasan and Bao, 2020). However, digital competence may have the potential to break this negative chain of reactions as it can help free the working memory of the mind to process digital learning resources effectively, thereby alleviating cognitive load that is related to learning through digital technologies (Sweller, 2005, 2020). The moderate to strong effect sizes of the constructs examined in this study also substantiated the suitability of the SDT theory that conceptualized digital competence as one of the potential

TABLE 5 | Summary of the three-cluster solution.

	Cluster 1	Cluster 2	Cluster 3
Size	36.3% (*n* = 252)	35.1% (*n* = 244)	28.6% (*n* = 199)
Input distribution	Academic disciplines NS&E (88.9%)	Academic disciplines HS (100%)	Academic disciplines HS (100%)
	Family income Middle and high income (70.6%)	Family income Middle and high income (88.1%)	Family income Lower income (51.3%)
	Gender Male (71.4%)	Gender Female (100%)	Gender Female (66.8%)
	Digital competence (mean = 3.61, SD = 0.73)	Digital competence (mean = 3.81, SD = 0.69)	Digital competence (mean = 3.02, SD = 0.65)
	Learning agency (mean = 3.73, SD = 0.73)	Learning agency (mean = 4.03, SD = 0.70)	Learning agency (mean = 3.36, SD = 0.71)
	Help-seeking behaviors (mean = 3.31, SD = 0.81)	Help-seeking behaviors (mean = 3.42, SD = 0.75)	Help-seeking behaviors (mean = 2.79, SD = 0.75)
	Mental load (mean = 2.64, SD = 0.98)	Mental load (mean = 2.28, SD = 0.84)	Mental load (mean = 3.07, SD = 0.75)
	Mental effort (mean = 2.74, SD = 0.99)	Mental effort (mean = 2.37, SD = 0.95)	Mental effort (mean = 3.22, SD = 0.83)
	Burnout (mean = 2.18, SD = 0.88)	Burnout (mean = 1.92, SD = 0.74)	Burnout (mean = 2.77, SD = 0.84)
	Engagement (mean = 3.32, SD = 0.85)	Engagement (mean = 3.52, SD = 0.76)	Engagement (mean = 2.58, SD = 0.76)

NS&E, nature sciences and engineering; HS, humanities and social sciences.

ways that maintain students' psychological well-being as well as learning engagement.

SES and Demographic Variables and Their Relationships With Digital Competence and Psychological Responses to Online Learning

Concerning SES, the findings of the relationships between family income and students' digital competence and psychological responses are largely congruent with prior studies on digital competence (e.g., Hatlevik et al., 2015) and recent studies about the impact of the COVID-19 pandemic on university students' health. For instance, Cao et al. (2020) found that students from higher SES were likely to experience lower psychological distresses. This may be because students from lower-income families often have limited access to digital resources and suffer from economic pressure. Consequently, they may face more obstacles and difficulties in online learning during this pandemic, thereby more likely risking to suffer higher levels of frustration, anxiety, and decreased efficacy than their counterparts from higher-income families (Hasan and Bao, 2020).

In addition, female students from lower-income families as indicated in Cluster 3 (**Table 5**) were more likely to experience high cognitive load and burnout. This finding is different from Cao et al. (2020), which indicated that female and male students experienced similar stresses and negative emotions in online settings. However, it corroborates the findings of Horesh et al. (2020) that women may be more vulnerable to psychological and emotional stresses than men during this pandemic. Further studies are needed to disentangle this controversy.

Contributions and Implications

This study has the following contributions. First, the findings of this study expand our knowledge of the role of digital competence in students' online learning, especially during the COVID-19 pandemic. Prior studies mostly focused on its measurement and its role in academic performance (e.g., Castaño-Muñoz et al., 2017; López-Meneses et al., 2020), little attention has been given to its potentials in preserving students' mental and emotional health, which is vital to university students during the pandemic and in the post-pandemic era when the students return to normal schooling (Hasan and Bao, 2020). The conceptualization of digital competence in SDT and relating it to challenges of students' psychological well-being in online learning provide a new perspective of understanding digital competence.

Second, this study contributes further evidence to the debates over the effect of students' SES on their learning in online settings. Different from previous studies that argued for the effect of individuals' SES on digital disparities (Calvani et al., 2012), the present study shows that SES may be related to not only individuals' competence in maneuvering the digital learning resources, but also their psychological responses while working on the resources.

Third, this study also contributes to the ongoing arguments related to the psychological impacts of the COVID-19 pandemic and informs the development of efficient interventions that preserve university students' psychological well-being (Parola et al., 2020). Psychological interventions serve as a conventional option. However, we may also think outside of the box and design interventions from a different perspective by tracing back to the source of mental and emotional problems related to online learning. As such, academic interventions that improve university students' digital competence while prompting their

agency and encouraging interpersonal communications in online learning may be a potentially effective alternative.

In addition, this study carries implications for practice in the following ways. First, the learner clusters identified in this study can inform the development of targeted, rather than one-size-fits-all, strategies and interventions that assist learners of specific population groups to adapt to online learning while maintaining their psychological well-being. To respond to the call for equal access to opportunities promised by online learning for the underrepresented population (Littenberg-Tobias and Reich, 2020), universities should increase support to female students from lower-income families so as to enhance their digital competence and learning agency, as well as to encourage their help-seeking behaviors. Such measures are promising to put them in a better position to cope with challenges in online learning, to decrease their cognitive load and academic burnout, and to strengthen their online engagement.

Second, students' digital competence can be improved in a variety of ways. For instance, universities ensure that faculty and students have access to all the digital resources and tools that are necessary to enhance the students' learning online and offline (Alarcón et al., 2020). They can also provide workshops helping students to manage digital learning resources effectively and assisting faculty to improve the digital competence of their students (He and Li, 2019). However, it may be a different scenario for universities from low- and middle-income countries and their students as they tend to be subject to more financial constraints than their counterparts in high-income countries (Islam et al., 2020). These universities have to make realistic and cost-saving plans that cater to their students' needs of developing digital competence. Affordable digital resources and tools should be provided. Besides, universities and faculty can build a strong bond with their students to improve their efficacy and attitudes toward online learning (Islam et al., 2020). They can provide students with models and hands-on opportunities that scaffold the mastery of digital competence (Røkenes and Krumsvik, 2016).

Third, even though digital competence is critical for students to be successful in online learning, encouraging students' learning agency and help-seeking behaviors is no less important. The combination of the three factors could collectively elicit intrinsic motivation from university students, which could empower them to manage cognitive load and academic burnout in online learning without the physical presence of peers and instructors, particularly during this pandemic. And fourth, the indirect effect of digital competence on academic burnout through mental load and mental effort suggests that solely enhancing students' digital competence may not decrease students' burnout directly. Instructors are advised to select and design learning materials and tasks of proper difficulty levels that are congruent with students' cognitive levels (Pohan, 2020). Although being subject to the constraints of time, resources, and experience in designing well-thought-out online learning courses, they can iteratively refine their courses based on their students' reactions and feedback, so as to reduce the extra mental effort needed for the students to master new information. In doing so, the students' experience of academic burnout can be expected to decrease eventually.

Limitations and Future Research

The findings of this study should be interpreted cautiously with the following limitations. First, as this study is cross-sectional, no causal relationships can be proven. Thus, future researchers are suggested to validate the findings related to digital competence' effect on the psychological well-being of university students and the role of SES and demographic variables in longitudinal studies so as to provide stronger argumentation. Second, the data of this study were collected from two universities that have relatively modernized digital facilities to support online learning during the pandemic. As a result, the findings of this study may suffer from the issue of overrepresenting technology-rich universities. Thus, future studies are recommended to test the research findings using a more balanced sample involving different types of universities.

Despite the limitations, this study offers a starting point for more scholastic endeavors that examine how digital competence helps preserve university students' psychological well-being and empower them for successful professional life and social participation in the future that is filled with uncertainties, challenges, and opportunities.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to their containing information that could compromise the privacy of research participants.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Ethics Review Committee, QDU. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

XW designed the study, helped with data collection, and analyzed the data. RZ designed the study, analyzed the data, and wrote the manuscript. ZW and TL helped with data analysis and edited the manuscript. All authors contributed to the article and approved the submitted version.

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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.2021.652594/full#supplementary-material

REFERENCES

Aesaert, K., Van Nijlen, D., Vanderlinde, R., and van Braak, J. (2014). Direct measures of digital information processing and communication skills in primary education: Using item response theory for the development and validation of an ICT competence scale. *Comput. Educat.* 76, 168–181. doi: 10.1016/j.compedu.2014.03.013

Alarcón, R., del Pilar Jiménez, E., and de Vicente−Yagüe, M. I. (2020). Development and validation of the DIGIGLO, a tool for assessing the digital competence of educators. *Br. J. Educat. Technol.* 2020, 1–15. doi: 10.1111/bjet.12919

Ali, W. (2020). Online and Remote Learning in Higher Education Institutes: A Necessity in light of COVID-19 Pandemic. *Higher Educat.* 10, 16–25. doi: 10.5539/hes.v10n3p16

Arguel, A., Lockyer, L., Kennedy, G., Lodge, J. M., and Pachman, M. (2019). Seeking optimal confusion: a review on epistemic emotion management in interactive digital learning environments. *Interact. Learn. Environ.* 27, 200–210. doi: 10.1080/10494820.2018.1457544

Asikainen, H., Salmela-Aro, K., Parpala, A., and Katajavuori, N. (2020). Learning profiles and their relation to study-related burnout and academic achievement among university students. *Learn. Individ. Differ.* 78:101781. doi: 10.1016/j.lindif.2019.101781

Benassi, M., Garofalo, S., Ambrosini, F., Sant'Angelo, R. P., Raggini, R., De Paoli, G., et al. (2020). Using Two-Step Cluster Analysis and Latent Class Cluster Analysis to Classify the Cognitive Heterogeneity of Cross-Diagnostic Psychiatric Inpatients. *Front. Psychol.* 11:1085. doi: 10.3389/fpsyg.2020.01085

Bergdahl, N., Nouri, J., Fors, U., and Knutsson, O. (2020). Engagement, disengagement and performance when learning with technologies in upper secondary school. *Comput. Educat.* 149:103783. doi: 10.1016/j.compedu.2019.103783

Calvani, A., Fini, A., Ranieri, M., and Picci, P. (2012). Are young generations in secondary school digitally competent? A study on Italian teenagers. *Comput. Educat.* 58, 797–807. doi: 10.1016/j.compedu.2011.10.004

Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., et al. (2020). The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Res.* 287:112934. doi: 10.1016/j.psychres.2020.112934

Castaño-Muñoz, J., Kreijns, K., Kalz, M., and Punie, Y. (2017). Does digital competence and occupational setting influence MOOC participation? Evidence from a cross-course survey. *J. Comput. Higher Educat.* 29, 28–46. doi: 10.1007/s12528-016-9123-z

Chang, C.-C., Liang, C., Chou, P.-N., and Lin, G.-Y. (2017). Is game-based learning better in flow experience and various types of cognitive load than non-game-based learning? Perspective from multimedia and media richness. *Comput. Hum. Behav.* 71, 218–227. doi: 10.1016/j.chb.2017.01.031

Chen, K.-C., and Jang, S.-J. (2010). Motivation in online learning: Testing a model of self-determination theory. *Comput. Hum. Behav.* 26, 741–752. doi: 10.1016/j.chb.2010.01.011

Chin, W. W. (1998). "The partial least squares approach to structural equation modeling," in *Modern methods for business research*, ed. G. A. Marcoulides (Mahwah, NJ: Lawrence Erlbaum Associates), 295–336.

Chin, W. W., Marcolin, B. L., and Newsted, P. R. (2003). A partial least squares latent variable modeling approach for measuring interaction effects: Results from a Monte Carlo simulation study and an electronic-mail emotion/adoption study. *Informat. Syst. Res.* 14, 189–217. doi: 10.1287/isre.14.2.189.16018

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*, 2 Edn. Hillside. NJ: Lawrence Earlbaum Associates.

Deci, E. L., and Ryan, R. M. (2008). Self-determination theory: A macrotheory of human motivation, development, and health. *Canad. Psychol. Psychol. Canad.* 49, 182–185. doi: 10.1037/a0012801

European Commission (2019). *The Digital Competence Framework 2.0*. Brussels: European Commission.

European Union (2018). Council recommendation of 22 May 2018 on key competences for lifelong learning. *Offic. J. Eur. Union* 4, 1–13.

Evans, D. J., Bay, B. H., Wilson, T. D., Smith, C. F., Lachman, N., and Pawlina, W. (2020). Going virtual to support anatomy education: A STOPGAP in the midst of the Covid−19 pandemic. *Anatomic. Sci. Educ.* 13, 279–283. doi: 10.1002/ase.1963

Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. *Educat. Technol. Res. Dev.* 68, 2449–2472. doi: 10.1007/s11423-020-09767-4

Feldon, D. F., Callan, G., Juth, S., and Jeong, S. (2019). Cognitive load as motivational cost. *Educat. Psychol. Rev.* 31, 319–337. doi: 10.1007/s10648-019-09464-6

Fornell, C., and Larcker, D. F. (1981). Structural equation models with unobservable variables and measurement error: Algebra and statistics. *J. Market. Res.* 18, 382–388. doi: 10.2307/3150980

Gelbard, R., Goldman, O., and Spiegler, I. (2007). Investigating diversity of clustering methods: An empirical comparison. *Data Knowled. Engine.* 63, 155–166. doi: 10.1016/j.datak.2007.01.002

Gudmundsdottir, G. B., Gassó, H. H., Rubio, J. C. C., and Hatlevik, O. E. (2020). Student teachers' responsible use of ICT: Examining two samples in Spain and Norway. *Comput. Educat.* 152:103877. doi: 10.1016/j.compedu.2020.103877

Hair, J., Hult, G. T. M., Ringle, C., and Sarstedt, M. (2014). *A primer on partial least squares structural equation modeling (PLS-SEM)*. Thousand Oaks: Sage.

Hair, J., Ringle, C. M., and Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *J. Market. Theor. Pract.* 19, 139–152. doi: 10.2753/MTP1069-6679190202

Hartnett, M. (2015). Influences that undermine learners' perceptions of autonomy, competence and relatedness in an online context. *Australas. J. Educat. Technol.* 31, 86–99. doi: 10.14742/ajet.1526

Hartnett, M., St George, A., and Dron, J. (2011). Examining motivation in online distance learning environments: Complex, multifaceted, and situation-dependent. *Int. Rev. Res. Open Distribut. Learn.* 12, 20–38. doi: 10.19173/irrodl.v12i6.1030

Hasan, N., and Bao, Y. (2020). Impact of "e-Learning crack-up" perception on psychological distress among college students during COVID-19 pandemic: A mediating role of "fear of academic year loss". *Children Youth Serv. Rev.* 118:105355. doi: 10.1016/j.childyouth.2020.105355

Hatlevik, O. E., Ottestad, G., and Throndsen, I. (2015). Predictors of digital competence in 7th grade: a multilevel analysis. *J. Comp. Assisted Learn.* 31, 220–231. doi: 10.1111/jcal.12065

He, T., and Li, S. (2019). A comparative study of digital informal learning: The effects of digital competence and technology expectancy. *Br. J. Educat. Technol.* 50, 1744–1758. doi: 10.1111/bjet.12778

Henseler, J., Ringle, C. M., and Sinkovics, R. R. (2009). The use of partial least squares path modeling in international marketing. *Adv. Int. Market.* 20, 277–319. doi: 10.1108/S1474-797920090000020014

Horesh, D., Kapel Lev−Ari, R., and Hasson−Ohayon, I. (2020). Risk factors for psychological distress during the COVID−19 pandemic in Israel: Loneliness, age, gender, and health status play an important role. *Br. J. Health Psychol.* 25, 925–933. doi: 10.1111/bjhp.12455

Huntington-Klein, N., and Gill, A. (2020). Semester course load and student performance. *Res. Higher Educat.* 2020, 1–28. doi: 10.1007/s11162-020-09614-8

Hwang, G.-J., Yang, L.-H., and Wang, S.-Y. (2013). A concept map-embedded educational computer game for improving students' learning performance in natural science courses. *Comput. Educat.* 69, 121–130. doi: 10.1016/j.compedu.2013.07.008

Islam, M. A., Barna, S. D., Raihan, H., Khan, M. N. A., and Hossain, M. T. (2020). Depression and anxiety among university students during the COVID-19 pandemic in Bangladesh: A web-based cross-sectional survey. *PLoS One* 15:e0238162. doi: 10.1371/journal.pone.0238162

Janssen, J., Stoyanov, S., Ferrari, A., Punie, Y., Pannekeet, K., and Sloep, P. (2013). Experts' views on digital competence: Commonalities and differences. *Comput. Educat.* 68, 473–481. doi: 10.1016/j.compedu.2013.06.008

Järvelä, S. (2011). How does help-seeking help?–New prospects in a variety of contexts. *Learn. Instruct.* 21, 297–299. doi: 10.1016/j.learninstruc.2010.07.006

Jena, R. (2015). Technostress in ICT enabled collaborative learning environment: An empirical study among Indian academician. *Comput. Hum. Behav.* 51, 1116–1123. doi: 10.1016/j.chb.2015.03.020

Juhaňák, L., Zounek, J., Záleská, K., Bárta, O., and Vlčková, K. (2019). The relationship between the age at first computer use and students' perceived competence and autonomy in ICT usage: A mediation analysis. *Comput. Educat.* 141:103614. doi: 10.1016/j.compedu.2019.103614

Kearney, M., Burden, K., and Rai, T. (2015). Investigating teachers' adoption of signature mobile pedagogies. *Comput. Educat.* 80, 48–57. doi: 10.1016/j.compedu.2014.08.009

Kent, P., Jensen, R. K., and Kongsted, A. (2014). A comparison of three clustering methods for finding subgroups in MRI, SMS or clinical data: SPSS TwoStep Cluster analysis, Latent Gold and SNOB. *BMC Med. Res. Methodol.* 14:113. doi: 10.1186/1471-2288-14-113

Kristensen, T. S., Borritz, M., Villadsen, E., and Christensen, K. B. (2005). The Copenhagen Burnout Inventory: A new tool for the assessment of burnout. *Work Stress* 19, 192–207. doi: 10.1080/02678370500297720

Kuittinen, M., and Meriläinen, M. (2011). The effect of study—related burnout on student perceptions. *J. Int. Educ. Bus.* 4, 42–62. doi: 10.1108/18363261111170586

Littenberg-Tobias, J., and Reich, J. (2020). Evaluating access, quality, and equity in online learning: A case study of a MOOC-based blended professional degree program. *Inter. Higher Educ.* 47:100759. doi: 10.1016/j.iheduc.2020.100759

López-Meneses, E., Sirignano, F. M., Vázquez-Cano, E., and Ramírez-Hurtado, J. M. (2020). University students' digital competence in three areas of the DigCom 2.1 model: A comparative study at three European universities. *Australas. J. Educat. Technol.* 36, 69–88. doi: 10.14742/ajet.5583

Maderick, J. A., Zhang, S., Hartley, K., and Marchand, G. (2016). Preservice teachers and self-assessing digital competence. *J. Educat. Comput. Res.* 54, 326–351. doi: 10.1177/0735633115620432

Mannerström, R., Hietajärvi, L., Muotka, J., and Salmela-Aro, K. (2018). Identity profiles and digital engagement among Finnish high school students. *Cyberpsychology* 12, 2–15. doi: 10.5817/CP2018-1-2

Paas, F., Tuovinen, J. E., Tabbers, H., and Van Gerven, P. W. (2003). Cognitive load measurement as a means to advance cognitive load theory. *Educat. Psychol.* 38, 63–71. doi: 10.1207/S15326985EP3801_8

Parola, A., Rossi, A., Tessitore, F., Troisi, G., and Mannarini, S. (2020). Mental health through the COVID-19 quarantine: a growth curve analysis on Italian young adults. *Front. Psychol.* 11:567484. doi: 10.3389/fpsyg.2020.567484

Podsakoff, P. M., MacKenzie, S. B., and Podsakoff, N. P. (2012). Sources of method bias in social science research and recommendations on how to control it. *Annu. Rev. Psychol.* 63, 539–569. doi: 10.1146/annurev-psych-120710-100452

Pohan, C. A. (2020). *In support of student learning: Managing cognitive load during emergency remote instruction*. Merced, CA: University of California Merced Center for Engaged Teaching and Learning.

Qayyum, A. (2018). Student help-seeking attitudes and behaviors in a digital era. *Int. J. Educ. Technol. Higher Educat.* 15, 1–16. doi: 10.1186/s41239-018-0100-7

Qi, C. (2019). A double-edged sword? Exploring the impact of students' academic usage of mobile devices on technostress and academic performance. *Behav. Informat. Technol.* 38, 1337–1354. doi: 10.1080/0144929X.2019.1585476

Rasheed, R. A., Kamsin, A., and Abdullah, N. A. (2020). Challenges in the online component of blended learning: A systematic review. *Comput. Educat.* 144:103701. doi: 10.1016/j.compedu.2019.103701

Røkenes, F. M., and Krumsvik, R. J. (2016). Prepared to teach ESL with ICT? A study of digital competence in Norwegian teacher education. *Comput. Educat.* 97, 1–20. doi: 10.1016/j.compedu.2016.02.014

Salmela-Aro, K., Hietajärvi, L., and Lonka, K. (2019). Work burnout and engagement profiles among teachers. *Front. Psychol.* 10:2254. doi: 10.3389/fpsyg.2019.02254

Sanchez, G. (2013). *PLS path modeling with R*. Berkeley, CA: Trowchez Editions.

Schneider, S., Nebel, S., Beege, M., and Rey, G. D. (2018). The autonomy-enhancing effects of choice on cognitive load, motivation and learning with digital media. *Learn. Instruct.* 58, 161–172. doi: 10.1016/j.learninstruc.2018.06.006

Selwyn, N. (2016). Digital downsides: Exploring university students' negative engagements with digital technology. *Teaching Higher Educat.* 21, 1006–1021. doi: 10.1080/13562517.2016.1213229

Silamut, A. A., and Petsangsri, S. (2020). Self-directed learning with knowledge management model to enhance digital literacy abilities. *Educat. Informat. Technol.* 25, 4797–4815. doi: 10.1007/s10639-020-10187-3

Sweller, J. (2005). "Implications of cognitive load theory for multimedia learning," in *The Cambridge handbook of multimedia learning*, ed. R. E. Mayer (New York: Cambridge University Press), 19–30.

Sweller, J. (2020). Cognitive load theory and educational technology. *Educat. Technol. Res. Dev.* 68, 1–16. doi: 10.1007/s11423-019-09701-3

Tenenhaus, M., Amato, S., and Esposito Vinzi, V. (2004). "A global goodness-of-fit index for PLS structural equation modelling," in *Paper presented at the Proceedings of the XLII SIS Scientific Meeting*, (Padova: CLEUP).

Vanslambrouck, S., Zhu, C., Lombaerts, K., Philipsen, B., and Tondeur, J. (2018). Students' motivation and subjective task value of participating in online and blended learning environments. *Internet Higher Educ.* 36, 33–40. doi: 10.1016/j.iheduc.2017.09.002

Vrieze, S. I. (2012). Model selection and psychological theory: a discussion of the differences between the Akaike information criterion (AIC) and the Bayesian information criterion (BIC). *Psychol. Methods* 17, 228–243. doi: 10.1037/a0027127

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Entrepreneurial Self-Efficacy Mediates the Impact of the Post-pandemic Entrepreneurship Environment on College Students' Entrepreneurial Intention

Jiping Zhang[1,2]* *and Jianhao Huang*[2]

[1] *The Office of Psychological Counselor, College of Foreign Languages, Ningbo University, Ningbo, China,* [2] *Department of Education Management, China-Asean International College, Dhurakij Pundit University, Bangkok, Thailand*

The mechanism of how the COVID-19 global pandemic has affected the entrepreneurial intentions of college students remains unknown. To investigate the impact of the entrepreneurial environment on entrepreneurial self-efficacy and entrepreneurial intentions in the post-pandemic era, 913 college students were invited to complete a questionnaire. The data were analyzed with structural equation models. The conclusions revealed by the questionnaire are as followed: college students have retained some entrepreneurial intention in the post-pandemic era; the factors influencing the entrepreneurial intention include sex, family entrepreneurial history, major, and education background; and entrepreneurial self-efficacy can play a major role to mediate the impact caused by the post-pandemic entrepreneurial environment on entrepreneurial intentions. The research conclusions provide important insights to improve college students' entrepreneurial intentions in the post-pandemic environment.

Keywords: entrepreneurial self-efficacy, COVID-19, entrepreneurial intention, entrepreneurial environment, post-pandemic

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***Correspondence:**
Jiping Zhang
zhangjiping@nbu.edu.cn

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INTRODUCTION

The world witnessed the unprecedented epidemic of COVID-19 in 2020, which brought a huge shock to the global economy, trade, as well as investment. Major economies around the world successively experienced significant declines in the economic growth of varying degrees, accompanied by a sharp spike in unemployment and deterioration in the performance of the market (China Macroeconomic Forum, 2020). Therefore, economic recovery after the epidemic is becoming the top priority for any country. According to the *Global Competitiveness Report*, entrepreneurship, which is a momentum for a country to promote economic development, plays an irreplaceable role in maintaining social stability and achieving economic recovery in efficiency-driven countries. The reform of innovation and entrepreneurship education in higher education plays a critical role in the country's socio-economic development, which in turn influences the international status of a country. Therefore, countries around the world attach great importance to the cultivation of entrepreneurial intentions (EI) among college students. In 2015, China's State Council issued "Opinions on Several Policy Measures to Vigorously Promote Mass Entrepreneurship and Innovation," putting forward "Mass Entrepreneurship and Innovation." As college students

are the reserve force for national development, study on their entrepreneurial intentions in the post-epidemic environment (PEE) is vital to the country's economic recovery.

It has been found that the entrepreneurial environment is a significant positive predictor of entrepreneurial intentions (Wu and Mao, 2020). Essel et al. (2020) have found that a good entrepreneurial environment promotes entrepreneurial intentions with empirical studies. Also, some scholars have found a decline in social entrepreneurial intentions due to the epidemic. For example, Inés Ruiz-Rosa et al. (2020) have found that the epidemic caused a severe socio-economic crisis and great uncertainty, which led to a decline in students' entrepreneurial intentions. However, the post-epidemic entrepreneurial environment has been changed dramatically. Under the epidemic prevention and control guidelines, people in China and beyond has experienced online activities like online shopping and online education, and people's mindset and lifestyles changed at the same time, which is more embracing a new lifestyle with the internet economy (Wang et al., 2020; Tang and Liang, 2021). Although the epidemic has brought a severe blow to the service industries such as transportation, travel, and retail. But online consumption such as telecommuting, telemedicine, online education, online entertainment, and emerging industries such as unmanned delivery and smart manufacturing have all shown strong potential to grow (Duan, 2020). Be that as it may, there is no sound evidence on how exactly the post-epidemic entrepreneurial environment predicts entrepreneurial intentions.

However, currently, many countries are under the pressure of the epidemic, and when it is under control and becomes stable, it is an urgent need to create a good entrepreneurial environment to boost people's entrepreneurial intentions. China has taken the lead in controlling the epidemic, and as of 27 September 2020, all 31 provinces (autonomous regions and municipalities) and the Xinjiang Production and Construction Corps have resumed cross-provincial (autonomous regions and municipalities) group travels and entered the post-epidemic era (Babna, 2020). General Secretary Xi Jinping pointed out: "The epidemic is both a challenge and an opportunity for industrial development. We need to take it as an opportunity to transform and upgrade traditional industries and innovate new industries." In the post-epidemic situation, the Chinese government has already announced many entrepreneurship-friendly policies. Through the review of literature, it has been found that there is no precedent research on how entrepreneurial intentions are changed in the post-epidemic environment and how the entrepreneurial environment affects entrepreneurial intentions, and a possible reason behind this may be that most countries are still in the midst of the epidemic. But now China is embracing a post-epidemic era, and relevant studies are of great value and innovative significance.

Meanwhile, entrepreneurial self-efficacy (ESE), which refers to self-efficacy in the context of entrepreneurship, has been a key topic in research on entrepreneurship, which draws the attention of many scholars. In fact, entrepreneurial self-efficacy is dual; in that, it is both a mediating variable and an outcome variable. In this research, entrepreneurial self-efficacy is considered as a key mediating variable in the relationship between entrepreneurial environment and entrepreneurial intention in the post-pandemic era. With this in mind, this study also focuses on the relationship between entrepreneurial environment and entrepreneurial intention and investigates whether entrepreneurial self-efficacy can play a mediating role.

In summary, based on the literature review, this study finds that there is no precedent research conducted, even though there is sound evidence that entrepreneurial environment can predict entrepreneurial intentions, and entrepreneurial self-efficacy can bring a mediating effect in entrepreneurship. Given that China is among the first to enter the post-epidemic era, which can be considered as a sound representative. As a result, this study chooses China to study how the post-epidemic entrepreneurial environment (PEE) affects entrepreneurial intentions, which is both innovative and practical.

LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

The Theory of Social Cognitive Model

Bandura's (1977) Social Cognitive Theory suggests that entrepreneurial intentions are deliberate, rational behavioral tendencies, which are the combined result of the entrepreneurial environment, entrepreneurial cognition, and individual-environment interactions. The theory emphasizes the influence of the social environment, in which the individual lives, on people's behavior, pointing that the external environment can act as a resource for the individual to enhance self-prediction, manipulation, or volitional control. Thus, it can provide the individual with precise information that affects the direction and intensity of his or her behavior. At the same time, the influencing process of the external environment on behavior varies according to the individual's cognitive knowledge and characteristics. In other words, the external environment can influence human behavior with various stimuli, and this influence is realized through the psychological process and internal self-regulatory system (i.e., self-efficacy) of an individual. Therefore, according to Social Cognitive Theory, the entrepreneurial environment can be viewed as the external environment, and entrepreneurial self-efficacy can be viewed as the individual's cognitive knowledge and characteristics. Both of them can play major roles in the forming of an individual's entrepreneurial intentions and are vital variables in the study on entrepreneurial intentions. The entrepreneurial environment can affect entrepreneurial intentions through individual judgments on the accessibility to resources and support.

Entrepreneurship Intention

Entrepreneurial intention is defined as "a self-acknowledged conviction by a person that they intend to set up a new business venture and consciously plan to do so in the future" (Thompson, 2009). Similar to personal commitment, the Entrepreneurial intention of college students can predict the possibility of whether

they will start a business in the future or not (Liu, 2011). As a consequence, this study regards entrepreneurial intentions as the behavioral dispositions and ideas of college students who choose to start their own business in the future.

Linking Post-pandemic Entrepreneurial Environment to Entrepreneurial Intention

The entrepreneurial environment, which includes all social, cultural, economic, and political conditions, as well as existing opportunities to receive entrepreneurial resources, is a vital combination of factors that influences entrepreneurial activities (Zhang and Chen, 2004). The entrepreneurial intention model proposed by Lüthje and Franke (2010) indicates that the influence of social-environmental factors is vital for an individual's entrepreneurial intention, that is to say, whether, at school, or society, environmental factors that can hinder entrepreneurship will frustrate an individual's entrepreneurial intentions. Previous research has found that the entrepreneurial environment has a substantial impact on entrepreneurial intentions (Rajib and Niladri, 2020; Shi et al., 2020). To date, the entrepreneurial environment in China has changed with the outbreak of the global pandemic, but there has been little research on whether the post-pandemic entrepreneurial environment can affect the entrepreneurial intentions of college students. Thus, this study proposes a hypothesis based on previous research:

Hypothesis 1: The post-pandemic entrepreneurial environment has a substantial effect on student's entrepreneurial intention.

The Mediating Role Played by Entrepreneurial Self-Efficacy

Bandura (1977) has first introduced the concept of self-efficacy from a psychological perspective and defined it as people's beliefs in their capabilities to do a job. Boyd and Vozikis (1994) have defined entrepreneurial self-efficacy as the belief that people are confident to become an entrepreneur, engage in entrepreneurial activities, and ultimately achieve their entrepreneurial goals. Self-efficacy determines one's orientation of goals, the effort paid to achieve goals, and persistence. As a psychological resource, Self-efficacy has a positive impact on one's behavior. Research has disclosed that entrepreneurial self-efficacy can play a mediating role in the relationship between multiple network embedding and entrepreneurial intention (Li et al., 2019). Also, it can moderate the relationship between extraversion, openness, emotional stability, and entrepreneurial intention (Jin and Huang, 2019). According to the Social Cognitive Theory, both the entrepreneurial environment and entrepreneurial self-efficacy are momentous in the formation of entrepreneurial intentions. Farashah (2015) has studied the institutional normative environment of 54 countries (regions), observing that the entrepreneurial self-efficacy of adults had a positive effect on individual entrepreneurial intentions; while a recent empirical study from Saudi Arabia has shown a partially mediating role played by entrepreneurial self-efficacy in the relationship between entrepreneurial environment and entrepreneurial intentions (Elnadi and Gheith, 2021).

Based on a thorough literature review, the relationship between the entrepreneurial environment, entrepreneurial self-efficacy, and college students' entrepreneurial intention was assessed in the post-pandemic era. Specifically, the direct effect of the post-pandemic entrepreneurial environment on entrepreneurial intention was tested and whether entrepreneurial self-efficacy can play a mediating role was examined as well. According to the existing research, we made the following hypotheses:

Hypothesis 2: The post-pandemic entrepreneurial environment has a substantial effect on entrepreneurial self-efficacy.

Hypothesis 3: Students' entrepreneurial self-efficacy has a significant influence on entrepreneurial intention.

Hypothesis 4: Entrepreneurial self-efficacy can serve as a mediator for the entrepreneurial intention in the post-pandemic entrepreneurial environment.

METHODS

Participants and Procedures

The test was completed between August and October 2020 and was divided into a pre-test and a formal test. Complete data were tested and retrieved twice. Two questionnaires were administered to different participants.

Pre-test Sample Adopted in the Study

The pre-test questionnaire was accomplished in August 2020. 127 questionnaires were distributed to students who were majoring in foreign languages at a comprehensive university in Zhejiang Province, China with the convenience sampling method. The total number of participants is 127. Eight invalid questionnaires were excluded, and the efficiency of the questionnaire was thus 93.7%. Among them, 73 students majored in English, nine majored in Japanese, and 37 majored in German; 62 were juniors, 48 were seniors, and nine were postgraduates. After an analysis of the content, reliability, and validity of questionnaires, some items and revised the initial questionnaire was deleted to finalize the formal one.

Formal Sample Adopted in the Study

The official questionnaire was carried out from the end of August to October 2020. The questionnaires were distributed to students studying in three schools in Zhejiang Province, China with the stratified random sampling method. The three schools included a comprehensive university, a general private university, and a general junior college. With an online platform[1], a total of 1,050 questionnaires were distributed and retrieved. To ensure that participants were represented, 350 individuals were drawn from each of the three schools based on four demographic variables: gender, profession, educational background, and family background, for achieving the integrity of the sample structure.

[1] www.wjx.cn

Finally, 913 valid questionnaires (effective rate 86.95%) were obtained, of which 220 were completed by men and 693 were accomplished by women. Participants were students who are majoring in science, engineering, agriculture, and medicine (n = 134), humanities and social sciences (n = 186), sports and art (n = 453), and business administration (n = 140). Concerning participants' educational background, 563 participants had a junior college degree, 313 had a bachelor's degree, and 37 had a postgraduate degree. A total of 240 participants had a family member who had started their businesses, and 673 people did not. 374 participants were the only child in their family and 539 had siblings.

Test Process

This study was carried out in accordance with there commendations of the Human Ethics Committee of the Ningbo University. Class was designed to be the unit of the test, and one postgraduate student who had experience in this kind of testing before was responsible for the test. Before the test started, the researcher had provided specific training for the responsible person, which includes the instructions to the questionnaire, the content of the questionnaire, and notes of the testing process. During the test, the respondent would be informed of the academic purpose of the test and the anonymity of the questionnaire. The respondents were able to finish all the questions in the questionnaire with adjusted time, which is in line with their situation and can be more than enough.

Measures

The initial questionnaire applied in this study included four sections and a total of 28 items, which includes seven items measuring the basic information of the participant, five items on the entrepreneurial self-efficacy scale, five items assessing entrepreneurial intention, and 11 items evaluating the post-pandemic entrepreneurial environment (including the four original items about the entrepreneurial environment and seven additional items related to the post-pandemic entrepreneurial environment). The questionnaire was also translated and revised for non-Chinese students.

The translation and revision of three scales were conducted in line with the following procedure: First, two master students majoring in English translation translated and back-translated questions of the original one to narrow the cross-cultural gap. Second, seven questions concerning the post-pandemic entrepreneurial environment were added to the entrepreneurial environment questionnaire and were reviewed by experts in this field to verify the questionnaire. Third, 10 college students were randomly selected to complete the questionnaire to make sure that there were no semantic ambiguities or unclear expressions. Fourth, 119 college students were selected for the pre-test with the convenience sampling method. Finally, the formal questionnaire was determined with item analysis and exploratory factor analysis achieved in the three scales of the pre-test questionnaire.

Background Variables

This part of the questionnaire collects data on students' sex, major, grade, educational background, family members' entrepreneurship history, whether they are from a one-child family or not, and a possible choice of entrepreneurship.

The Post-pandemic Entrepreneurial Environment Scale

This 11-item scale is a revised version based on the Entrepreneurial Environment Questionnaire (Jena, 2020). The revised questionnaire has seven questions. It is scored on a 5-point scale. Analysis of pre-test results shows: KMO = 0.832, Cronbach's alpha = 0.877, and factor loading values of 0.721−0.911. This scale, therefore, owns good reliability.

The Entrepreneurial Intention of College Students Scale

The Questionnaire of the Entrepreneurial Intention of College Students is a 6-item unidimensional scale, which was designed by Li and Chen (2009). After revised by Jena (2020), there are five questions. And each of them is scored with a 5-point scale. The overall reliability of the pre-test scale is 0.918, with a KMO of 0.889 and factor loading values of 0.721 to 0.911. This scale, therefore, shows good reliability.

The Entrepreneurial Self-Efficacy Scale

The Entrepreneurial Self-Efficacy Questionnaire is designed by Wilson et al. (2007) and has been tested to have a good validity (Rajib and Niladri, 2020). It has five items, and each of them is scored with a 5-point scale. This scale also presents a good validity.

Data Analysis

Reliability and validity of the scale of post-pandemic entrepreneurial environment, entrepreneurial self-efficacy, and entrepreneurial intention are assessed with SPSS and AMOS. And then, a correlation analysis is adopted to explore the relationship between the three main variables in SPSS. Finally, the specific mechanisms that can underlie these associations, including the mediating effect of entrepreneurial self-efficacy was examined, and the significance level was set at 0.05.

Cronbach's alpha coefficient is applied as a reliability measure; Cronbach's alpha is 0.959, 0.944, and 0.962 for the post-pandemic entrepreneurial environment scale, entrepreneurial self-efficacy scale, and entrepreneurial intention scale, respectively.

The validity of the questionnaire is tested with exploratory factor analysis and confirmatory factor analysis. The KMO values for the self-efficacy scale, the entrepreneurial intention scale, and the post-pandemic entrepreneurial environment scale are 0.95, 0.89, and 0.911, respectively, and all had a p-value < 0.001 (**Table 1**). Consequently, all three scales are considered to have good structural validity.

AMOS is applied to carry out the confirmatory factor analysis, and the model adaptation is presented in **Table 2**. Based on the verification of various indicators, the three scales adopted in this study are viewed as one with good reliability and validity, which supports the report that they include accurate and effective questions and can collect reliable research data (Hou et al., 2004).

TABLE 1 | Reliability and Validity of the Post-pandemic Entrepreneurial Environment, Entrepreneurial Self-Efficacy, and Entrepreneurial Intention Scales.

	Values	PEE	ESE	EI
Reliability	Cronbach's alpha	0.959	0.944	0.962
	KMO Values	0.911	0.908	0.913
	Bartlett's test of sphericity *P*-value	0.000	0.000	0.000
Validity	Interpretation Rate	80.45%	81.99%	86.93%
	Factor Loading Value	0.801∼0.927	0.88∼0.915	0.864∼0.932

****P < 0.001; PEE refers to Post-pandemic Entrepreneurial Environment; ESE means Entrepreneurial Self-Efficacy; EI stands for Entrepreneurial Intention.*

TABLE 2 | Models of the Confirmatory Factor Analysis.

Scales	RMSEA (<0.08)	RMR (<0.08)	GFI (>0.9)	CFI (>0.9)	IFI (>0.9)	CN (HOELTER. 05) (>200)
PEE	0.033	0.004	0.997	0.999	0.999	1071
ESE	0.074	0.01	0.98	0.993	0.993	272
EI	0.069	0.006	0.991	0.997	0.997	404

PEE refers to Post-pandemic Entrepreneurial Environment; ESE means Entrepreneurial Self-Efficacy;EI stands for Entrepreneurial Intention.

RESULTS

Descriptive Statistics and Correlation Analysis

The Status Quo of Entrepreneurial Intention, Entrepreneurial Environment, and Self-Efficacy

As shown in **Table 3**, the mean total score is 3.86 (SD = 0.72) for the entrepreneurial environment scale, 3.49 (SD = 0.81) for the self-efficacy scale, and 3.45 (SD = 0.90) for students' entrepreneurial intention scale. Given that all scales are measured with a 5-point scoring system, these results indicate that participants have scored at the upper-middle level. Besides, when asked "which type of entrepreneurship do you prefer in the post-pandemic era," 60% of the students chose online business.

Differences in Entrepreneurial Intentions by Sex, Family Members' Entrepreneurship History, and Being an Only Child or Not

Independent samples *t*-tests are rolled out with entrepreneurial intention as the dependent variable and sex (male/female), family members' entrepreneurship history (yes/no), and one-child family (yes/no) as the independent variables. Male participants have significantly greater entrepreneurial intentions than female participants ($t = 2.637$, $p < 0.01$), and students whose family members had an entrepreneurship history are more likely to have greater entrepreneurial intention than students whose family members did not have an entrepreneurship history ($t = 3.812$, $p < 0.01$). There is no significant difference in entrepreneurial intention for whether students were the only child in the family or not.

An analysis of variance (ANOVA) is conducted as well with entrepreneurial intention as the dependent variable and the major and educational background as the independent variables. There are significant differences in entrepreneurial intention between students from different majors [$F(4,913) = 19.555$, $p < 0.001$]. Specifically, the entrepreneurial intention of students majoring in science, engineering, agriculture, and medicine is significantly higher than that of students majoring in humanities and social sciences ($p < 0.001$), and the entrepreneurial intention of students majoring in sports and art is significantly higher than that of students majoring in humanities and social sciences ($p < 0.001$) as well as in business administration ($p < 0.01$). Furthermore, educational background has a vital influence on entrepreneurial intentions [$F(3,913) = 64.314$, $p < 0.001$], whereby junior college students have higher entrepreneurial intentions than undergraduates. However, the number of graduate students is too small to be considered.

TABLE 3 | The Post-pandemic Entrepreneurial Environment, Entrepreneurial Self-Efficacy, and Entrepreneurial Intentions.

Variables	M	SD	1	2
ESE	3.486	0.812		
PEE	3.456	0.909	0.670***	
EI	3.869	0.729	0.788***	0.682***

****P < 0.001; PEE refers to Post-pandemic Entrepreneurial Environment; ESE means Entrepreneurial Self-Efficacy; EI stands for Entrepreneurial Intention.*

The Post-pandemic Entrepreneurial Environment, Entrepreneurial Self-Efficacy, and Entrepreneurial Intentions

Table 3 represents the averages, standard deviations, and correlation coefficients for the post-pandemic entrepreneurial environment, entrepreneurial self-efficacy, and entrepreneurial intention. College students' perception of the post-pandemic entrepreneurial environment and entrepreneurial self-efficacy is not obvious (M1 = 3.486, M2 = 3.456), which is slightly higher than the expected average of 3, but the entrepreneurial intention is relatively high (M3 = 3.869), close to 4. Entrepreneurial self-efficacy is positively correlated with both the post-pandemic entrepreneurial environment and entrepreneurial intention (**Table 3**).

Structural Equation Modeling Test

After analysis on the overall reliability and validity of the three scales, AMOS22.0 is adopted to construct a structural equation modeling, which generates a model with path coefficients, performing analysis on path effects. This step is applied to verify Hypothesis 1, Hypothesis 2, and Hypothesis 3.

Model Generation

To present the relationship between the post-pandemic entrepreneurial environment, entrepreneurial self-efficacy, and entrepreneurial intention scale scores, a structural equation modeling diagram (**Figure 1**) is formed based on the assumptions of this study.

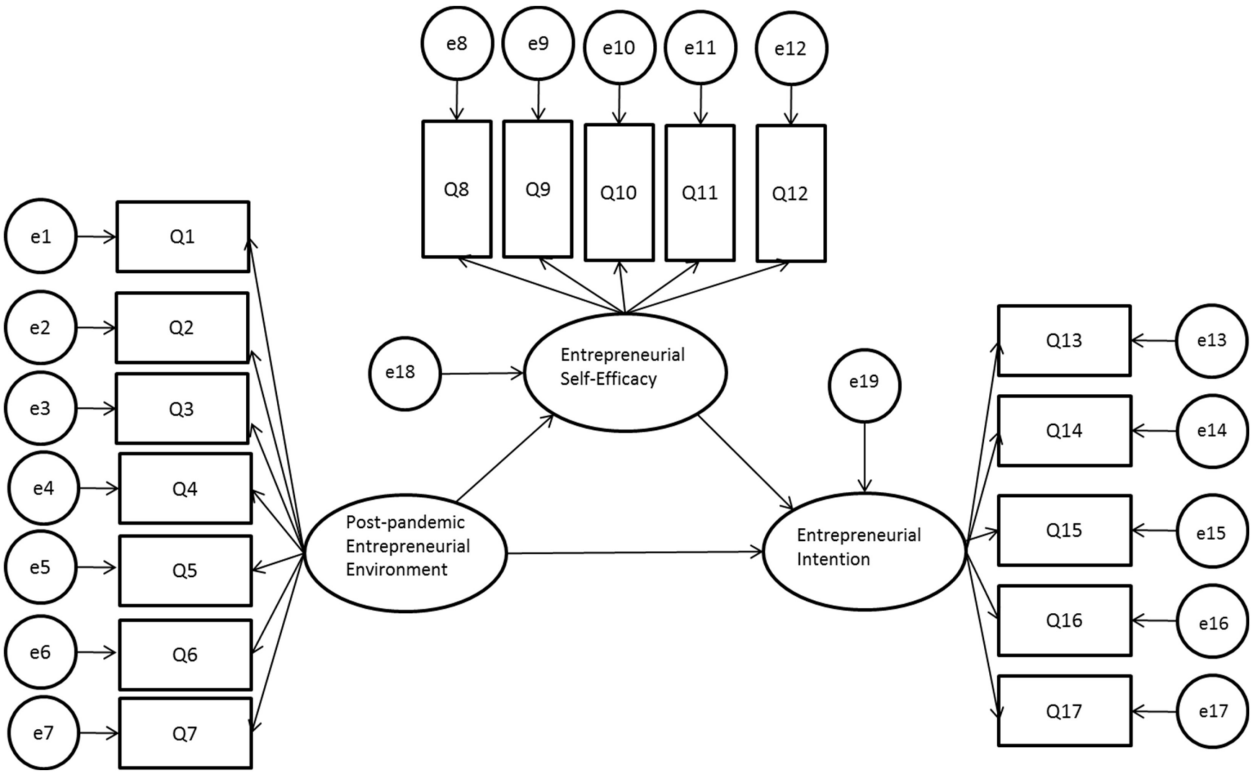

FIGURE 1 | The Structural Equation Modeling Diagram of the post-pandemic entrepreneurial environment scale, entrepreneurial self-efficacy scale, and entrepreneurial intention scale (Q1∼Q17 represent the item of the scale, e1∼e17 refer to the error terms of the items).

TABLE 4 | The Overall fitting situation of the Model.

Model Fit	RMSEA	RMR	GFI	CFI	IFI	PNFI
Standard	<0.08	<0.08	>0.9	>0.9	>0.9	>0.5
Results	0.077	0.038	0.909	0.968	0.968	0.806

Structural Equation Modeling Fitting Analysis

With analysis on the structural equation modeling diagram of the post-pandemic entrepreneurial environment scale, entrepreneurial self-efficacy scale, and entrepreneurial intention scale, the results of the model fit are presented in **Table 4**. Most of the indicators can meet the ideal standard (RMSEA = 0.077, RMR = 0.038, GFI = 0.909, CFI = 0.968, IFI = 0.968, PNFI = 0.806), and the model fits well on the whole, which indicates that the hypotheses can be established.

Analysis of Model Path

AMOS is applied to run the structural equation model based on the collected data (**Table 5**). The effect of the post-pandemic entrepreneurial environment on entrepreneurial intention is significant and positive, with a coefficient of 0.236. The influence of the post-pandemic entrepreneurial environment on entrepreneurial self-efficacy is also vital and positive, with a coefficient of 0.696. The impact of entrepreneurial self-efficacy on entrepreneurial intention is significantly positive as well, with a coefficient of 0.654. Besides, the post-pandemic entrepreneurial environment had a significant positive effect on entrepreneurial self-efficacy, with a coefficient of 0.654.

Bootstrap's Mediating Effect Analysis

With the analysis on the relationship between post-pandemic entrepreneurial environment, entrepreneurial self-efficacy, and entrepreneurial intentions, the specific mechanisms on how these variables interact, as well as the mediating effects of entrepreneurial self-efficacy is explored, which is applied to verify Hypothesis 4.

In the analysis of the indirect effects, MacKinnon et al. (2004) have compared the traditional method, distribution of the product, and five nonparametric bootstrap methods, and found that the bias-corrected nonparametric percentile bootstrap method can provide the most accurate confidence intervals and the highest statistical power for measuring the mediating effects. A bootstrap method is adopted in AMOS to test indirect effects.

The effect values of the post-pandemic entrepreneurial environment on entrepreneurial intentions, which are obtained with the nonparametric percentile bootstrap method, are shown in **Table 6**. The confidence intervals of the bias-corrected non-parametric percentiles for the total effect, direct effect, and indirect effect do not include zero, which signifies that the post-pandemic entrepreneurial environment has a significant total and direct impact on entrepreneurial intentions. Furthermore, the

TABLE 5 | Coefficients of the Model Path Analysis.

Relationships	Standardized path coefficient	Standard error	Critical ratio
ES ← PEE	0.696***	0.031	22.293
EI← PEE	0.236***	0.036	7.73
EI← ESE	0.654***	0.039	19.311

*PEE refers to Post-pandemic Entrepreneurial Environment; ESE stands for Entrepreneurial Self-Efficacy; EI represents Entrepreneurial Intention; ***P < 0.001.*

TABLE 6 | The Effect of Post-pandemic Entrepreneurial Environment on Entrepreneurial Intentions.

EI ← PEE	Path coefficients	95% CI
Total Effect	0.690***	0.735, 0.642
Direct Effect	0.236***	0.319, 0.166
Indirect Effect	0.455***	0.524, 0.392

*PEE refers to Post-pandemic Entrepreneurial Environment; EI stands for Entrepreneurial Intention; ***P < 0.001.*

indirect effect of entrepreneurial self-efficacy is also substantial, with an effect size between 0.642 and 0.735; the direct effect size is between 0.166 and 0.319, and the indirect effect size ranges between 0.392 and 0.524. Entrepreneurial self-efficacy brings a partially indirect effect on the post-pandemic entrepreneurial environment and entrepreneurial intentions, accounting for 65.9% of the total effect.

DISCUSSION AND CONCLUSION

In the Post-pandemic Era, College Students Still Have Entrepreneurial Intentions and Are More Inclined to Start an Online Business

The results of this study show that college students still have entrepreneurial intentions in the post-pandemic world. In a sample survey of 2,975 college students, Yan and Ye (2009) have found a medium level of entrepreneurial intent. As a result, compared with pre-epidemic studies, the post-pandemic environment has posed little effect on the entrepreneurial intentions of college students, which suggests that while the epidemic may harm the country's economy, it also witnesses many favorable entrepreneurial policies that are put in place to support enterprises during these difficulties. Besides, the questionnaire reveals that college students in the post-pandemic environment are inclined to start a business online compared with that in the pre-epidemic environment. This may be caused by the changes in the social environment after the pandemic. For instance, people may be more likely to buy products online and engage in online education, and their way of thinking can be more adaptable to the Internet environment. The post-pandemic entrepreneurial environment is both an opportunity and a challenge for college students. As an emerging group, college students are more familiar with the Internet than preceding generations with a high degree of acceptance, which shows that starting a business online can become the main way to guide entrepreneurial intention, as reflected in the results.

Sex, Family Members' Entrepreneurship History, Major, and Educational Background's Impact on Students' Entrepreneurial Intentions

It is found in this study that the entrepreneurial intentions of male students are significantly higher than that of female students, which is consistent with the conclusion of previous studies (Zhu and Zhou, 2010; Li et al., 2011). This can be related to the conventional idea in Chinese culture that "men should be outgoing and start a career and women should work hard to deal with home errands." In the embodiment of these gender traits, men in China are more likely to be trained as one with toughness and bravery, while women in China are more likely to be taught as who are quiet and careful.

Second, our results show that students whose family members have an entrepreneurship history have significantly greater entrepreneurial intentions than those who do not, which may be caused by the family entrepreneurial atmosphere. Students whose family members have an entrepreneurship history have more opportunities to observe and learn actual entrepreneurial practices; indeed, a person can learn new responses by observing the behavior of others and reinforcing the results according to Bandura's social cognitive theory. Therefore, students whose family members have entrepreneurial experiences are more likely to be familiar with entrepreneurship and show more entrepreneurial intentions than students whose family members do not.

In addition, significant differences in entrepreneurial intentions are also found between various majors, in which students majoring in science, technology, agriculture, and medicine have significantly higher entrepreneurial intentions than those majoring in humanities and social sciences, and students majoring in sports and art have significantly higher entrepreneurial intentions than those majoring in humanities and social sciences. This finding can be explained by the demand of the domestic market. Most students majoring in science, engineering, agriculture, medicine, sports, and art have links with more professional technology and larger market demand, which makes them easier to start a business.

Finally, students with a junior college degree have stronger entrepreneurial intention than those with a bachelor's degree, and the reason behind this may be that junior colleges place greater focus on practice and application compare with bachelor's degree programs.

The Links Between Post-pandemic Entrepreneurial Environment, Entrepreneurial Self-Efficacy, and Entrepreneurial Intention

The results illustrate that the influence of the post-pandemic entrepreneurial environment on entrepreneurial intention and entrepreneurial self-efficacy is rather vital and positive,

and entrepreneurial self-efficacy can also greatly affects entrepreneurial intention. The results show that the better the post-pandemic entrepreneurial environment, the stronger the entrepreneurial intention, which is consistent with previous reports (Zhu and Zhang, 2014; Ye and Fang, 2017). It is found in this study that the better the entrepreneurial environment, the stronger the self-efficacy and entrepreneurial intention, which is also consistent with the social cognitive theory, which states the influence of environmental and personal factors on behavior. When the post-pandemic entrepreneurial environment is sound and stable, more successful entrepreneurs will emerge, people's entrepreneurial self-efficacy will increase, and more people will be motivated to develop entrepreneurial intentions.

Entrepreneurial Self-Efficacy Have a Strong Mediating Effect on the Impact Caused by the Post-pandemic Entrepreneurial Environment on Entrepreneurial Intentions, and the Mediating Effect Is Relatively High

In this study, it is safe to conclude that the stronger an individual's self-efficacy, the stronger their entrepreneurial intention; the better the environment for entrepreneurship, the stronger the entrepreneurial intentions, which further validates the ternary interaction theory on the links between an individual, their environment, and behavior, as proposed by the social cognitive theory. At the same time, it is also found that self-efficacy has a strong mediating effect on the impact brought by the post-pandemic entrepreneurial environment on entrepreneurial intentions, which further illustrates that despite the global economic trauma brought by the epidemic, the human factor should never be ignored. In the post-pandemic entrepreneurial environment, the role of entrepreneurial self-efficacy is still critical.

SUGGESTIONS

Further Optimizing the Entrepreneurial Environment for College Students in the Post-pandemic Era

First, the situation of the epidemic should never be overlooked and mild measures need to be continued to provide a safe environment for the public. Especially, the current situation is still unstable with possible further outbreaks. Second, it is vital to maintain stable domestic economic growth. Finally, the government should consider rolling out more entrepreneurial policies to support the entrepreneurship of college students.

Entrepreneurship Education in Universities and Colleges Should Strengthen Students' Entrepreneurial Self-Efficacy

Entrepreneurship education can enhance students' self-efficacy through both curricular and extra-curricular activities. For example, students' skills for problem-solving and money management can be cultivated and developed at both classroom and amateur practice; skills in communication and persuasion can be also fostered through speech competitions, roadshows, and other activities; and leadership and independent spirit can be encouraged through participation in student organizations, such as student councils, clubs, as well as entrepreneurship associations.

Schools Entrepreneurship Education Should Stratify and Classify College Students According to Their Abilities

Students with family members who have started their businesses or majors with a large market demand should be paid extra attention to develop their entrepreneurial skills. The process of entrepreneurship education needs to be considered in conjunction with majors to encourage students to practice their professional knowledge so as to start their businesses. Besides, universities can set up an on-campus entrepreneurship park to provide opportunities for students who are interested in starting their businesses, and the school can also look for successful alumni entrepreneurs to do lectures so that students can know the exemplary entrepreneurs around them.

LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

In this study, questionnaires are adopted to collect data and conduct analysis with a focus on the influence of the post-pandemic entrepreneurial environment and entrepreneurial self-efficacy on entrepreneurial intentions. However, the study leaves the question of whether other factors might also influence entrepreneurial intentions unanswered. Future research can supplement the data collected in this study to better understand the challenges affecting entrepreneurial intentions in the post-pandemic environment, and different independent variables can be included accordingly. Such investigations can help to enhance the entrepreneurial intentions of college students in the post-pandemic era.

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/s.

ETHICS STATEMENT

This study was carried out in accordance with the recommendations of the Human Ethics Committee of the

Ningbo University. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

JZ designed the study, analyzed the data, and drafted the manuscript. JH assisted in analyzing and interpreting the data, and participated in the revision of the manuscript. Both authors contributed to the study and approved the submitted version.

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REFERENCES

Babna, M. (2020). *Guangming Daily*. Available online at: https://news.gmw.cn/2020-05/22/content_33849195.htm (accessed March 23, 2020).

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. *Psychol. Rev.* 84, 191–215. doi: 10.1016/0146-6402(78)90002-4

Boyd, N. G., and Vozikis, G. S. (1994). The influence of self-efficacy on the development of entrepreneurial intentions and actions. *Entrep. Theory Pract.* 18, 63–77. doi: 10.1177/104225879401800404

China Macroeconomic Forum (2020). Available online at: http://www.china.com.cn/opinion/think/2020-06/22/content_76190159.htm (accessed March 23, 2020).

Duan, W. B. (2020). New infrastructure is not a "magic bullet" but a new driving force. *People's Tribune*. 86–89.

Elnadi, M., and Gheith, M. H. (2021). Entrepreneurial ecosystem, entrepreneurial self-efficacy, and entrepreneurial intention in higher education: evidence from Saudi Arabia. *Int. J. Manag. Educ.* 19:100458. doi: 10.1016/j.ijme.2021.100458

Essel, E. O., Wang, M., Essel, C. H., and Dumor, K. (2020). Unemployment blues: analysis of the dual mediating effects of knowledge and perception on entrepreneurial intentions in the environment. *SAGE Open* 10:2158244020936218. doi: 10.1177/2158244020936218

Farashah, A. D. (2015). The effects of demographic,cognitive and institutional factors development of entrepreneurial intention: toward socio-cognitive model of entrepreneurial career. *J. Int. Entrep.* 13, 452–476. doi: 10.1007/s10843-015-0144-x

Hou, J. T., Wen, Z. L., and Cheng, Z. J. (2004). *Structural Equation Model and Its Application*. Beijing: National Institute of Education Science.

Jena, R. K. (2020). Measuring the impact of business management student's attitude towards entrepreneurship education on entrepreneurial intention: a case study. *Comput. Hum. Behav.* 107:106275. doi: 10.1016/j.chb.2020.106275

Jin, D., and Huang, S. S. (2019). Relationship between college students' Five-factor personality, entrepreneurial self-efficacy, and entrepreneurial intention. *J. Yangzhou Univ. High. Educ. Study Ed.* 6, 68–74. doi: 10.19411/j.cnki.1007-8606.2019.06.013

Li, H. L., Zhang, H. X., and Gong, Y. M. (2011). The relationship between the gender, gender role and entrepreneurial intention of college students. *J. East China Norm. Univ. Educ. Sci.* 29, 64–69. doi: 10.16382/j.cnki.1000-5560.2011.04.003

Li, N. F., and Chen, Y. W. (2009). Development and cross-cultural application of a specific instrument to measure entrepreneurial intentions. *Entrep. Theory Pract.* 33, 593–617. doi: 10.1111/j.1540-6520.2009.00318.x

Li, X. G., Wang, X. G., Yang, B. X., and Gao, F. (2019). Influence of multiple network embedding on entrepreneurial intention: based on mediating role of self-efficacy. *Technol. Econ.* 8, 78–85.

Liu, M. (2011). An analysis of gender disparity in students' entrepreneurial intention and its influencing factors. *Fudan Educ. Forum.* 6:2. doi: 10.13397/j.cnki.fef.2011.06.012

Lüthje, C., and Franke, N. (2010). The 'making' of an entrepreneur: testing a model of entrepreneurial intent among engineering students at mit. *R D Manag.* 33, 135–147. doi: 10.1111/1467-9310.00288

MacKinnon, D. P., Lockwood, C. M., and Williams, J. (2004). Confidence limits for the indirect effect: distribution of the product and resampling methods. *Multivariate Behav. Res.* 39, 99–128. doi: 10.1207/s15327906mbr3901_4

Rajib, R., and Niladri, D. (2020). Exploring entrepreneurial intention among engineering students in India: a multiple basket approach. *Int. J. Technol. Des. Educ.* 2, 1–30. doi: 10.1007/s10798-020-09596-9

Ruiz-Rosa, I., Gutiérrez-Tao, D., and García-Rodríguez, F. J. (2020). Social entrepreneurial intention and the impact of covid-19 pandemic: a structural model. *Sustainability* 12:6970. doi: 10.3390/su12176970

Shi, Y., Yuan, T., Bell, R., and Wang, J. (2020). Investigating the relationship between creativity and entrepreneurial intention: the moderating role of creativity in the theory of planned behavior. *Front. Psychol.* 11:1209. doi: 10.3389/fpsyg.2020.01209

Tang, K. Y., and Liang, H. J. (2021). Lifestyle choices in the post–epidemic Era. *J. HIT (Soc. Sci. Ed.)* 23, 50–57. doi: 10.16822/j.cnki.hitskb.2021.01.008

Thompson, E. R. (2009). Individual entrepreneurial intent: construct clarification and development of an internationally reliable metric. *Entrep. Theory Pract.* 3, 669–694. doi: 10.1111/j.1540-6520.2009.00321.x

Wang, C. Y., Zheng, X., Zhang, Y., Yao, G. N., and Kang, S. N. (2020). Implementation and diffusion of online higher education policies: a case study on Tsinghua University. *Tsingh. J. Educ.* 41, 47–59. doi: 10.14138/j.1001-4519.2020.04.004713

Wilson, F., Kickul, J., and Marlino, D. (2007). Gender, entrepreneurial self-efficacy, and entrepreneurial career intentions: implications for entrepreneurship education. *Entrep. Theory Pract.* 31, 387–406. doi: 10.1111/j.1540-6520.2007.00179.x

Wu, F. X., and Mao, C. Y. (2020). Business environment and entrepreneurial motivations of urban students. *Front. Psychol.* 11:1483. doi: 10.3389/fpsyg.2020.01483

Yan, J. W., and Ye, X. (2009). An investigation on college students' entrepreneurial intention. *Psychol. Sci.* 6, 1471–1474. doi: 10.16719/j.cnki.1671-6981.2009.06.062

Ye, B. J., and Fang, X. T. (2017). Entrepreneurial environment on college students' entrepreneurial intention: moderated mediating effect. *Psychol. Sci.* 6, 164–170. doi: 10.16719/j.cnki.1671-6981.20170625

Zhang, Y. L., and Chen, L. X. (2004). Analysis of the core elements and entrepreneurship environment of small and medium-sized enterprises. *Econ. Affairs* 3, 29–34.

Zhu, H., and Zhang, Y. L. (2014). Effects of entrepreneurship education in Beijing colleges on students' entrepreneurial intentions: from the perspective of student engagement. *Tsinghua J. Educ.* 12, 100–107. doi: 10.14138/j.1001-4519.2014.06.015

Zhu, H. L., and Zhou, L. (2010). An empirical research on gender differences of university students' entrepreneurial motivation–taking Xiamen university as an example. *High. Educ. Sci.* 4, 68–71. doi: 10.3969/j.issn.1000-4076.2010.04.014

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Psychological Distress and Trust in University Management Among International Students During the COVID-19 Pandemic

Karamat Khan[1]*, *Yanyan Li*[2]*, *Sheng Liu*[3] and *Chuntao Li*[4,5]

[1] School of Economics, Henan University, Kaifeng, China, [2] School of Education, Henan University, Kaifeng, China, [3] School of Business, Anhui University, Hefei, China, [4] School of Finance, Zhongnan University of Economics and Law, Wuhan, China, [5] School of International Education, Huanghuai University, Zhumadian, China

Since the end of 2019, the outbreak of the COVID-19 pandemic has engendered widespread fear and anxiety across China. Nearly half a million international students pursuing their studies in Chinese universities have also been exposed to the psychological distress triggered by the unfolding crisis. In addition to government and medical institutions' efforts, universities have also endeavored to mitigate concerns among these students under quarantine on campus by providing reliable information as well as medical, monetary, and emotional support. In this study, international students' trust in university management teams and its role in remediating their anxieties were evaluated using an online survey conducted after 10 days of the lockdown of Wuhan, China. The empirical analysis incorporates quantitative data from 180 international students. Ordinary least squares regression and probit regression were used in the analysis with the non-robust and robust models. The study found students' perception of trust in university management to be negatively associated with their anxiety levels. Additionally, having trust in university management was found to positively influence students' commitment to the self-quarantine guidelines. These results reinforce the important role of universities and their relationship with international students during public health emergencies.

Keywords: COVID-19, university management, trust, anxiety, self-quarantine

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***Correspondence:**
Karamat Khan
karamatkhan88@gmail.com
Yanyan Li
yanyanli@yahoo.com

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INTRODUCTION

The novel coronavirus (COVID-19) was first identified in Wuhan, Hubei province, China, at the end of 2019 and spread rapidly from one location to another, causing panic worldwide. Around 132 million people have been infected worldwide by the COVID-19 pandemic, with over 2.86 million fatalities reported by the end of March 2021 (World Health Organization, 2021). The effects of the COVID-19 pandemic have been significant, reaching beyond national health care sectors and into social, political, cultural, and economic domains (Aucejo et al., 2020; Bartik et al., 2020; Cao et al., 2020; Flesia et al., 2020; Khan et al., 2020).

A wide range of psychological issues, such as anxiety, loss, grief, suspicion, and fear, have been experienced by individuals, families, groups, and communities during the crisis (AlAteeq et al., 2020; Asmundson and Taylor, 2020; Liu et al., 2020; Xiang et al., 2020). Some groups of people would appear to be more vulnerable than others in terms of susceptibility to the disease as well as to other associated challenges emerging from the pandemic

(Aylie et al., 2020; Flesia et al., 2020; Sheroun et al., 2020). Students are one such group that has attracted extensive attention from society and academia alike (Cao et al., 2020; Amendola et al., 2021; Conrad et al., 2021; Wang et al., 2021; Zeng et al., 2021). For instance, the pandemic forced many universities to close their campuses and shift to online learning. COVID-19-related psychological stress combined with the sudden changes in learning methods posed significant problems for students, with negative consequences for their mental health (Cao et al., 2020; Collins, 2021; Wang et al., 2021; Zeng et al., 2021).

Compared to local students, international students pursuing their studies abroad face more complicated and unique challenges (Chen et al., 2020). Even under normal circumstances, international students are more vulnerable to psychological distress due to difficulties accessing medical care and are less motivated to seek out psychological services than their domestic peers (Alharbi and Smith, 2018; Brunsting et al., 2018). The vulnerability of international students intensifies during a crisis like COVID-19 owing to their lack of access to public resources, financial constraints, cultural or language barriers, inability to access reliable information, and the absence of the basic necessities of life (Park and Lee, 2016; Chen et al., 2020; Lee et al., 2021).

Moreover, some campuses were closed without recognition of the fact that many international students may not have a place to live outside of such campuses, or would not be able to access a secure return to their home countries as a result of closed borders, limited international flights, and the possibility of exposure to COVID-19 during travel (Ma et al., 2020; Conrad et al., 2021; Gewirtz O'Brien et al., 2021; Mok et al., 2021). Those who remained in their host countries were faced with unmet psychological needs concerning relatedness as a result of their physical separation from loved ones and a loss of social support in the local culture—not to mention the psychosocial issues involved with wider society's response to COVID-19 (Chen et al., 2020; Fakhar-e-Alam Kulyar et al., 2020; Conrad et al., 2021).

In general, many studies have investigated students' mental health and coping strategies amid the COVID-19 pandemic (Aucejo et al., 2020; Aylie et al., 2020; Cao et al., 2020; Amendola et al., 2021; Conrad et al., 2021; Wang et al., 2021; Zeng et al., 2021; Zhang et al., 2021). Our review suggests that international students, as a minority group on campus, face greater impediments to maintaining their mental health during the COVID-19 pandemic, and may require more attention because of their unique challenges and stressors. However, prior studies have often omitted a particular focus on international students' needs, or have addressed them as being the same as for local students. Consequently, there is an opportunity to add to this under-researched area by investigating the impact of the pandemic on the mental health of international students and the coping strategies that could help to reduce their anxieties during the crisis (Amoah and Mok, 2020; Chen et al., 2020; Amendola et al., 2021).

This study is specifically focused on international students who are studying in China. Its principal hypothesis is that international students with higher trust in their university's management will experience less anxiety during the COVID-19 pandemic crisis. According to Stolle (2001), "trust" refers to a sense of anticipated support provided mostly unconditionally from something being trusted. In the present study's context, we define trust as a student's confidence in their university's measures and support structures in place to prevent them from contracting the disease and experiencing psychological distress. For example, many universities restricted students' movement, started online classes, and provided food, medicine, and other groceries on their doorsteps free of cost or at subsidized prices during the crisis. "University management" here refers to a university's management at any level, but also specifically the international school of the university that is responsible for the affairs of the international students attending the university.

Further to our principal hypothesis, we also postulate that trust in university management will positively affect students' tendency to accept self-quarantine behavior. Correspondingly, our study's findings will also help reveal the extent to which international students practice the preventive measures recommended by the Chinese Center for Disease Control and Prevention (2020) and the World Health Organization (2020a). Thus, the results of this study provide meaningful evidence that can help governmental and educational institutions take effective steps to support such vulnerable populations in a pandemic situation, now and in the future.

MATERIALS AND METHODS

Participants and Procedures

The study aimed to explore the impact of trust in university management on psychological distress among international students and their self-quarantine behavior during the COVID-19 pandemic. For this purpose, an online cross-sectional study (see **Supplementary Material** for the questionnaire) was undertaken from February 3 to 14, 2020—precisely 10 days after the Wuhan lockdown on January 23, 2020. We approached participants through official WeChat groups that had already been developed by the universities for their international students. During the online investigation, international students were quarantined in their campus dormitories/off-campus residences, due to a government lockdown policy. The participants were recruited using a non-probability sampling technique (a combination of purposive and convenience sampling techniques). We collected 180 valid responses from international students located in several places in Hubei, but from Wuhan in particular. Although a portion of the participants was not actually in Wuhan, the epicenter of the outbreak, they would have been closely monitoring social media related to the pandemic.

Measures

Trust

We used a 10-item scale to assess international students' trust in the university's management team (Warner-Søderholm et al., 2018). The scale was adapted to our study context, and included two items from each of the five subdimensions of the trust construct: benevolence, integrity, competence, identification, and concern (e.g., "University management really does care about the well-being of international students"). The items were rated on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly*

agree). If a reverse-coded question was used, it was converted into the same direction at the data entry stage. The scale had an alpha reliability coefficient of 0.949.

Anxiety

The Clinical Anxiety Scale (Westhuis and Thyer, 1989) was adapted to measure the anxiety levels of the respondents on a 5-point Likert scale (Quah and Hin-Peng, 2004). Our instrument consisted of 10 items in relation to which respondents indicated their level of agreement with the statements using a rating from 1 (*strongly disagree*) to 5 (*strongly agree*). For example, we asked participants, "Thinking of how you feel these days, would you say 'I feel calm'?" Negative item scores were reversed, so lower total scores indicated higher anxiety. The scale had an alpha reliability coefficient of 0.886.

Acceptance of Self-Quarantine

Following Quah and Hin-Peng (2004), we asked the respondents if they would be willing to self-quarantine themselves if they had had non-close contact with a COVID-19-infected person. Responses were given on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). We created a dichotomous variable based on the average score on the item ($M = 3.78$; $SD = 1.19$). The variable took a value of 1 if the respondent showed higher acceptance for self-quarantine (i.e., score >4), and 0 otherwise.

Control Variables

We controlled for several variables that might affect the dependent variables, to ensure a rigorous test of the primary hypothesis of this study.

Essential Knowledge of COVID-19

Participants' essential knowledge about the disease may affect their anxiety levels and attitude to accepting self-quarantine. We used five questions to test each participant's knowledge of the COVID-19 disease. Responses were scored 0 (*incorrect*) or 1 (*correct*); a composite index indicated the number of correct answers, from none correct (0) to all five correct (5). We created a dichotomous variable based on the average score for knowledge of COVID-19 ($M = 2.93$; $SD = 1.10$). The variable took a value of 1 if the respondent had a greater knowledge of the disease (score >3), and 0 otherwise.

Self-Health Perception

Individual self-health perception may also influence a person's anxiety levels and tendency to accept self-quarantine. We asked the participants if they had had, in the preceding 2 weeks, any of the six physical health symptoms (e.g., flu symptoms, high temperature, sore throat) that are associated with the COVID-19 disease (Chinese Center for Disease Control and Prevention, 2020; World Health Organization, 2020b). We created a dichotomous variable that took a value of 1 if the participant reported at least one physical health symptom during the previous 2 weeks, and 0 otherwise.

Demographic Characteristics

We also collected data on the demographic characteristics of the participants. Participants who were in Wuhan, male, married, and belonged to the age category of 30–39 years old were given a score of 1, while 0 was assigned for participants who were from outside Wuhan, female, unmarried, and in the age category of 20–29. According to a recent report, 77% of international students in China are originally from Asia or Africa (Ministry of Education PRC, 2019). Therefore, we constructed a variable consisting of three ethnic groups, distinguishing between participants of Asian origin, of African origin, and of other origins. Finally, information pertaining to the current educational levels of respondents to the survey was also collected that delineated whether students were studying Ph.D., master's, or undergraduate programs in any Chinese university.

Preventive Measures

The Chinese Center for Disease Control and the World Health Organization have recommended many preventive measures for the general public to adopt that could reduce the risks of transmitting or contracting COVID-19 (Chinese Center for Disease Control and Prevention, 2020; World Health Organization, 2020a). However, standard data collection surveys rarely include information about such preventive measures being

TABLE 1 | Descriptive statistics.

Variables	M ± SD	Frequency (%)
Anxiety	2.766 ± 0.790	
Trust	3.997 ± 0.829	
Self-quarantine	3.783 ± 1.188	
Knowledge	2.928 ± 1.104	
Preventive measures	9.856 ± 1.354	
Self-health perception		
Reported one symptom		30 (16.67%)
No symptom		150 (83.33%)
Location		
Wuhan		82 (45.56%)
Other		98 (54.44%)
Gender		
Male		119 (66.11%)
Female		61 (33.89%)
Age (range)		
20–29		122 (67.78%)
30–39		58 (32.22%)
Marital status		
Married		43 (23.89%)
Unmarried		137 (76.11%)
Education		
Ph.D.		90 (50%)
Master's degree		66 (36.67%)
Undergraduate		24 (13.33%)
Ethnic group		
Asian origin		123 (68.33%)
African origin		31 (17.22%)
Other origin		26 (14.25%)

M, mean; SD, standard deviation.

adopted by the public during a significant outbreak. Therefore, in our study, we asked the international students to report the extent to which they had followed the preventive measures (e.g., "Over the past 2 weeks, I have washed my hands with water and soap before and after I leave my home/room/dormitory").

RESULTS

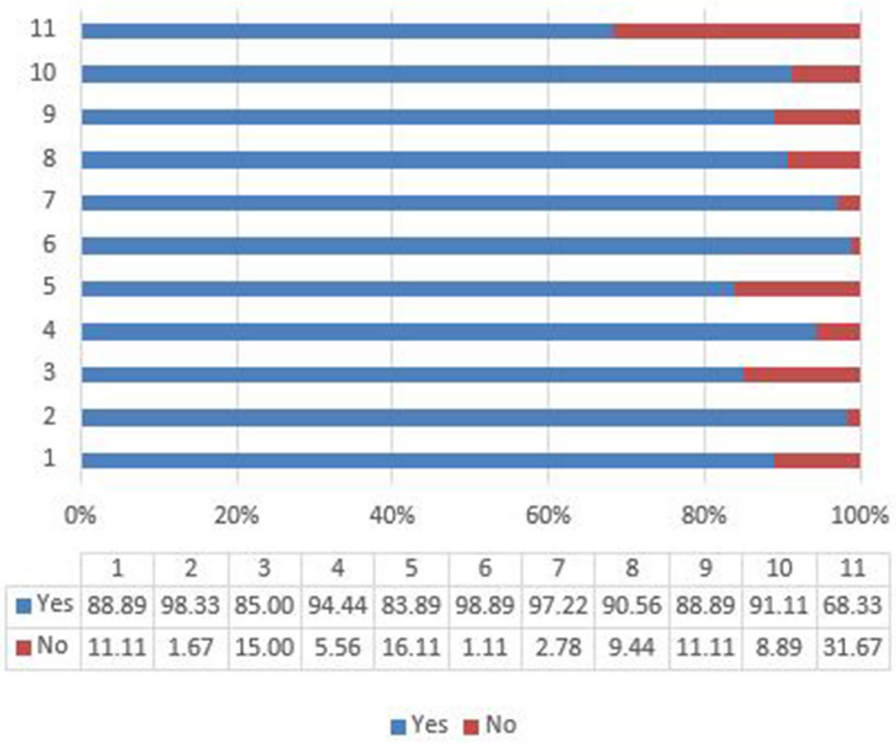
Descriptive Statistics

Means (*M*s), standard deviations (*SD*s), and frequencies are reported for our study's variables in **Table 1**. As shown, international students reported higher levels of trust in the university management ($M = 3.997$, $SD = 0.829$) and acceptance of self-quarantine ($M = 3.783$, $SD = 1.188$). The mean score for anxiety was 2.76 ($SD = 0.790$). The mean score pertaining to knowledge of COVID-19 was 2.928 ($SD = 1.104$) out of 5. Thus, the study's participants were found to possess approximately 58.56% of essential knowledge about COVID-19. Participants reported that they were practicing nearly all ($M = 9.856$, $SD = 1.354$) of the COVID-19 infection prevention measures recommended by the World Health Organization and the Chinese Center for Disease Control and Prevention. A total of 30 (16.67%) students reported that they had at least one of the COVID-19 symptoms.

The demographic data collected show that participants from Wuhan were comparable in numbers to those from other locations (Wuhan = 45.56%, Other Cities = 54.44%). Further, 66.11% of participants were men (vs. 33.89% female), married 23.89% (vs. 76.11% unmarried), and 67.78% belonged to the age category of 20–29 (vs. 32.22% over the age of 29). **Table 1** also details that 50% of the study's participants were pursuing their Ph.D. studies in China, 36.7% their master's degrees, and 13.3% were undergraduate students. Finally, the data show that 68.3% of respondents were of Asian origin, 17.2% from Africa, and the remainder were from other ethnic groups.

Measures Taken for the Prevention of COVID-19

Figure 1 shows the respective proportions of respondents who started practicing each of the 11 measures recommended by the Chinese Center for Disease Control and Prevention and the World Health Organization for reducing the risks of contracting and transmitting COVID-19, directed against the two main modes of transmission (i.e., person-to-person droplet spread and fomites). **Table 2** lists the preventive measures adopted by the participants. Most reported that they favored staying at home or in their room/dormitory during the outbreak (89%), washing their hands with soap before and after leaving home (98%), avoiding touching their face with their hands (85%), avoiding contact with people who have COVID-19 symptoms (94%), and using sanitizer to wash their hands when outside (84%). The participants also reported that they wore a mask (99%) when going outside, which is an important measure with which to reduce transmission of COVID-19 through fomites.



	1	2	3	4	5	6	7	8	9	10	11
Yes	88.89	98.33	85.00	94.44	83.89	98.89	97.22	90.56	88.89	91.11	68.33
No	11.11	1.67	15.00	5.56	16.11	1.11	2.78	9.44	11.11	8.89	31.67

FIGURE 1 | Preventive measures.

TABLE 2 | Preventive measures.

1	If possible, I did not leave home/room/dormitory.
2	I washed my hands with water and soap before and after I left home.
3	I didn't touch my eyes, nose, and/or mouth with hands I had not washed.
4	I avoided contact with people who had fever or respiratory symptoms.
5	I washed my hands with hand sanitizers when I was outside.
6	I wore a mask when I went outside.
7	I avoided crowded places.
8	I went to the hospital much less.
9	I avoided using public transportation.
10	I ate food that would strengthen my immune system.
11	I exercised to strengthen my immune system.

Further, they avoided crowded places, visiting hospitals, and public transportation (97, 91, and 89%, respectively), and ate healthy food and took part in exercise (91 and 68%, respectively) in order to try to improve their immune systems.

Trust in University Management, Psychological Distress, and Self-Quarantine

This study explored the impact of trust in university management on psychological distress and self-quarantine behavior among international students during the COVID-19 pandemic. We used the ordinary least squares method for the continuous dependent variable, while the probit regression approach was employed for the binary dependent variable. For the probit regressions, we also report the marginal effects (MEs). We first estimated a non-robust model without adjusting for heteroscedasticity. This served as our baseline specification model. However, heteroscedasticity is considered a common problem with cross-sectional data. To reduce the influence of the heteroscedasticity of the variables that may exist in the regression models on the significance of the coefficients, a robust estimator of standard errors is used in regression analysis. We also checked for multicollinearity and normal distribution. These statistics were found to be in the acceptable range using different tests suggested by historical research. Data were analyzed with Stata (version 15).

We first examined the impact of trust in university management on international student's anxiety levels. In column 1 of **Table 3**, we present our baseline specification model. These results show that trust has a negative impact on anxiety but is weakly significant from a statistical viewpoint ($\beta = -0.139$, $p < 0.10$). However, the statistical significance strengthens in column 2 of **Table 3**, when we use heteroscedasticity robust standard errors ($\beta = -0.139$, $p < 0.05$). Overall, we find support for our hypothesis that international students' perception of trust in university management may decrease their anxiety levels. Moreover, we find that a participant's self-health perception is positively associated with their anxiety level. These results are statistically significant in both the baseline and robust models ($\beta = -0.336$, $p < 0.05$). With regard to other control variables, we did not find a significant impact on anxiety levels.

Next, we investigated the influence of trust in university management on self-quarantine behavior of international students. We estimated a probit model since the variable we want to explain takes only two values. Initially, we estimated a non-robust model, and then we used heteroscedastic-robust standard errors to increase the robustness of our results. In general, we do not interpret the coefficients of the probit regression but rather the MEs. Marginal effects tell us that how much the (conditional) probability of the outcome variable changes with the change of the regressor, holding all other regressors constant. Accordingly, we report the MEs at the sample mean values of the regressors in columns 4 and 6 of **Table 3**. We find a significant and positive influence of trust in university management on self-quarantine behavior, not just in the non-robust model but also when we use heteroscedastic-robust standard errors ($ME = 0.110$, $p < 0.05$).

We also find that individuals with essential knowledge of COVID-19 disease are more likely to accept self-quarantine ($ME = 0.194$, $p < 0.01$). The results are consistent in both the baseline and robust models. Self-health perception is found to be insignificant both in a non-robust and a robust model. The results in relation to the demographic data show that male and married individuals have a higher probability of accepting self-quarantine than unmarried and female individuals ($ME = 0.166$, $p < 0.05$;

TABLE 3 | Main results.

Variables	Anxiety	Anxiety	Self-quarantine		Self-quarantine	
	(1) *SE*	(2) Robust *SE*	(3) *SE*	(4) ME	(5) Robust *SE*	(6) ME
Trust	−0.139*	−0.139**	0.326**	0.101**	0.326**	0.101**
	(0.0744)	(0.0685)	(0.147)	(0.0437)	(0.147)	(0.0444)
Knowledge	−0.0320	−0.0320	0.626***	0.194***	0.626***	0.194***
	(0.132)	(0.140)	(0.237)	(0.0693)	(0.240)	(0.0705)
Self-health	0.366**	0.366**	0.362	0.112	0.362	0.112
	(0.159)	(0.153)	(0.283)	(0.0865)	(0.274)	(0.0838)
Location	0.140	0.140	−0.0619	−0.0191	−0.0619	−0.0191
	(0.127)	(0.130)	(0.230)	(0.0710)	(0.218)	(0.0674)
Gender	0.0730	0.0730	0.537**	0.166**	0.537**	0.166**
	(0.125)	(0.123)	(0.234)	(0.0695)	(0.237)	(0.0697)
Marital status	0.208	0.208	0.692**	0.214**	0.692**	0.214**
	(0.156)	(0.156)	(0.286)	(0.0839)	(0.277)	(0.0840)
Age	−0.0594	−0.0594	−0.235	−0.0727	−0.235	−0.0727
	(0.153)	(0.149)	(0.284)	(0.0873)	(0.265)	(0.0817)
Education						
Ph.D.	0.197	0.197	−0.0111	−0.00343	−0.0111	−0.00343
	(0.198)	(0.193)	(0.363)	(0.112)	(0.354)	(0.110)
Master's	0.0795	0.0795	0.384	0.119	0.384	0.119
degree	(0.194)	(0.190)	(0.357)	(0.109)	(0.344)	(0.106)
Ethnic Group						
African origin	−0.209	−0.209	−0.950**	−0.294**	−0.950**	−0.294**
	(0.222)	(0.232)	(0.428)	(0.127)	(0.410)	(0.122)
Asian origin	−0.105	−0.105	−0.353	−0.109	−0.353	−0.109
	(0.179)	(0.186)	(0.317)	(0.0971)	(0.301)	(0.0926)
Constant	3.107***	3.107***	−2.277***		−2.277***	
	(0.371)	(0.344)	(0.729)		(0.716)	
Observations	180	180	180		180	
R^2/Pseudo	0.095	0.095	0.1174		0.1174	

SE, standard error; ME, marginal effect.
****p < 0.01; **p < 0.05; *p < 0.10.*

ME = 0.214, $p < 0.05$). As for as ethnic group is considered, we find that individuals of African origin are less likely to exhibit self-quarantine behavior (ME = −0.294, $p < 0.05$). Finally, we do not find any significant relationships on the bases of location, age, and education.

DISCUSSION

The current study presents one of the first empirical investigations into the associations between international students' trust in university management, mental health, and acceptance of self-quarantine behavior. The findings of this study suggest that trust in university management is negatively associated with students' anxiety levels and can also positively influence students' willingness to comply with self-quarantine guidelines during the pandemic crisis.

People require advice from a trusted source on how to act in crisis situations (Yang and Cho, 2017; Ma et al., 2020). Governmental and public agencies are ideal sources of reliable information and immediate support in such contexts because citizens place a high premium on national administration. Therefore, citizens' acceptance of policies and practices are highly dependent on trust in these institutions (Yang and Cho, 2017). On the other hand, international students, because of their immigrant status and lack of familiarity with the local health care system, are more reliant on universities for emotional support and guidance (Amoah and Mok, 2020; Chen et al., 2020; Conrad et al., 2021). Anxiety, according to control/alienation theory, results from one's inability to control stress. Therefore, to compensate for one's inability, individuals seek others' help to gain control over stress (Sherman, 1987; Mirowsky and Ross, 1989; Ross and Mirowsky, 1989). Conceivably, expecting to obtain any sort of support from the university, or having trust in university management, may be one of the means available for international students to be able to control their anxiety.

The study's results also suggest that individual self-health perception is positively associated with anxiety. Furthermore, we found that male and married individuals are more likely to comply with quarantine guidelines than female, unmarried, or students of African origin. This finding is in line with those presented in the prior literature in which researchers showed that demographic characteristics may predict self-isolation behavior (Commodari and La Rosa, 2020; Nkire et al., 2021). Our study also found that essential knowledge about the disease is positively associated with self-quarantine. This finding is consistent with a recent study that showed quarantined persons had a greater knowledge of the disease and behavioral compliance toward quarantine measures (Yan et al., 2021). Finally, a significant proportion of the participants in our study were found to follow the preventive measures recommended by the World Health Organization and the Chinese Center for Disease Control and Prevention to reduce exposure to the disease and its subsequent transmission.

The findings of this study offer useful policy insights for higher education institutions across different parts of the world, specifically where these institutions are mainly dependent on international students as one of their primary funding sources or incomes. To prepare successfully for the unpredictable future that lies ahead in terms of the internationalization of education, universities must expand the current support system and help students in protecting themselves and in mentally dealing with this pandemic. We recommend that the hosting institutions, in collaboration with other concerned bodies, should develop innovative strategies to improve the psychological well-being of the students as well as expand the existing student counseling facilities.

The study was limited by its cross-sectional survey, small sample size, and convenience sampling technique. Future research should enroll a greater number of respondents using random sampling techniques. We also recognize that this study's sample was limited to only international students in China. Further research could tap the scope of the generality of this study in other settings. Despite these limitations, though, our study provides the first empirical evidence suggesting that building a trust-based relationship may improve international students' well-being under public health emergencies.

DATA AVAILABILITY STATEMENT

The original data presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding author/s.

ETHICS STATEMENT

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

AUTHOR CONTRIBUTIONS

All authors contributed to the article and approved the submitted version.

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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.2021.679661/full#supplementary-material

REFERENCES

AlAteeq, D. A., Aljhani, S., and AlEesa, D. (2020). Perceived stress among students in virtual classrooms during the COVID-19 outbreak in KSA. *J. Taibah Univ. Med. Sci*. 15, 398–403. doi: 10.1016/j.jtumed.2020.07.004

Alharbi, E. S., and Smith, A. P. (2018). Review of the literature on stress and wellbeing of international students in English-speaking countries. *Int. Educ. Stud.* 11, 22–44. doi: 10.5539/ies.v11n6p22

Amendola, S., von Wyl, A., Volken, T., Zysset, A., Huber, M., and Dratva, J. (2021). A longitudinal study on generalized anxiety among university students during the first wave of the COVID-19 pandemic in Switzerland. *Front. Psychol.* 12:643171. doi: 10.3389/fpsyg.2021.643171

Amoah, P. A., and Mok, K. H. (2020). *The COVID-19 Pandemic and Internationalisation of Higher Education: International Students' Knowledge, Experiences, and Wellbeing*. Emerald Blog. Available online at: https://www.emeraldgrouppublishing.com/opinion-and-blog/covid-19-pandemic-and-internationalisation-higher-education-international-students (accessed May 05, 2021).

Asmundson, G. J. G., and Taylor, S. (2020). How health anxiety influences responses to viral outbreaks like COVID-19: what all decision-makers, health authorities, and health care professionals need to know. *J. Anxiety Disord.* 71:102211. doi: 10.1016/j.janxdis.2020.102211

Aucejo, E. M., French, J., Ugalde Araya, M. P., and Zafar, B. (2020). The impact of COVID-19 on student experiences and expectations: evidence from a survey. *J. Public Econ*. 191:104271. doi: 10.1016/j.jpubeco.2020.104271

Aylie, N. S., Mekonen, M. A., and Mekuria, R. M. (2020). The psychological impacts of COVID-19 pandemic among university students in Bench-Sheko Zone, South-west Ethiopia: a community-based cross-sectional study. *Psychol. Res. Behav. Manag.* 13, 813–821. doi: 10.2147/PRBM.S275593

Bartik, A. W., Bertrand, M., Cullen, Z., Glaeser, E. L., Luca, M., and Stanton, C. (2020). The impact of COVID-19 on small business outcomes and expectations. *Proc. Natl. Acad. Sci. U.S.A.* 117, 17656–17666. doi: 10.1073/pnas.2006991117

Brunsting, N. C., Zachry, C., and Takeuchi, R. (2018). Predictors of undergraduate international student psychosocial adjustment to US universities: a systematic review from 2009-2018. *Int. J. Intercult. Relat.* 66, 22–33. doi: 10.1016/j.ijintrel.2018.06.002

Cao, W., Fang, Z., Hou, G., Han, M., Xu, X., Dong, J., et al. (2020). The psychological impact of the COVID-19 epidemic on college students in China. *Psychiatry Res.* 287:112934. doi: 10.1016/j.psychres.2020.112934

Chen, J. H., Li, Y., Wu, A. M. S., and Tong, K. K. (2020). The overlooked minority: mental health of International students worldwide under the COVID-19 pandemic and beyond. *Asian J. Psychiatr*. 54:102333. doi: 10.1016/j.ajp.2020.102333

Chinese Center for Disease Control and Prevention. (2020). *Home/COVID19*. Available online at: http://www.chinacdc.cn/en/COVID19 (accessed February 01, 2020).

Collins, F. E. (2021). Measuring COVID-19-related fear and threat in Australian, Indian, and Nepali university students. *Pers. Individ. Dif.* 175:110693. doi: 10.1016/j.paid.2021.110693

Commodari, E., and La Rosa, V. L. (2020). Adolescents in quarantine during COVID-19 pandemic in Italy: perceived health risk, beliefs, psychological experiences and expectations for the future. *Front. Psychol.* 11:559951. doi: 10.3389/fpsyg.2020.559951

Conrad, R. C., Hahm, H. C., Koire, A., Pinder-Amaker, S., and Liu, C. H. (2021). College student mental health risks during the COVID-19 pandemic: implications of campus relocation. *J. Psychiatr. Res.* 36, 117–126. doi: 10.1016/j.jpsychires.2021.01.054

Fakhar-e-Alam Kulyar, M., Bhutta, Z. A., Shabbir, S., and Akhtar, M. (2020). Psychosocial impact of COVID-19 outbreak on international students living in Hubei province, China. *Travel Med. Infect. Dis.* 37:101712. doi: 10.1016/j.tmaid.2020.101712

Flesia, L., Monaro, M., Mazza, C., Fietta, V., Colicino, E., Segatto, B., et al. (2020). Predicting perceived stress related to the COVID-19 outbreak through stable psychological traits and machine learning models. *J. Clin. Med.* 9:3350. doi: 10.3390/jcm9103350

Gewirtz O'Brien, J. R., Auerswald, C., English, A., Ammerman, S., Beharry, M., Heerde, J. A., et al. (2021). Youth experiencing homelessness during the COVID-19 pandemic: unique needs and practical strategies from international perspectives. *J. Adolesc. Health*. 68, 236–240. doi: 10.1016/j.jadohealth.2020.11.005

Khan, K., Zhao, H., Zhang, H., Yang, H., Shah, M. H., and Jahanger, A. (2020). The impact of COVID-19 pandemic on stock markets: an empirical analysis of world major stock indices. *J. Asian Fin. Econ. Bus.* 7, 463–474. doi: 10.13106/jafeb.2020.vol7.no7.463

Lee, J., Kim, N., and Su, M. (2021). Immigrant and international college students' learning gaps: Improving academic and sociocultural readiness for career and graduate/professional education. *Int. J. Educ. Res. Open* 2–2:100047. doi: 10.1016/j.ijedro.2021.100047

Liu, N., Zhang, F., Wei, C., Jia, Y., Shang, Z., Sun, L., et al. (2020). Prevalence and predictors of PTSS during COVID-19 outbreak in China hardest-hit areas: gender differences matter. *Psychiatry Res.* 287:112921. doi: 10.1016/j.psychres.2020.112921

Ma, T., Heywood, A., and MacIntyre, C. R. (2020). Travel health risk perceptions of Chinese international students in Australia – implications for COVID-19. *Infect. Dis. Health* 25, 197–204. doi: 10.1016/j.idh.2020.03.002

Ministry of Education PRC (2019). *Statistical Report on International Students in China for 2018*. Press Release, 3–7. Available online at: http://en.moe.gov.cn/news/press_releases/201904/t20190418_378586.html (accessed April 12, 2020).

Mirowsky, J., and Ross, C. E. (1989). *Social Causes of Psychological Distress*. New York, NY: Aldine de Gruyter.

Mok, K. H., Xiong, W., Ke, G., and Cheung, J. O. W. (2021). Impact of COVID-19 pandemic on international higher education and student mobility: student perspectives from mainland China and Hong Kong. *Int. J. Educ. Res.* 105:101718. doi: 10.1016/j.ijer.2020.101718

Nkire, N., Mrklas, K., Hrabok, M., Gusnowski, A., Vuong, W., Surood, S., et al. (2021). COVID-19 pandemic: demographic predictors of self-isolation or self-quarantine and impact of isolation and quarantine on perceived stress, anxiety, and depression. *Front. Psychiatry* 12:553468. doi: 10.3389/fpsyt.2021.553468

Park, H.-J., and Lee, B. J. (2016). The role of social work for foreign residents in an epidemic: the MERS crisis in the Republic of Korea. *Soc. Work Publ. Health* 31, 656–664. doi: 10.1080/19371918.2016.1160352

Quah, S. R., and Hin-Peng, L. (2004). Crisis prevention and management during SARS outbreak, Singapore. *Emerg. Infect. Dis.* 10, 364–368. doi: 10.3201/eid1002.030418

Ross, C. E., and Mirowsky, J. (1989). Explaining the social patterns of depression: control and problem solving - or support and talking. *J. Health Soc. Behav.* 30, 206–219. doi: 10.2307/2137014

Sherman, H. J. (1987). *Foundations of Radical Political Economy*. Armonk, NY: M.E. Sharpe.

Sheroun, D., Wankhar, D. D., Devrani, A., Pv, L., Gita, S., and Chatterjee, K. (2020). A study to assess the perceived stress and coping strategies among B.Sc. nursing students of selected colleges in Pune during COVID-19 pandemic lockdown. *Int. J. Sci. Healthc. Res.* 5, 280–288. Available online at: https://ijshr.com/IJSHR_Vol.5_Issue.2_April2020/IJSHR_Abstract.0038.html

Stolle, D. (2001). "Clubs and congregations: the benefits of joining an association," in *Trust in Society* ed K. S. Cook (New York, NY: Russell Sage Foundation), 202–244.

Wang, X., Zhang, R., Wang, Z., and Li, T. (2021). How does digital competence preserve university students' psychological well-being during the pandemic? An investigation from self-determined theory. *Front. Psychol.* 12:652594. doi: 10.3389/fpsyg.2021.652594

Warner-Søderholm, G., Bertsch, A., Sawe, E., Lee, D., Wolfe, T., Meyer, J., et al. (2018). Who trusts social media? *Comput. Hum. Behav.* 81, 303–315. doi: 10.1016/j.chb.2017.12.026

Westhuis, D., and Thyer, B. A. (1989). Development and validation of the Clinical Anxiety Scale: a rapid assessment instrument for empirical practice. *Educ. Psychol. Meas.* 49, 153–163. doi: 10.1177/0013164489491016

World Health Organization (2021). *WHO Coronavirus (COVID-19) Dashboard*. Available online at: https://covid19.who.int (accessed March 02, 2021).

World Health Organization. (2020a). *Coronavirus disease (COVID-19) Advice for the Public*. Available online at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public (accessed February 01, 2020).

World Health Organization. (2020b). *Coronavirus Disease (COVID-19) Q&A*. Available online at:https://www.who.int/emergencies/diseases/novel-coronavirus-2019/question-and-answers-hub/q-a-detail/q-a-coronaviruses (accessed February 01, 2020).

Xiang, Y.-T., Yang, Y., Li, W., Zhang, L., Zhang, Q., Cheung, T., et al. (2020). Timely mental health care for the 2019 novel coronavirus outbreak is urgently needed. *Lancet Psychiatry* 7, 228–229. doi: 10.1016/S2215-0366(20)30046-8

Yan, T., Zhizhong, W., Jianzhong, Z., Yubo, Y., Jie, L., Junjun, Z., et al. (2021). Depressive and anxiety symptoms among people under quarantine during the COVID-19 epidemic in China: a cross-sectional study. *Front. Psychiatry* 12:566241. doi: 10.3389/fpsyt.2021.566241

Yang, S., and Cho, S.-I. (2017). Middle East respiratory syndrome risk perception among students at a university in South Korea, 2015. *Am. J. Infect. Control* 45, e53–e60. doi: 10.1016/j.ajic.2017.02.013

Zeng, W., Zeng, Y., Xu, Y., Huang, D., Shao, J., Wu, J., et al. (2021). The influence of post-traumatic growth on college students' creativity during the COVID-19 pandemic: the mediating role of general self-efficacy and the moderating role of deliberate rumination. *Front. Psychol.* 12:665973. doi: 10.3389/fpsyg.2021.665973

Zhang, K., Wu, S., Xu, Y., Cao, W., Goetz, T., and Parks-Stamm, E. J. (2021). Adaptability promotes student engagement under COVID-19: the multiple mediating effects of academic emotion. *Front. Psychol.* 11:633265. doi: 10.3389/fpsyg.2020.633265

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BRIEF RESEARCH REPORT
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School Professional Needs to Support Student Mental Health During the COVID-19 Pandemic

Amy Rusch[1]*, *Natalie Rodriguez-Quintana*[2], *Seo Youn Choi*[1], *Annalise Lane*[1], *Maureen Smith*[2], *Elizabeth Koschmann*[2] and *Shawna N. Smith*[1,2,3]

[1]Department of Health Management and Policy, University of Michigan School of Public Health, Ann Arbor, MI, United States, [2]Department of Psychiatry, Michigan Medicine, Ann Arbor, MI, United States, [3]Department of Survey Research, University of Michigan Institute of Social Research, Ann Arbor, MI, United States

School closures due to COVID-19 left students in Michigan without physical access to school mental health professionals (SMHPs) and other supports typically available in schools. This report examines the needs of SMHPs across Michigan during the early months of the COVID-19 pandemic and how those needs informed programming and resources provided by a University of Michigan school mental health training and implementation program. In April 2020, a web-based survey asking about student and SMHP mental health was sent to 263 SMHPs who had previously participated in this program. 155 SMHPs (58.9%) responded. Nearly half of SMHPs reported their students' most pressing needs were support for self-care, anxiety, depression, and traumatic stress. Some SMHPs also met screening criteria themselves for depression and/or anxiety. This survey provided an overview of SMHPs' concerns early in the COVID-19 pandemic and drove development of new COVID-19-related resources designed to support SMHPs.

Keywords: COVID-19, public health, adolescent health, public health practice, mental health, school health

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***Correspondence:**
Amy Rusch
amyrusch@umich.edu

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INTRODUCTION

High schools increasingly provide numerous services to students, including mental health support. Historically, the inclusion of general health care in the school setting (e.g., school nurses) began in the early 20th century and was increasingly common by the 1980s (Flaherty and Osher, 2003). From that point, the provision of comprehensive health services, including mental health services, in the school setting has gained attention, but has typically seen slower adoption and lower funding than other services (Flaherty and Osher, 2003; Weir, 2020). Despite challenges, school-based mental health care delivered by trained, mental health professionals has become an important resource for students facing anxiety, depression, and other mental health concerns.

School-based delivery of mental health services for students is particularly important in light of numerous barriers that preclude most young people from accessing needed clinic- or community-based mental health treatment (Brener et al., 2001; Burns et al., 1995; Schlitt et al., 2000). Barriers to care include logistical or practical challenges, such as insufficient numbers of qualified child and adolescent mental health providers, long wait lists, and inadequate insurance coverage; as well as more nuanced or societal challenges, such as social stigma, shame, or mistrust of the healthcare system (Brener et al., 2001). These barriers are often most pronounced in settings impacted by social determinants of health. For example, communities impacted by poverty and limited resources may also have higher rates of trauma exposure, family stress, and mental health concerns (Burns et al.,

1995; Schlitt et al., 2000). Thus, embedding mental health services in schools provides a critical strategy for addressing significant inequities in health care access.

As mental health care has increasingly been provided in the school setting, the various models of service delivery have adapted based on funding, program creation, and students' needs (Flaherty et al., 1996). Currently, school-based mental health delivery often involves first screening students to identify their needs (Fazel et al., 2014). Students with identified symptoms may be offered an intervention, typically provided by a school mental health professional (SMHP; school social workers, counselors, psychologists, etc.) (Whiston and Quinby, 2009). These interventions can be delivered individually or via structured group sessions (Whiston and Quinby, 2009). Research conducted prior to and during the COVID-19 pandemic shows that schools are the most frequent setting in which youth receive mental health care, including treatment for anxiety disorders (e.g., Social Anxiety Disorder), mood disorders (e.g., Major Depressive Disorder), and other mental health concerns (Costello et al., 2014; Duong et al., 2020).

Given this context, when Michigan Governor Gretchen Whitmer mandated closure of all K-12 school buildings across the state on March 16, 2020 (Whitmer-Executive Order, 2020-05; Whitmer-Executive Order, 2020-35), students were left without physical access to an important source of mental health care (Lee and Ward, 2020). At the same time, the COVID-19 pandemic brought about unparalleled shifts in social circumstances, such as social distancing and quarantine guidelines (CDC, 2020), that contributed to increased social isolation and decreased social support for students, further impacting mental health (Jones et al., 2021). These changes highlighted the important role that mental health care often plays in promoting learning, as seen through the development of school-based mental health in the 1990s, and renewed calls to prioritize mental health delivery in the school setting in response to its sudden in-person absence (Flaherty and Osher, 2003; Weir, 2020).

For educators and school staff, COVID-19 school closures produced a number of new challenges in the delivery of mental health support. For example, in a sample of 583 adolescents (80% female, 71% White) surveyed between April 27 and July 13, 2020, symptoms of depression were reported among 55%, anxiety among 48%, and Post-Traumatic Stress among 45% (Jones et al., 2021; Murata et al., 2021; Zhou S.-J. et al., 2020). These rates are higher than those observed prior to the COVID-19 pandemic. Further, circumstances have placed SMHPs at higher risks of anxiety, emotional exhaustion, and depressive symptoms than before the pandemic (Joshi and Sharma, 2020). Increased prevalence of anxiety and depression (Muller et al., 2020), as well as sleep disturbances and intense grief reactions (Murata et al., 2021), have been identified among health care workers who, much like SMHPs, have had their work significantly impacted by COVID-19 (Joshi and Sharma, 2020). COVID-19 school closures also resulted in new barriers to school-based mental health services, further magnifying the increased mental health needs of both students and SMHPs (Asarnow et al., 2005; Costello et al., 2014; Jones et al., 2021; Weist et al., 2007).

Virtual mental health care (i.e., telemedicine) in schools has quickly become one solution for reaching students (Liu et al., 2020; Sullivan et al., 2020; Zhou X. et al., 2020). However, many challenges to remote counseling and mental health service delivery exist. These include concerns about maintaining student privacy and confidentiality, technological difficulties, an inability of providers to observe important nonverbal cues, and difficulties in recognizing and acting on emergency situations (Stoll et al., 2020). Additional challenges include student skepticism toward virtual counseling (Li and Leung, 2020), difficulty scheduling appointments *via* email or text messaging, and variability in student internet access or technological availability (Hasking et al., 2021). In the context of the COVID-19 pandemic, the need for SMHPs to rapidly transition to virtual mental health care delivery, while also transitioning their other school duties, likely magnified these challenges and further complicated efforts to provide students with sufficient mental health care. In turn, this likely exacerbated the already significant risk of vicarious trauma and burnout that school staff face even under typical circumstances (Joshi and Sharma, 2020).

As COVID-19 school closures have persisted and many districts have employed virtual platforms for sustained use, increased emphasis has been placed on better accommodating student needs. This includes better avenues for determining specific student mental health needs (Jones et al., 2021) and for best supporting SMHPs in providing effective student mental health services (Olson et al., 2021). However, these changes also require development of resources and professional development opportunities for SMHPs to minimize mental health impacts of the pandemic on student populations and also encourage best practices for remote school-based mental health care delivery.

TRAILS (Transforming Research into Action to Improve the Lives of Students) is a University of Michigan (U-M) school mental health implementation program designed to improve youth access to evidence-based mental health services by training and supporting SMHPs in cognitive behavioral therapy (CBT) and mindfulness practices. To date, TRAILS has trained over 7,000 school staff and mental health care providers and partnered with over 350 schools across Michigan and several other U.S. states. When COVID-19 halted in-person programming offered by TRAILS, the program recognized a need to pivot to supporting virtual mental health care delivery by SMHPs. To inform this effort, TRAILS administered a brief 16-item web-based survey to SMHPs who had engaged with the program, seeking information about both student and SMHP needs with respect to mental health care and support for program delivery. This research brief describes the needs identified by SMHPs in this survey.

METHODS

In April 2020, shortly following Michigan's statewide school closures, TRAILS distributed a survey to 263 SMHPs that had participated in their programming to help TRAILS understand

their present needs and inform programmatic next steps. Specifically, the survey was sent to a convenience sample that included all SMHPs that had completed TRAILS training at any point between 2013 (program inception) and December 2019. Qualtrics, an online data collection platform, was used to distribute the survey. SMHPs were invited to voluntarily complete the anonymous survey via email and were offered a $20 incentive for participating. The survey was open for one month (April 1–May 1, 2020). This study was approved by the Michigan Medicine Institutional Review Board (IRBMED).

Measures

SMHPs were asked the school district in which they were employed, their professional role, and regular caseload in the survey. Other measures were intended to assess SMHP needs and mental health. When validated measures for constructs of interest were available, they were used (e.g., Patient Health Questionnaire 2-item [PHQ-2] and the Generalized Anxiety Disorder 2-item [GAD-2] to assess SMHP depression and anxiety symptoms). Due to the novel situational circumstances created by COVID-19 and the speed at which student mental health care delivery drastically changed, the study team did not validate new measures. However, the questions comprising the survey were based on past evaluative work done by TRAILS. While more validated measures related to COVID-19 are available now (Cortez et al., 2020; Evren et al., 2020; Lee, 2020; Taylor et al., 2020; Zurlo et al., 2020), in April 2020 when the survey was distributed, few validated measures were available (Ahorsu et al., 2020).

Needs Assessment

In order to better inform the TRAILS programming needs during the pandemic, SMHPs were asked to report on their capability of contacting students, the mental health needs of their students, SMHPs' own mental health and wellness (as described below), and resources and supports needed to promote student mental health and wellness. In addition, questions about students internet access and resource distribution were included in order to determine challenges to virtual delivery of mental health services. While the measures for the needs assessment have not been validated, the questions comprising them were based on past work done by TRAILS and were informed by TRAILS leadership, who have extensive experience working with SMHPs to improve student mental health care delivery in the school setting.

SMHPs Depression and Anxiety Symptoms

Validated, brief screening tools were included to measure SMHP symptoms of depression and anxiety during the beginning of the pandemic and concomitant school closures (i.e., in the 2 weeks prior to survey response). The PHQ-2 (Kroenke et al., 2003) was used to screen for symptoms of depression and the GAD-2 (Kroenke et al., 2007; Plummer et al., 2016) was used to screen for symptoms of anxiety. These brief, lower-burden two-item measures have similar sensitivity and specificity to their respective 9-item and 7-item measures (Kroenke et al., 2003; Plummer et al., 2016), and have been validated in a number of diverse patient populations, including adolescents (Richardson et al., 2010), young adults aged 14–26 with a substance use disorder diagnosis (Bentley et al., 2021), patients with migraines aged 16–65 (Seo and Park, 2015), and a sample of elderly persons aged 58–82 (Wild et al., 2014). The psychometrically validated measures have each demonstrated adequate internal consistency reliability (Cronbach's alpha PHQ-2 α = 0.73–0.83 [Löwe et al., 2005; Zhang et al., 2013; Dadfar et al., 2019]; GAD-2 α = 0.77–0.81 [Hughes et al., 2018; Staples et al., 2019]). Both the PHQ-2 and the GAD-2 have score ranges of 0–6, with a score of three or higher indicating a positive screen.

Analysis

To better understand the needs of SMHPs and their students at the beginning of the pandemic and subsequently inform TRAILS programming, SMHP responses to the needs assessment questions were explored using univariate descriptive analyses. Frequencies and percentages for SMHPs' responses to the needs assessment questions were examined. Findings were then summarized with respect to student mental health needs, current state of student contact, SMHP training needs, and SMHP mental health support needs. We also computed scores for the SMHP mental health screening and examined the distribution of PHQ-2 and GAD-2 total scores, namely examining the proportion of SMHPs that screened positive for depression or anxiety. Findings most relevant to informing TRAILS programming in response to COVID-19 are presented.

RESULTS

Of the 263 SMHPs who were sent the survey, 155 completed the survey (58.9%). Respondents represented 68 of 544 Michigan school districts (**Figure 1**). Respondents were predominantly student support staff, including school social workers, counselors, psychologists, and nurses (n = 119, 76.8%). The remainder were instructional staff (n = 29, 18.7%), other school staff (n = 6, 3.9%), or school administrators (n = 1, 0.6%).

Student Mental Health Needs

SMHPs were asked to rank the needs they felt were most pressing to their students. As shown in **Figure 2**, nearly half of SMHPs ranked general support for self-care and wellness as the most pressing student mental health need (n = 69, 44.5%). Support for coping with anxiety or depression was ranked as the second most common pressing need (n = 55, 35.5%), followed by support for coping with traumatic stress as the most common third most pressing need (n = 50, 32.3%), and support for coping with grief or loss as the fourth most common pressing need (n = 49, 31.6%). SMHPs believed that safety planning/crisis planning (due to neglect, risk of trauma exposure, or risk of suicide) were less pressing needs for students; only 5.8% (n = 9) ranked any of the safety planning needs as the most pressing need for their students.

Student Contact

Nearly all SMHPs surveyed (n = 146, 94.2%) reported contacting one or more students in the month following COVID-19 school

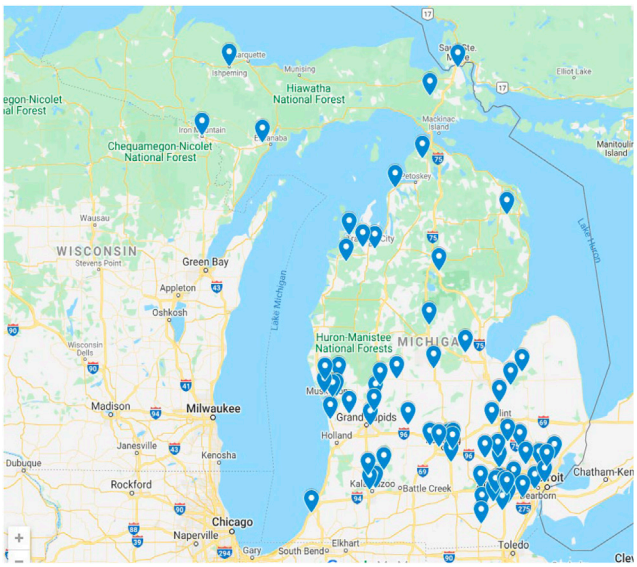

FIGURE 1 | Michigan school districts employing survey respondents.
Note: Survey question: "In what school district are you employed?"

closures. Thirty-seven percent of SMHPs (n = 57) indicated they had been in contact with 1–10 students, while 19% (n = 30) had been in contact with more than 50 students.

SMHPs reported using various methods to contact their students. The most common form of communication reported was individual or small group email or text messages, with nearly three out of four SMHPs endorsing this method (n = 113, 72.9%). Two other popular methods were large-group/mass emails (n = 80, 51.6%) and posting information/resources on student-accessible websites (n = 76, 49.0%). Less frequently used forms of communication were individual or small group phone calls (n = 59, 38.1%) or individual or small group video chat (n = 44,

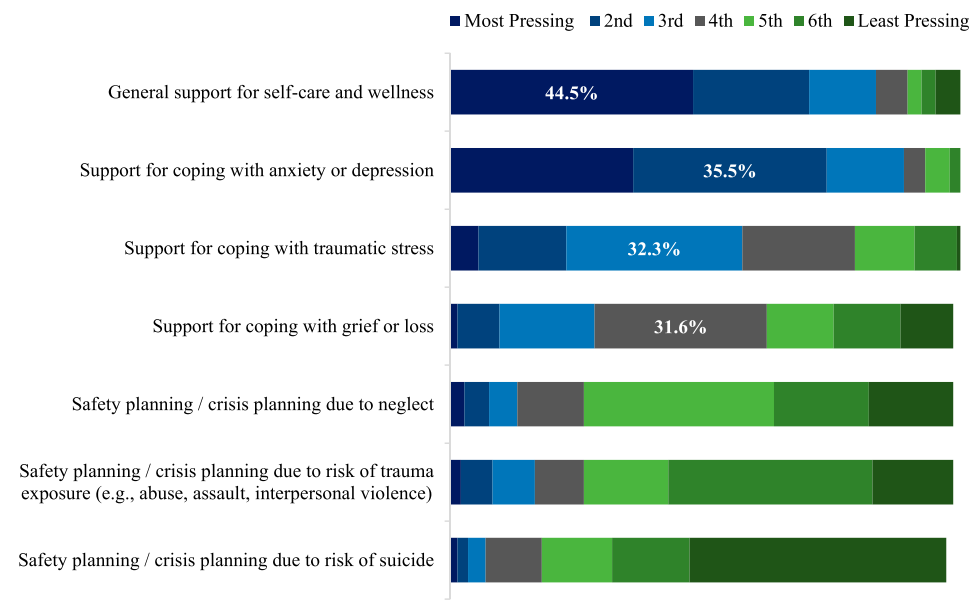

FIGURE 2 | Students' most pressing mental health needs as perceived by school mental health professionals.
Note: Survey question: "What do you believe are the most pressing mental health needs of your students right now? [Drag and drop to rearrange the items below, placing them in order from: 1 = most pressing concern to 7 = least pressing concern]" N = 155; No responses = 10.

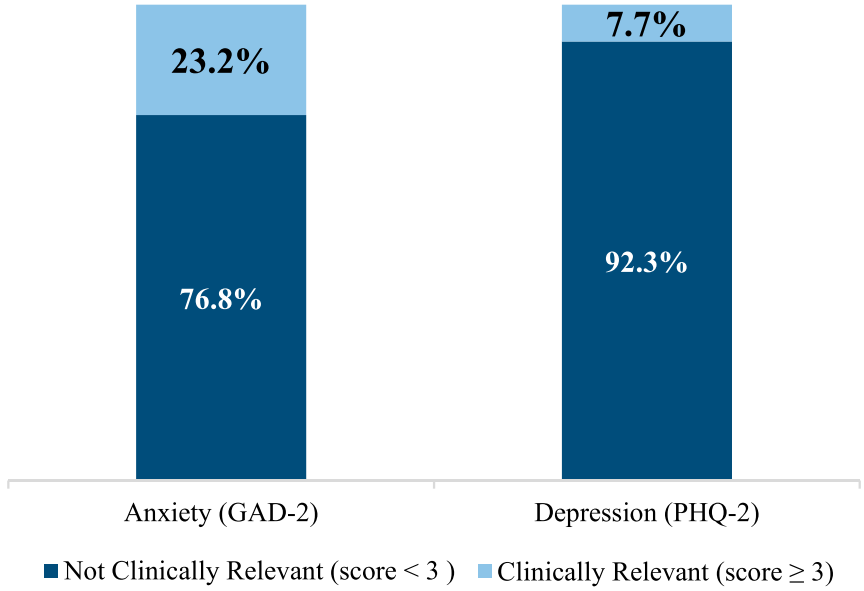

FIGURE 3 | Anxiety and Depression in School Mental Health Professionals Based on GAD-2 and PHQ-2 Scores.
Note: *N* = 155; No responses = 7. SMHPs screen for Generalized Anxiety Disorder if GAD-2 score is higher than or equal to 3 (Cronbach's α = 0.80). SPs screen for Major Depressive Disorder if PHQ-2 score is higher than or equal to 3 (Cronbach's α = 0.75).

28.4%). A small number of SMHPs (*n* = 12, 7.7%) also mentioned that they had been in touch with students *via* other methods, including letters and forms sent to students by postal mail, interactions through platforms like Google Classroom and Instagram, and driving by students' houses.

SMHP Training Needs

SMHPs were asked which types of training would be most helpful in navigating their new remote learning environment. Seventy percent (*n* = 109) indicated that professional training or consultation on best practices for remote delivery (i.e., phone, video, email) of mental health support services for youth would be most helpful. This was followed by endorsements of access to regular webinars on CBT and mindfulness techniques with students to support mental health during COVID-19 (*n* = 89, 57.4%) and training/consultation on best practices for delivering mental health support during public health emergencies (*n* = 80, 51.6%). About 20% of SMHPs indicated that access to group and individual consultations to think through difficult or high-risk student cases and plan service delivery options would also be helpful (*n* = 38 [24.5%] and *n* = 31 [20.0%], respectively).

SMHP Mental Health

Clinical measures indicated that 23.2% of SMHPs (*n* = 36) screened positive for anxiety disorders with a score of 3 or higher on the GAD-2; 7.7% (*n* = 12) scored 3 or higher on the PHQ-2, indicating likely major depressive disorder (**Figure 3**).

Reflecting on their own needs for support to manage their personal mental health and wellness during the COVID-19 pandemic, more than half of SMHPs (*n* = 88, 56.8%) were interested in online self-care resources designed for mental health workers during a public health emergency. Other supports of interest included information about where to find urgent mental health support for education and healthcare workers (*n* = 33, 21.3%) and group or individual consultation/support to help prevent depression, burnout, and vicarious trauma (*n* = 36 [23.2%] and *n* = 35 [22.6%], respectively). Seventeen percent (*n* = 26) did not endorse any of the listed resources.

DISCUSSION

The COVID-19 pandemic and resultant school closures changed the way that school professionals interacted with their students and required SMHPs to quickly reformat how they supported their students' mental health, while also adding significant strain to their own mental health and wellness. The web-based survey described in this study, launched in April 2020 immediately following Michigan statewide school closures, examined the impact of the pandemic and school closures on mental health both for students and for SMHPs responsible for delivering mental health services in the school setting. Results helped the TRAILS implementation program determine the most pressing needs for supporting SMHP mental health care delivery in Michigan schools.

Overall, SMHPs indicated that their students' main mental health needs in response to COVID-19 were related to self-care, anxiety, and depression. SMHPs shared that they would be interested in materials and training to help them navigate virtual delivery of care to their students regarding these concerns. Additionally, SMHPs reported experiencing their own distress (i.e., depression and

anxiety) and expressed interest in resources for managing their own mental health and wellness.

While SMHPs are frequently overburdened in their roles under normal circumstances (Joshi and Sharma, 2020), COVID-19 added significant challenges to SMHP delivery of mental health care to their students. TRAILS saw a need to provide better support for SMHPs and the web-based survey reported on here was used to help identify how to prioritize resource development to improve provision of school mental health given challenges and changes. In response to the needs SMHPs expressed, TRAILS developed a rapid response plan that included the following: 1) development of self-care materials and training for SMHPs, 2) adaptation of clinical and implementation supports for virtual delivery of student mental health care, and 3) the development of a 7-session youth CBT and mindfulness skill group called Coping with COVID-19 (CC-19) (Rodriguez-Quintana et al., in press). To date, a total of four CC-19 trainings have been offered since May 2020, reaching a total of 1,332 people. Since the implementation of these changes in the TRAILS program, the TRAILS website saw an increase in webpage views, from 160,778 between November 2019 and March 2020, to 565,621 between March 2020 and October 2020. Additionally, between April 20, 2020 and April 20, 2021, more than 73,000 people from over 120 different countries visited TRAILStoWellness.org, resulting in over one million page views in this time period.

Limitations

Given that this survey was developed as a first-line rapid assessment tool, the survey and our findings have several important limitations. First, SMHPs surveyed were from a select number of districts in Michigan and from a pool of SMHPs that were actively engaged with implementing mental health care in their schools via the TRAILS program. As such, they likely do not fully capture the experiences of all SMHPs in the state or nationwide. However, they do reflect perspectives of a number of SMHPs across Michigan that were actively invested in delivering mental health services to students prior to the pandemic. Second, the survey was conducted in the early weeks of the COVID-19 pandemic during a time of active transition for Michigan schools and the study did not address student and SMHP needs beyond the early months of COVID-19 school closures. The long-term needs of coping with COVID-19 for both students and SMHPs may have been different than those initially reported. To better understand and support the short- and long-term needs of SMHPs, especially if virtual learning options continue beyond COVID-19, further steps are needed, including conducting a more comprehensive needs assessment to inform implementation supports and reduce the burden on SMHPs. Fourth, as the study team tried to quickly gauge and respond to the pressing needs facing student and SMHP mental health in direct response to COVID-19, the survey questions were designed to explore the unprecedented situation. The novelty of the situation meant that validated instruments for assessing many key constructs of interest were not available; the urgency of the assessment meant that TRAILS opted to field the survey without extensive validation or pre-testing efforts. These limitations notwithstanding, however, this survey offered a unique glimpse into the early experiences of SMHPs responsible for delivering mental health support to students early in the COVID-19 pandemic.

CONCLUSION

The COVID-19 pandemic and associated school closures caused significant disruption to SMHPs' typical interaction with students, requiring changes to how they delivered mental health support under uncertain and quickly changing circumstances. This survey, fielded in the 6 weeks immediately following initial COVID-19 school closures in Michigan, helped researchers and staff within this implementation program understand SMHP needs and inform program support for students and SMHPs. The survey informed TRAILS' development of COVID-19-related materials/trainings and resulted in increased training participation and significantly increased web traffic. As COVID-19 school closures persist, or as hybrid models of school instruction are tested, new trainings and resources should be developed based on the needs of the communities for which they are meant to serve.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusion 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 University of Michigan Institutional Review Board. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

EK and SS conceptualized the overarching research goals and aims. MS and EK developed the survey that informed this research and designed the methodology. AR, SC and AL wrote the preliminary manuscript. AR, NRQ, SC and MS performed the analyses and contributed to the results. AR created the data visualization for the figures. AR and NRQ carried out major revisions of the manuscript. AR, NRQ, SC, AL, MS, EK and SS edited and revised the manuscript. All authors approved of the final manuscript.

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REFERENCES

Ahorsu, D. K., Lin, C.-Y., Imani, V., Saffari, M., Griffiths, M. D., and Pakpour, A. H. (2020). The Fear of COVID-19 Scale: Development and Initial Validation. *Int. J. Ment. Health Addict.* 1-9. doi:10.1007/s11469-020-00270-8

Asarnow, J. R., Jaycox, L. H., Duan, N., LaBorde, A. P., Rea, M. M., Tang, L., et al. (2005). Depression and Role Impairment Among Adolescents in Primary Care Clinics. *J. Adolesc. Health* 37 (6), 477–483. doi:10.1016/j.jadohealth.2004.11.123

Bentley, K. H., Sakurai, H., Lowman, K. L., Rines-Toth, L., McKowen, J., Pedrelli, P., et al. (2021). Validation of Brief Screening Measures for Depression and Anxiety in Young People with Substance Use Disorders. *J. Affective Disord.* 282, 1021–1029. doi:10.1016/j.jad.2021.01.005

Brener, N. D., Martindale, J., and Weist, M. D. (2001). Mental Health and Social Services: Results from the School Health Policies and Programs Study 2000. *J. Sch. Health* 71 (7), 305–312. doi:10.1111/j.1746-1561.2001.tb03507.x

Burns, B. J., Costello, E. J., Angold, A., Tweed, D., Stangl, D., Farmer, E. M. Z., et al. (1995). Children's Mental Health Service Use across Service Sectors. *Health Aff.* 14 (3), 147–159. doi:10.1377/hlthaff.14.3.147

CDC (2020). *COVID-19 and Your Health*. Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/coronavirus/2019-ncov/if-you-are-sick/quarantine.html.

Cortez, P. A., Joseph, S. J., Das, N., Bhandari, S. S., and Shoib, S. (2020). Tools to Measure the Psychological Impact of the COVID-19 Pandemic: What Do We Have in the Platter? *Asian J. Psychiatry* 53, 102371. doi:10.1016/j.ajp.2020.102371

Costello, E. J., He, J.-p., Sampson, N. A., Kessler, R. C., and Merikangas, K. R. (2014). Services for Adolescents with Psychiatric Disorders: 12-Month Data from the National Comorbidity Survey-Adolescent. *Ps* 65 (3), 359–366. doi:10.1176/appi.ps.201100518

Dadfar, M., Salabifard, S., Dadfar, T., Roudbari, M., and Moneni Safarabad, N. (2019). Validation of the Patient Health Questionnaire-2 with Iranian Students. *Ment. Health Religion Cult.* 22 (10), 1048–1056. doi:10.1080/13674676.2019.1699042

Duong, M. T., Bruns, E. J., Lee, K., Cox, S., Coifman, J., Mayworm, A., et al. (2020). Rates of Mental Health Service Utilization by Children and Adolescents in Schools and Other Common Service Settings: A Systematic Review and Meta-Analysis. *Adm. Pol. Ment Health* 48, 420–439. doi:10.1007/s10488-020-01080-9

Evren, C., Evren, B., Dalbudak, E., Topcu, M., and Kutlu, N. (2020). Measuring Anxiety Related to COVID-19: A Turkish Validation Study of the Coronavirus Anxiety Scale. *Death Stud.* 0 (0), 1–7. doi:10.1080/07481187.2020.1774969

Fazel, M., Hoagwood, K., Stephan, S., and Ford, T. (2014). Mental Health Interventions in Schools in High-Income Countries. *The Lancet Psychiatry* 1 (5), 377–387. doi:10.1016/S2215-0366(14)70312-8

Flaherty, L. T., and Osher, D. (2003). "History of School-Based Mental Health Services in the United States," in *Handbook of School Mental Health Advancing Practice and Research*. Editors M. D. Weist, S. W. Evans, and N. A. Lever (US: Springer), 11–22. doi:10.1007/978-0-387-73313-5_2

Flaherty, L. T., Weist, M. D., and Warner, B. S. (1996). School-based mental health services in the United States: history, current models and needs. *Commun. Ment. Health J.* 32 (4), 341–52. doi:10.1007/BF02249452

Hasking, P., Lewis, S. P., Bloom, E., Brausch, A., Kaess, M., and Robinson, K. (2021). Impact of the COVID-19 Pandemic on Students at Elevated Risk of Self-Injury: The Importance of Virtual and Online Resources. *Sch. Psychol. Int.* 42 (1), 57–78. doi:10.1177/0143034320974414

Hughes, A. J., Dunn, K. M., Chaffee, T., Bhattarai, J., and Beier, M. (2018). Diagnostic and Clinical Utility of the GAD-2 for Screening Anxiety Symptoms in Individuals with Multiple Sclerosis. *Arch. Phys. Med. Rehabil.* 99 (10), 2045–2049. doi:10.1016/j.apmr.2018.05.029

Jones, E. A. K., Mitra, A. K., and Bhuiyan, A. R. (2021). Impact of COVID-19 on Mental Health in Adolescents: A Systematic Review. *Ijerph* 18 (5), 2470. doi:10.3390/ijerph18052470

Joshi, G., and Sharma, G. (2020). Burnout: A Risk Factor Amongst Mental Health Professionals during COVID-19. *Asian J. Psychiatry* 54, 102300. doi:10.1016/j.ajp.2020.102300

Kroenke, K., Spitzer, R. L., Williams, J. B. W., Monahan, P. O., and Löwe, B. (2007). Anxiety Disorders in Primary Care: Prevalence, Impairment, Comorbidity, and Detection. *Ann. Intern. Med.* 146 (5), 317. doi:10.7326/0003-4819-146-5-200703060-00004

Kroenke, K., Spitzer, R. L., and Williams, J. B. W. (2003). The Patient Health Questionnaire-2: Validity of a Two-Item Depression. *Screener* 41 (11), 10. doi:10.1097/01.mlr.0000093487.78664.3c

Lee, S. A. (2020). Coronavirus Anxiety Scale: A Brief Mental Health Screener for COVID-19 Related Anxiety. *Death Stud.* 44 (7), 393–401. doi:10.1080/07481187.2020.1748481

Lee, S. J., and Ward, K. P. (2020). Mental Health, Relationships, and Coping during the Coronavirus Pandemic. Available at: https://www.parentingincontext.org/uploads/8/1/3/1/81318622/research_brief_mental_health_relationships_and_coping_during_the_coronavirus_pandemic_final.pdf.

Li, T. M. H., and Leung, C. S. Y. (2020). Exploring Student Mental Health and Intention to Use Online Counseling in Hong Kong during the COVID-19 Pandemic. *Psychiatry Clin. Neurosci.* 74 (10), 564–565. doi:10.1111/pcn.13117

Liu, S., Yang, L., Zhang, C., Xiang, Y.-T., Liu, Z., Hu, S., et al. (2020). Online Mental Health Services in China during the COVID-19 Outbreak. *The Lancet Psychiatry* 7 (4), e17–e18. doi:10.1016/S2215-0366(20)30077-8

Löwe, B., Kroenke, K., and Gräfe, K. (2005). Detecting and Monitoring Depression with a Two-Item Questionnaire (PHQ-2). *J. Psychosomatic Res.* 58 (2), 163–171. doi:10.1016/j.jpsychores.2004.09.006

Muller, A. E., Hafstad, E. V., Himmels, J. P. W., Smedslund, G., Flottorp, S., Stensland, S. Ø., et al. (2020). The Mental Health Impact of the Covid-19 Pandemic on Healthcare Workers, and Interventions to Help Them: A Rapid Systematic Review. *Psychiatry Res.* 293, 113441. doi:10.1016/j.psychres.2020.113441

Murata, S., Rezeppa, T., Thoma, B., Marengo, L., Krancevich, K., Chiyka, E., et al. (2021). The Psychiatric Sequelae of the COVID-19 Pandemic in Adolescents, Adults, and Health Care Workers. *Depress. Anxiety* 38 (2), 233–246. doi:10.1002/da.23120

Olson, J. R., Lucy, M., Kellogg, M. A., Schmitz, K., Berntson, T., Stuber, J., et al. (2021). What Happens when Training Goes Virtual? Adapting Training and Technical Assistance for the School Mental Health Workforce in Response to COVID-19. *Sch. Ment. Health* 13 (1), 160–173. doi:10.1007/s12310-020-09401-x

Plummer, F., Manea, L., Trepel, D., and McMillan, D. (2016). Screening for Anxiety Disorders with the GAD-7 and GAD-2: A Systematic Review and Diagnostic Metaanalysis. *Gen. Hosp. Psychiatry* 39, 24–31. doi:10.1016/j.genhosppsych.2015.11.005

Richardson, L. P., Rockhill, C., Russo, J. E., Grossman, D. C., Richards, J., McCarty, C., et al. (2010). Evaluation of the PHQ-2 as a Brief Screen for Detecting Major Depression Among Adolescents. *Pediatrics* 125 (5), e1097–e1103. doi:10.1542/peds.2009-2712

Rodriguez-Quintana, N., Meyer, A. E., Bilek, E., Flumenbaum, R., Miner, K., Scoville, L., et al. (in press). Development of a Brief Group CBT Intervention to Reduce COVID-19 Related Distress Among School-Age Youth. *Cogn. Behav. Pract.*, S1077722921000468. doi:10.1016/j.cbpra.2021.03.002

Schlitt, J., Santelli, J., Juszczak, L., Brindis, C., Nystrom, R., Klein, J., et al. (2000). *Creating Access to Care: School-Based Health center Census 1998-99*. Washington, DC: National Assembly on School-Based Heath Care.

Seo, J.-G., and Park, S.-P. (2015). Validation of the Generalized Anxiety Disorder-7 (GAD-7) and GAD-2 in Patients with Migraine. *J. Headache Pain* 16 (1), 97. doi:10.1186/s10194-015-0583-8

Staples, L. G., Dear, B. F., Gandy, M., Fogliati, V., Fogliati, R., Karin, E., et al. (2019). Psychometric Properties and Clinical Utility of Brief Measures of Depression, Anxiety, and General Distress: The PHQ-2, GAD-2, and K-6. *Gen. Hosp. Psychiatry* 56, 13–18. doi:10.1016/j.genhosppsych.2018.11.003

Stoll, J., Müller, J. A., and Trachsel, M. (2020). Ethical Issues in Online Psychotherapy: A Narrative Review. *Front. Psychiatry* 10, 993. doi:10.3389/fpsyt.2019.00993

Sullivan, A. B., Kane, A., Roth, A. J., Davis, B. E., Drerup, M. L., and Heinberg, L. J. (2020). The COVID-19 Crisis: A Mental Health Perspective and Response Using Telemedicine. *J. Patient Experience* 7 (3), 295–301. doi:10.1177/2374373520922747

Taylor, S., Landry, C. A., Paluszek, M. M., Fergus, T. A., McKay, D., and Asmundson, G. J. G. (2020). Development and Initial Validation of the COVID Stress Scales. *J. Anxiety Disord.* 72, 102232. doi:10.1016/j.janxdis.2020.102232

Weir, K. (2020). Safeguarding Student Mental Health. Available at: https://www.apa.org. https://www.apa.org/monitor/2020/09/safeguarding-mental-health.

Weist, M. D., Rubin, M., Moore, E., Adelsheim, S., and Wrobel, G. (2007). Mental Health Screening in Schools. *J. Sch. Health* 77 (2), 53–58. doi:10.1111/j.1746-1561.2007.00167.x

Whiston, S. C., and Quinby, R. F. (2009). Review of School Counseling Outcome Research. *Psychol. Schs.* 46 (3), 267–272. doi:10.1002/pits.20372

Whitmer—Executive Order (2020-35). Provision of K-12 Education during the Remainder of the 2019-2020 School Year—RESCINDED. (2020). Available at: https://www.michigan.gov/whitmer/0,9309,7-387-90499_90705-524032–,00.html.

Whitmer—Executive Order (2020-05). Temporary Prohibition on Large Assemblages and Events, Temporary School Closures—RESCINDED. (2020). Available at: https://www.michigan.gov/whitmer/0,9309,7-387-90499_90705-521595–,00.html.

Wild, B., Eckl, A., Herzog, W., Niehoff, D., Lechner, S., Maatouk, I., et al. (2014). Assessing Generalized Anxiety Disorder in Elderly People Using the GAD-7 and GAD-2 Scales: Results of a Validation Study. *Am. J. Geriatr. Psychiatry* 22, 1029–1038. doi:10.1016/j.jagp.2013.01.076

Zhang, Y.-L., Liang, W., Chen, Z.-M., Zhang, H.-M., Zhang, J.-H., Weng, X.-Q., et al. (2013). Validity and Reliability of Patient Health Questionnaire-9 and Patient Health Questionnaire-2 to Screen for Depression Among College Students in China. *Asia-Pacific Psychiatry* 5 (4), 268–275. doi:10.1111/appy.12103

Zhou, S.-J., Zhang, L.-G., Wang, L.-L., Guo, Z.-C., Wang, J.-Q., Chen, J.-C., et al. (2020). Prevalence and Socio-Demographic Correlates of Psychological Health Problems in Chinese Adolescents during the Outbreak of COVID-19. *Eur. Child. Adolesc. Psychiatry* 29 (6), 749–758. doi:10.1007/s00787-020-01541-4

Zhou, X., Snoswell, C. L., Harding, L. E., Bambling, M., Edirippulige, S., Bai, X., et al. (2020). The Role of Telehealth in Reducing the Mental Health Burden from COVID-19. *Telemed. E-Health* 26 (4), 377–379. doi:10.1089/tmj.2020.0068

Zurlo, M. C., Cattaneo Della Volta, M. F., and Vallone, F. (2020). COVID-19 Student Stress Questionnaire: Development and Validation of a Questionnaire to Evaluate Students' Stressors Related to the Coronavirus Pandemic Lockdown. *Front. Psychol.* 11. doi:10.3389/fpsyg.2020.576758

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Academic Self-Regulation, Chronotype and Personality in University Students During the Remote Learning Phase due to COVID-19

Naomi Staller[1], Nadine Großmann[2], Alexander Eckes[3], Matthias Wilde[2], Florian H. Müller[4] and Christoph Randler[1]*

[1]Department for Didactics of Biology, Eberhard Karls University Tübingen, Tübingen, Germany, [2]Department for Didactics of Biology, Bielefeld University, Bielefeld, Germany, [3]Osnabrück University, Osnabrück, Germany, [4]University Klagenfurt, Klagenfurt, Austria

During the COVID-19 shutdown phase in Germany, universities stopped presence teaching and students had to turn to digital instruction. To examine their capability to cope with the changed learning situation, we assessed how basic psychological need satisfaction and frustration, motivational regulation, vitality, and self-efficacy of 228 German biology-teaching students (75% female) relate to their chronotype and personality (Big Five). Specifically, we were interested in possible effects of chronotype and personality dimensions on variables related to successful remote learning. Since the pandemic and remote learning will accompany teaching and learning at university in 2021, predictors of successful remote learning need to be identified to support student learning optimally in digital learning environments. In our study, morning-oriented, conscientious, and open students with low neuroticism seem to better cope with the shutdown environment due to vitality, self-efficacy, and partly their self-determined motivation. Moreover, our findings implicate students might need different support depending on their chronotype and personality during the digital learning phase.

Keywords: chronotype (morningness-eveningness), big five personality, motivation, self-efficacy, vitality, basic psychological needs (BPN), remote learning (distance)

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****Correspondence:***
Naomi Staller
naomi.staller@uni-tuebingen.de

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INTRODUCTION

During the COVID-19 pandemic, the German government-imposed restrictions to limit viral transmission. As a part of this strategy, universities implemented online teaching and required students to work from home. In combination with asynchronous learning arrangements, students were able to change their sleep-wake cycle to sleeping later and longer (Staller and Randler, 2020). This led to a natural approximation to the inherent biological rhythm. The chronotype as the measurable manifestation of the biological rhythm describes the time of day at which a person is best able to cope with particularly challenging tasks. It is becoming an increasingly important predictor of *academic achievement* (see e.g., Arbabi et al., 2015; Tonetti et al., 2015). Since students were able to live in accordance with their own biological rhythm the conditions for academic success with respect to the chronotype may have improved during the restriction phase in Germany. This is corroborated

by a study of Horzum et al. (2014). These authors suggested that online teaching with free-choice time schedules diminished the achievement discrepancies between chronotypes. Besides their chronotype, students' motivation has a crucial impact on *academic achievement* (Ryan and Deci, 2017). With the sleep schedule in line with the inherent biological needs rather than with social expectations, the pandemic and remote learning phase open a rare opportunity to study the relationship between chronotype dependent characteristics and motivation-related constructs such as basic psychological need satisfaction and frustration, motivational regulation, vitality, and self-efficacy (see e.g., Eccles and Wigfield, 2002; Richardson et al., 2012; Kirmizi, 2015; Ryan and Deci, 2017). Additionally, we examine personality dimensions (Big Five) which are related to chronotype (e.g., DeYoung et al., 2007; Tonetti et al., 2009; Randler and Saliger, 2011) as well as motivational regulation (e.g., Müller et al., 2006; Komarraju et al., 2009) to provide a more holistic picture. Our study aimed at offering a first exploratory insight into the relationships of chronotype, well-being and motivation in the situation of asynchronous learning arrangements. Our findings provide valuable guidance for the design of digital learning environments and further analyses during remote learning.

THEORETICAL AND EMPIRICAL BACKGROUND

Chronotype and Circadian Preference

Chronotype is a personality-like trait in which humans are categorized according to their daytime preference, their wake and bedtimes, or their midpoint of sleep on days off. According to the current state of research, chronotype is divided into either demarcated types (morning type, evening type, or neither type; e.g., Adan et al., 2012; Horne and Östberg, 1976) or determined by a score on a continuum (from morningness to eveningness; Roenneberg et al., 2003). As a personality trait, it refers to the preferred daytime for physical or cognitive activities, thereby indicating the particularly efficient periods. Morning-oriented people reach their peak performance in the morning while evening-oriented people show their best performance in the late afternoon (Kerkhof and Van Dongen, 1996; Roenneberg et al., 2003). Chronotype differs from sleep duration by its inherent trait of timing that is irrelevant to the length of sleep (Adan et al., 2012). In the current study, we view chronotype as a unidimensional construct with a parametric score.

Motivation in Organismic Integration Theory

In Organismic Integration Theory, a sub-theory of self-determination theory (Ryan and Deci, 2017), motivational qualities and regulations that differ in their degree of perceived self-determination during an action are described. The prototype of a self-determined action is the intrinsically motivated action (Ryan and Deci, 2002). Here, an individual only pursues the goal of performing the action itself and no contingencies outside the action (Guay et al., 2000; Ryan and Deci, 2017). The action is performed to feel an inherent satisfaction and pleasure (Ryan and Deci, 2017). Extrinsically motivated actions, on the other hand, are performed to achieve a goal that is separable from the action (Guay et al., 2000; Vallerand and Ratelle, 2002; Ryan and Deci, 2017). They are therefore described as instrumental (Vallerand and Ratelle, 2002). However, this does not mean that extrinsically motivated actions are solely perceived as externally determined (Reeve, 2002; Ryan and Deci, 2017). Based on the perceived degree of heteronomous control or self-determination, Ryan and Deci (2017) describe four types of motivational regulation of extrinsically motivated actions: external, introjected, identified, and integrated.

Externally regulated actions are performed to achieve a positively rated state (e.g., a reward) or to avoid a negatively rated state (e.g., a punishment) (Vallerand and Ratelle, 2002; Ryan and Deci, 2017). The execution of such actions is experienced as being externally determined (Ryan and Deci, 2017; Thomas et al., 2018). Actions that are based on introjected regulation are described as being rather externally determined (Ryan and Deci, 2002). With the execution of introjected regulated actions, individuals tend to avoid guilt and shame (avoidance type; Guay et al., 2000; Vallerand and Ratelle, 2002) or to strengthen or maintain their self-esteem (approach type; Assor et al., 2009). One regulation that results in a rather self-determined quality of action is the identified regulation (Ryan and Deci, 2002, 2017; Vallerand and Ratelle, 2002). An individual performs an identified regulated action when the goal and the underlying values of this action are considered valuable by the individual (Ryan and Deci, 2017). The underlying goals of such self-determined actions can be separated from the beliefs of the individual (Vallerand and Ratelle, 2002). If the beliefs of the individual and the goals of the action are no longer separable, an action is subject to integrated regulation (Vallerand and Ratelle, 2002; Ryan and Deci, 2017). The goals and needs of the self are in line with the goals of the action while performing an integrated regulated action (Ryan and Deci, 2002). These actions already share qualities with intrinsically regulated actions such as the voluntary execution and perceived self-determination (Ryan and Deci, 2002).

Motivation in Basic Psychological Needs Theory

The motivational regulation of an action is determined, among other things, by the degree of the perceived satisfaction and frustration of the three-universal basic psychological needs for autonomy, competence, and relatedness (Ryan and Deci, 2017; Vansteenkiste et al., 2020). The need for autonomy describes an individuals' striving to be the origin of his/her action and having a sense of choice in actions (Reeve, 2002; Ryan and Deci, 2017). Moreover, individuals perceive themselves as being autonomous if they can execute actions voluntarily and without external pressure (Reeve, 2002; Ryan and Deci, 2017). The need for competence entails an individuals' desire to feel effective and be able to express and improve his/her own skills in his/her interactions with the environment (Reeve, 2002; Ryan and Deci,

2017). The need for relatedness describes an individuals' wish to belong to a community and to interact with significant others (Reeve, 2002; Ryan and Deci, 2017). A satisfaction of the depicted needs most likely results in a self-determined motivational regulation whereas a frustration thereof fosters controlled types of motivational regulation and negatively affects self-determined regulation (Vansteenkiste et al., 2020). Furthermore, the satisfaction of the basic needs facilitates well-being (Ryan and Deci, 2017). Vitality is regarded as one indicator of well-being and is defined by the availability of energy and feelings of enthusiasm (Ryan and Frederick, 1997; Martela et al., 2016). A satisfaction of the basic psychological needs combined with low levels of needs frustration support the facilitation of vitality (Ryan et al., 2006; Ryan et al., 2010).

Self-Efficacy

Self-efficacy in academic contexts can be described as the belief in one's abilities to organize and execute the action(s) required to reach a given educational goal (Bandura, 1997; Elias and McDonald, 2007) and is linked to motivation (Zimmermann, 2000) and academic achievement (Valentine, Dubois, and Cooper, 2004; Zajacova et al., 2004). Self-efficacy is related to the perception of competence. Since one's own belief about mastering tasks affects the balance between one's own ability and the requirements of the task it is a central prerequisite of perceiving competence. At the same time, events that resulted in a high or low perception of competence affect self-efficacy positively or negatively. Self-efficacy might therefore play an important role in coping with new and potentially challenging situations such as the remote learning phase.

Academic Achievement and Personality Characteristics

Academic achievement is determined by ability factors (e.g., cognitive abilities; Ackerman and Heggestad, 1997) as well as non-ability factors (e.g., personality characteristics; Chamorro-Premuzic and Furnham, 2006). For example, achieving academic goals requires the cognitive ability to understand the content, the ability to control distracting emotions as well as to work and learn in an appropriate manner. These, among other factors, must be properly fulfilled to accomplish *academic achievement*. In this context, personality characteristics need to be considered as important predictors for *academic achievement* because 1) certain personality traits affect behavior which, in turn, can have an influence on *academic achievement* (e.g., conscientiousness; Rothstein et al., 1994), 2) personality traits reflect behavior which a person will show rather than what a person is theoretically capable of (Goff and Ackerman, 1992; Furnham and Chamorro-Premuzic, 2004), and 3) in an university setting, personality traits show more predictive power than cognitive ability for *academic achievement* (Ackerman et al., 2001; Furnham et al., 2003; O'Connor and Paunonen, 2007). For example, conscientiousness has been consistently related positively to *academic achievement* prior to (O'Connor and Paunonen, 2007; Poropat, 2009) and during the COVID-19 pandemic (Corazzini et al., 2020). As a personality dimension of the big five, it determines self-regulation and impulse control (John et al., 2008), which proved to be important in utilizing emotions to achieve academic goals (Pekrun, 1992; Pekrun et al., 2002). Since *academic achievement* belongs to the most important influencing factors on educational and professional careers in modern society, students are confronted with both their actual academic performance and their expectations thereof.

The expectation of their academic performance triggers a variety of personal and task-related emotions as well as different motivational regulations, which, in turn, influence cognitive processes and performance (e.g., Ryan and Deci, 2017). Emotions that are directly linked to *academic achievement* are called *academic emotions* (e.g., anxiety and motivation to learn) (Pekrun et al., 2002). These modulate a student's behavior by triggering positive or negative directed intentions. Taken together, personality traits predefine how emotions influence behavioral tendencies and in consequence *academic achievement*.

Bridging Academic Achievement and Circadian Preference

Another important dimension of a personality trait-like characteristic affecting *academic achievement* is the circadian preference. Evening-oriented students show significantly worse grades in elementary school (Arbabi et al., 2015), middle school (Kolomeichuk et al., 2016), high school (Randler and Frech, 2006), and university (although this correlation weakens depending on the degree of free time allocation; Tonetti et al., 2015). Reasons given for this relationship are early school schedules (Goldstein et al., 2007) and the resulting lack of sleep for evening-oriented students (Roberts et al., 2009). These conclusions are further underlined by the findings of Jovanovski and Bassili (2007) who reported evening-oriented students prefer watching lectures online instead of attending them. Moreover, no correlation of chronotype with course performance was found. Horzum et al. (2014) reported similar results: the disadvantages evening-oriented students face in classroom teaching disappear with the switch to online teaching, because the students could adapt the lecture time to their personal needs. Additionally, various personality traits which favor *academic achievement* could be linked to morning orientation (e.g., conscientiousness; Adan et al., 2012; O'Connor and Paunonen, 2007; Önder et al., 2014; Poropat, 2009), while those which negatively affect advantageous academic behavior can be associated with evening orientation (e.g., extraversion; Adan et al., 2012; Chamorro-Premuzic and Furnham, 2005; Furnham and Chamorro-Premuzic, 2004; Furnham et al., 2003; Goff and Ackerman, 1992). However, the negative relationship between extraversion and *academic achievement* has yet to be validated, since some research shows no correlation or even suggests a positive correlation (e.g., Rothstein et al., 1994). Furthermore, evening orientation relates to the use of external stimuli (caffeine; Fleig and Randler, 2009), smoking and soft drinks (Gariépy et al., 2019), excessive cell phone use (Randler et al., 2016a;

Demirhan et al., 2016), and long screen times (Kauderer and Randler, 2013; Shimura et al., 2018; Gariépy et al., 2019). According to Ryan and Frederick (1997), these factors may affect vitality negatively. Overall, the relationship of circadian preference with self-regulation and *academic achievement* builds on a small but growing body of literature. Work in this domain suggests that evening orientation is associated with characteristics and behaviors that hinder *academic achievement*.

Remote Working, Chronotype, and Motivation

Previous research shows that the change in students' sleep-wake cycle caused by working from home resulted in positive alterations of sleep parameters for many people in different countries (Cellini et al., 2020; Gao and Scullin, 2020; Leone et al., 2020; Sinha et al., 2020; Staller and Randler, 2020). These findings support a modern approach to work environments called "New Ways of Working" (NWW; Baane et al., 2011). This concept tries to create temporal and spatial flexibility for employees while focusing on innovation and productivity with simultaneously reduced costs for employers (Nijp et al., 2016). It is proposed to adjust work to private life (Gajendran and Harrison, 2007; Nijp et al., 2015) and the employees' biological needs such as chronotype (Wittmann et al., 2006). The remote working situation that the students found themselves in during the COVID-19 restriction phase in Germany reflects the temporal and spatial flexibility NWW tries to create. Positive effects of this working approach are assumed to be e.g., employees' improved motivation due to gaining autonomy (Pritchard and Payne, 2003) and increased efficiency (Demerouti et al., 2014). By contrast, the lack of collegial support and exchange, which is considered a negative aspect of NWW (Halford, 2005), also applies to the university students' current situation. There is also evidence that NWW might lead to exhaustion at the end of the workday (Ten Brummelhuis et al., 2012). Thus, vitality might be undermined. In line with self-determination theory (Ryan and Deci, 2017), these characteristics of remote working may affect the relationship between academic self-regulation and *academic achievement*.

Taken together, our study aimed at providing insight into the relationship between different related personality and motivational variables that affect *academic achievement*. Some interactions between these variables have already been shown in previous studies. Our study takes a more holistic approach to the relationship between these variables. Moreover, as shown, these relationships may be influenced by the remote learning situation. However, knowing these relationships is significant for designing learning environments that enable students to learn successfully in times of remote learning.

Research Question

Our study aims to investigate the effects of personality variables on various variables related to successful learning in an unprecedented situation, lockdown, and digital teaching. The identification of such predictors of successful remote learning can help to support student learning optimally in digital learning environments. As to the unprecedented situation we opted to derive an exploratory research agenda for A) the personality traits and B) chronotype based on findings of literature and previous studies in face-to-face teaching that are specified hereafter in more detail.

A) In respect to the personality traits we derive:
   - the big five personality variables have an impact on the satisfaction and frustration of the students' basic needs (Deniz and Satici, 2017)
   - the big five personality variables have an impact on the students' motivational regulation (Müller et al., 2006; Komarraju et al., 2009).
   - the big five personality variables have an impact on the students' vitality (Nishimura and Suzuki, 2016).
   - the big five personality variables have an impact on the students' self-efficacy (Şahin and Çetin, 2017).

B) Regarding chronotype, it can be assumed that:
   - chronotype has an impact on the satisfaction and frustration of the students' basic needs (Tavernier et al., 2019)
   - chronotype has an impact on the students' motivational regulation (Kadzikowska-Wrzosek, 2020)
   - chronotype has an impact on the students' vitality (Randler and Schaal, 2010).
   - chronotype has an impact on the students' self-efficacy (Przepiórka et al., 2019).

METHODS

Participants and Data Collection

We investigated biology-teaching students (N = 228; M_{Age} = 23.36 years, SD_{Age} = 4.24 years, range = 18–43 years; 75% female, n = 171) in their bachelor or master studies participating in an one-time online survey. The study took place during the first lockdown in Germany in June 2020. Participants were invited via email distribution lists. These students gave their permission to use their anonymous data for scientific purposes and were included in our evaluation. Their participation in the survey was voluntary. After filling out the questionnaire, all participating students could take part in a raffle to win gift cards/vouchers. All participants studied in an online environment and took very different courses (e.g., lecture series or seminars). Furthermore, they all had access to a learning platform (e.g., Lernraum or studIP). 48 subjects were not included in the calculations because they did not complete the questionnaire. The dropouts are similar to the sample in demographic data, gender (dropouts: 69% female/sample: 75% female), age (dropouts: Ø 23 years (youngest: 19 years/oldest: 34 years)/sample: Ø 23 years (youngest: 18 years/oldest: 43 years)) and origin. In conclusion, the aforementioned 228 students were included in the statistical analyses. Together with the questionnaires, participants' time spent on other commitments per week was assessed. Participants spent on average 17.66 h (SD = 19.30 h) on

other commitments beyond their study. Here, participants (N = 228) reported these commitments mainly in the categories (part-time) job (46.5%), nursing/caregiving activities (4.4%), family (7%) and household activities (11.4%). 16% of the investigated students lived alone at the time of the survey, while 83% lived in a shared apartment with roommates, their partner and/or children. 1% of the students did not specify their situation at home.

Big Five Personality

We followed the big five-dimensional concepts of personality (e.g., Costa and McCrae, 1995). To measure personality, we used a German translation of the short version of the big five inventory (Rammstedt and John 2007; Rammstedt et al., 2013). This scale was based on the BFI-44 (Benet-Martínez and John, 1998) and was shortened to a 10-item questionnaire with two items for each personality dimension (extraversion, agreeableness, openness, neuroticism, and conscientiousness). The items were rated on a seven-point rating scale (see 3.3). The BFI-10 always showed a clear five factor structure and correlations with peer-ratings showed good external validity (Rammstedt and John, 2007). Due to its brevity, the scale can be used when personality assessment is only one aspect of a study design and when time is short. We used a confirmatory factor analysis to test the model structure of the BFI. Root mean square error of approximation (RMSEA) was 0.057 (CI 0.028–0.083). The comparative fit index CFI was 0.954. This suggests a good fit of the scale.

Morningness-Eveningness Questionnaire (Reduced)

To assess circadian preference, we used the Adan and Almirall (1991) short Morningness-Eveningness Questionnaire (rMEQ). This scale is based on five different questions regarding wake and bedtime preferences, peak performance, morning affect and self-classification. The scale ranges from 4 to 25 (4–11: evening type; 12–17: neither type; 18–25: morning type). The rMEQ is a time efficient questionnaire that has received a lot of support for its convergent validity (Di Milia et al., 2013). For example, the reduced form correlates between 0.87 and 0.90 with the full scale containing 19 questions (Di Milia et al., 2013). The questionnaire scores have been validated against biologically measured variables, such as objectively assessed sleep-wake variables based on actigraphy (Thun et al., 2012). The German version of the rMEQ has been established and validated (Cronbach's $\alpha = 0.72$; Randler, 2013).

Basic Psychological Need Satisfaction and Frustration Scale

To assess the satisfaction and frustration of the students' basic psychological needs during the online semester, Heissel et al. (2018) validated German scales were used. The dimensions for satisfaction and frustration of the respective needs are the following: need for autonomy (satisfaction: four items, Cronbach's $\alpha = 0.74$; frustration: four items, Cronbach's $\alpha = 0.84$), need for competence (satisfaction: four items, Cronbach's $\alpha = 0.85$; frustration: four items, Cronbach's $\alpha = 0.83$), and the need for social relatedness (satisfaction: four items, Cronbach's $\alpha = 0.74$; frustration: four items, Cronbach's $\alpha = 0.72$). A five-point rating scale ("1 = not true at all" to "5 = absolutely true") was applied.

Scales for Motivational Regulation in Learning

To assess the students' motivational regulation during the online semester, the scales for motivational regulation in learning (Thomas et al., 2018), a translated and adapted version of the Academic Self-Regulation Questionnaire (Ryan and Connell, 1989), were used. The instrument contains four subscales: intrinsic motivational regulation (three items, Cronbach's $\alpha = 0.88$); identified motivational regulation (three Items, Cronbach's $\alpha = 0.72$); introjected motivational regulation (six items), and external motivational regulation (three items, Cronbach's $\alpha = 0.72$) (Thomas et al., 2018). In this study, the subscale introjected motivational regulation was assessed separately as approach type (three items, Cronbach's $\alpha = 0.78$) and avoidance type (three items, Cronbach's $\alpha = 0.83$). The items of all subscales were rated on a seven-point rating scale ("1 = not true at all" to "7 = absolutely true").

Vitality

Students' vitality during the online semester was assessed with a translated version of Ryan and Frederick (1997) Subjective Vitality Scale. Analysis of the factorial validity was carried out with a principal axes factor analysis (PFA; Moosbrugger and Kelava, 2012). The Kaiser-Meyer-Olkin criterium (KMO = 0.90) was found to be good (Hutcheson and Sofroniou, 1999) and showed that the sample was entitled for analysis. Bartlett's test of sphericity was significant with a $p < 0.001$. PFA showed one factor (eigenvalue of 4.58) and 65.40% of explained variance. The items had satisfactory factor loadings with values of 0.57–0.90 (Stevens, 2002). The seven items were rated on a seven-point rating scale as well (see 3.3). The internal consistency of the items was good (Cronbach's $\alpha = 0.91$).

Self-efficacy

To examine students' self-efficacy during the online semester, seven items by Jerusalem and Schwarzer (1986) were applied. The items were again rated on a seven-point rating scale (see 3.3). The internal consistency of the items was satisfactory (Cronbach's $\alpha = 0.82$).

Statistical Analyses

No specific assumptions were made in advance for the situation in which the study group found itself during the lockdown. We therefore analyzed the data in an exploratory manner based on related previous research (see *Research Question*) and looked for relevant models. To determine internal consistency as Cronbach's α, we used IBM SPSS Statistics 26. Afterward, we ran a series of multiple regressions with all 14 dependent variables. Independent predictors were personality, chronotype and the demographics age and gender. Only the significant total models were inspected for further analyses. We set a $p = 0.01$ as a threshold to accept a model as significant. For

TABLE 1 | Means, standard deviations and ranges of the independent (personality, chronotype) and dependent variables (basic psychological needs, motivational regulation, vitality, self-efficacy).

	Mean	Standard deviation	Range	Scale range
Extraversion	4.53	1.61	1–7	1–7
Neuroticism	4.23	1.41	1–7	1–7
Openness	4.91	1.59	1–7	1–7
Conscientiousness	4.80	1.27	2–7	1–7
Agreeableness	4.48	1.27	1.5–7	1–7
rMEQ score	14.63	4.04	5–23	4–25
Need frustration autonomy	3.38	0.97	1–5	1–5
Need frustration competence	2.29	0.99	1–5	1–5
Need frustration relatedness	2.11	0.83	1–4.5	1–5
Need satisfaction autonomy	3.24	0.82	1–5	1–5
Need satisfaction competence	3.36	0.85	1.25–5	1–5
Need satisfaction relatedness	2.92	0.85	1–5	1–5
Need satisfaction relatedness—Lecturer	3.53	0.83	1.25–5	1–5
Need satisfaction relatedness—Peers	3.63	0.87	1.33–5	1–5
Intrinsic regulation	3.65	1.64	1–7	1–7
Identified regulation	4.94	1.23	1.33–7	1–7
Introjected approach regulation	4.32	1.58	1–7	1–7
Introjected avoidance regulation	3.88	1.66	1–7	1–7
External regulation	4.72	1.46	1–7	1–7
Vitality	4.12	1.19	1–7	1–7
Self-efficacy	4.21	1.14	1.29–6.71	1–7

TABLE 2 | Correlation matrix between the independent (personality, chronotype) and dependent variables (basic psychological needs, motivational regulation, vitality, self-efficacy).

	Extraversion	Neuroticism	Openness	Conscientiousness	Agreeable-ness	rMEQ score
Need frustration autonomy	0.048	0.069	–0.107	–0.128	–0.007	**–0.151***
Need frustration competence	–0.096	**0.284*****	0.010	**–0.325*****	–0.012	**–0.186****
Need frustration relatedness	**–0.180****	**0.226****	**0.131***	–0.091	–0.103	–0.113
Need satisfaction autonomy	–0.103	0.069	0.093	0.128	0.053	0.117
Need satisfaction competence	0.019	**–0.179****	**0.131***	**0.162***	0.055	**0.157***
Need satisfaction relatedness	0.056	–0.097	–0.042	0.122	**0.195****	0.088
Need satisfaction relatedness—Lecturer	–0.051	–0.014	**0.234*****	–0.062	0.031	–0.011
Need satisfaction relatedness—Peers	0.059	**–0.135***	–0.009	0.019	0.121	0.017
Intrinsic regulation	**–0.185****	0.041	**0.146***	0.126	0.110	0.107
Identified regulation	–0.038	0.105	0.126	**0.233*****	0.097	**0.159***
Introjected avoidance regulation	–0.118	**0.320*****	0.041	**–0.160***	–0.048	0.026
Introjected approach regulation	–0.009	**0.147***	**0.177****	0.067	0.080	0.119
External regulation	0.048	0.002	0.112	–0.043	–0.024	0.028
Vitality	–0.015	**–0.247*****	0.077	**0.250*****	0.117	**0.264*****
Self-efficacy	0.022	**–0.322*****	0.092	**0.186****	0.022	**0.178****

*Note: *p< .05, **p< .01, ***p< .001.*
Note: Significant correlations are highlighted in bold.

the confirmatory factor analysis, AMOS 26 was used. Correlations between personality dimensions were tested and intercorrelations were below 0.28 showing below medium effects in all cases.

RESULTS

We calculated the distribution of the datasets and found them neither to be substantially skewed nor was a distinct kurtosis visible in any variable (the values for both, skewness and kurtosis did not exceed/fall below ±1). **Table 1** summarizes the means, standard deviations, and ranges of all investigated variables.

The mean rMEQ score was 14.63 (SD = 4.04) and ranged from 5–23. Men had a lower score compared to women (men: 13.65, SD = 4.38; women: 14.95, SD = 3.88; F = 4.52, p = 0.035, η^2 = 0.020). Age was unrelated to the rMEQ score (r = 0.027, p = 0.685). **Table 2** gives an overview of the correlations between the big five dimensions/chronotype and all investigated dependent variables. Furthermore, we calculated the correlations of the big five personality dimensions and the rMEQ score which showed mostly no significant correlations. Extraversion (r = 0.076, p = 0.253), Neuroticism (r = 0.010, p = 0.882), Openness (r = -0.109,

TABLE 3 | Results of the full models (linear regression) with the dependent variable (left column) and gender, age, rMEQ score, and personality as predictor variables of the basic psychological need satisfaction and frustration, motivational regulation, vitality, and self-efficacy. The corrected R-squared is only given for the models with a $p < 0.01$.

	F	*p*	Corrected R^2
Need frustration autonomy	1.79	0.08	
Need frustration competence	7.38	0.001	0.18
Need frustration relatedness	3.25	0.002	0.07
Need satisfaction autonomy	1.61	0.124	
Need satisfaction competence	3.12	0.002	0.07
Need satisfaction relatedness	2.19	0.03	
Need satisfaction relatedness—Lecturer	2.12	0.035	
Need satisfaction relatedness—Peers	1.60	0.125	
Intrinsic regulation	3.97	0.001	0.10
Identified regulation	3.26	0.002	0.07
Introjected approach regulation	2.76	0.006	0.06
Introjected avoidance regulation	5.47	<0.001	0.14
External regulation	0.67	0.72	
Vitality	6.91	<0.001	0.17
Self-efficacy	8.38	<0.001	0.21

$p = 0.101$), Agreeableness ($r = 0.103$, $p = 0.122$) with the exception of conscientiousness ($r = 0.283$, $p < 0.001$) which correlated with morningness.

Due to the many correlations, we ran a series of multiple linear simultaneous regressions with each of the motivation-related scales and subscales as dependent variables. **Table 3** presents the results of the full models.

In the following section, only the significant models with a $p < 0.01$ for the full model were analyzed (see **Table 4**).

A significant impact of gender on motivational aspects were found, with men reporting a higher degree of self-efficacy and women being more intrinsically motivated. Age showed a negative relationship with introjected avoidance motivational regulation. Extraversion related negatively to intrinsic motivational regulation. Neuroticism related negatively to self-efficacy, vitality, and need satisfaction competence while it related positively to introjected approach and avoidance motivational regulation, as well as need frustration competence and relatedness. Openness correlated positively with self-efficacy, intrinsic, identified, and introjected approach motivational regulation, as well as need satisfaction competence. Conscientiousness was related positively to self-efficacy, vitality, identified motivational regulation, need satisfaction competence, and negatively to introjected avoidance motivational regulation and need frustration competence. For the rMEQ, positive correlations were found with self-efficacy, vitality, and need satisfaction competence.

DISCUSSION

In our sample of biology-teaching students, the mean rMEQ score did not differ significantly from other German study samples (Randler 2013; Randler et al., 2016b). This is an expected result because chronotype remained stable during the COVID-19 shutdown phase in Germany while only sleep-wake timing changed (Staller and Randler, 2020). Gender differences in line with previous studies were found, with men being more evening-oriented (e.g., Randler and Engelke, 2019). Age effects were absent, most likely due to the low age variation (see e.g., Randler et al., 2016b, for a larger sample with the rMEQ). The relationship between morningness and vitality in our sample might have a biological reason: Morningness was linked to the cortisol awakening response in previous studies (CAR; see e.g., Randler and Schaal 2010), which may take account of this correlation as it reflects the theoretical connection to the diurnal cycle. Overall, personality and chronotype had a significant impact on online learning during the COVID-19 pandemic in these biology-teaching student sample.

Effects of Gender on Self-Efficacy

Our results are in line with previous findings on gender differences regarding self-efficacy (e.g., Fallan and Opstad, 2016). However, in a meta-analysis, Huang (2013) showed that such gender effects vary depending on the investigated subject domain. Whereas female students seem to have a higher self-efficacy in language arts, male students express a

TABLE 4 | Results of the multiple regressions. Full models are presented in **Table 3**. Standardized coefficient beta for the predictor variables is given. Predictors were gender, age, personality and rMEQ score. Dependent variables were basic psychological need satisfaction and frustration, motivational regulation, vitality, and self-efficacy.

	Gender	Age	Extraversion	Neuroticism	Openness	Conscientiousness	Agreeableness	rMEQ score
Need frustration autonomy	–0.029	–0.028	0.082	0.090	–0.120	–0.123	0.009	**–0.140***
Need frustration competence	0.084	0.022	0.039	**0.320*****	–0.023	**–0.304*****	0.079	–0.105
Need frustration relatedness	0.059	0.085	–0.094	**0.208****	0.096	–0.026	–0.048	–0.079
Need satisfaction competence	0.032	0.033	–0.041	**–0.189****	**0.153***	**0.151***	0.028	**0.137***
Intrinsic regulation	**–0.173***	0.07	**–0.219*****	–0.049	**0.131***	0.107	0.076	0.074
Identified regulation	–0.019	0.046	–0.050	0.083	**0.147***	**0.207****	0.068	0.109
Introjected approach regulation	–0.060	–0.089	0.025	**0.147***	**0.205****	0.019	0.064	0.120
Introjected avoidance regulation	0.063	**–0.167*****	–0.012	**0.343*****	0.049	**–0.174****	–0.004	0.092
Vitality	0.049	–0.025	–0.125	**–0.269*****	0.113	**0.223*****	0.071	**0.225*****
Self-efficacy	**0.228*****	–0.108	–0.072	**–0.293*****	**0.137***	**0.215*****	0.013	**0.174****

*Note: *p < .05, **p < .01, ***p < .001.*

Note: Significant coefficient beta values are highlighted in bold.

higher degree of self-efficacy in mathematics, social sciences, and computers (Huang, 2013).

Effects of Gender on Intrinsic Motivational Regulation

Biology as a school subject is assumed to be a female domain (e.g., Budde, 2008). Thus, females exhibit both more interest (Dietze et al., 2005) and a higher intrinsic motivational regulation than males in the school subject biology (Renaud-Dubé et al., 2010; Großmann et al., 2019). As a scientific field, biology might show the same underlying gender-related effects as described by Huang (2013) as well. However, since the study sample only consisted of biology-teaching students, the interest and intrinsic motivational regulation of all participants might have been above average, which could argue against the former conclusion.

Effects of Age on Introjected Approach Motivational Regulation

Our results show that younger students reported a higher level of introjected approach motivational regulation than older students. However, the correlation is small. One possible explanation might be that younger students feel more obligated to prove their abilities to others than older students do. They might have a stronger desire to manage what others think about them. However, we did not find such age-related effects for the avoidance type of introjected motivational regulation. Acting to avoid negative feelings such as guilt and shame seems to be independent of students' age. To test the reliability of the current findings more research is needed.

Effects of Extraversion on Intrinsic Motivational Regulation

In our sample, extraversion related negatively to intrinsic motivational regulation. This result is contrary to the findings of Komarraju et al. (2009) and Müller et al. (2006), who found a positive relationship between these variables. When it comes to the teacher profession, positive correlations between extraversion and intrinsic motivation should become particularly apparent, since extraversion predicts satisfaction and success in teacher training programs as well as in the teaching profession (Mayr, 2014). A possible explanation for our result might be that other people and external stimuli play a more important role to extroverts than to introverts. Specifically, extroverts' decision-making and behavior may be significantly influenced by what others think of them, suggesting a more externally determined rather than self-determined motivational regulation. A situation in which extrinsic motivational factors are largely absent, such as the COVID-19 shutdown, might lead to a lower level of both intrinsic motivation for learning and self-efficacy regarding extroverts. A lack of social exchange with peers and lecturers may therefore have a stronger effect on extroverts' motivation and might (at least partially) explain the contradiction to what Komarraju et al. (2009) and Müller et al. (2006) reported.

Effects of Neuroticism

The results of our sample replicated previous findings concerning the negative relationship between neuroticism and self-efficacy as well as vitality (Nishimura and Suzuki, 2016; Deniz and Satici, 2017). Neurotic people are less open toward new and unpredictable situations (Borkenau and Ostendorf, 2008). The unpredictable situation resulting from the COVID-19 pandemic and the unexpected move to online learning constitutes a major challenge for neurotic people. The significant correlations between neuroticism and the tested motivation-related variables (positive correlation with introjected approach and avoidance motivational regulation, need frustration competence and relatedness; negative correlation with need satisfaction competence) are in line with previous studies (Müller et al., 2006; Komarraju et al., 2009; Önder et al., 2014; Nishimura and Suzuki, 2016).

Effects of Openness

As was the case in the sample in Şahin and Çetin's (2017) study, our sample also yielded a positive correlation between openness and self-efficacy. This is contrary to the results of Judge et al. (2007), who found no impact of openness on self-efficacy. Openness as a predictor of self-efficacy might be explained by one's inherent openness to situations and experiences. More "open" students may face more challenging and difficult situations that allow them to perceive more self-efficacy than students with a more "reserved" character. This conjecture is backed up by the result of Corazzini et al. (2020) who found high levels of openness to new experiences correlating with better student scores during the COVID-19 pandemic. Moreover, openness correlated positively to intrinsic motivation, replicating the work of Komarraju et al. (2009) and Önder et al. (2014). Furthermore, it related to the other self-determined types of motivational regulation, namely identified and introjected approach. Self-determined motivational regulation indicates perceived competence. Therefore, the positive correlation of openness and need satisfaction competence fits into this line of reasoning. Moreover, openness and need satisfaction competence were shown to correlate positively in previous work as well (Nishimura and Suzuki, 2016). Regarding the remote learning phase during COVID-19 shutdown, we reason that openness to new experiences might be beneficial when new methods of learning are implemented, even though more research is needed to test the reliability of the current findings.

Effects of Conscientiousness

Conscientiousness showed a strong positive correlation with self-efficacy and vitality, thereby replicating previous findings (Nishimura and Suzuki, 2016; Deniz and Satici, 2017). This was a somewhat expected result, as conscientiousness is one of the most important influencing factors on learning and *academic achievement* (O'Connor and Paunonen, 2007; Poropat, 2009). Also, conscientiousness was found to be highly correlated to student scores during the COVID-19 pandemic (Corazzini et al., 2020). Our results are in line with Komarraju et al. (2009), Önder et al. (2014), and Müller et al. (2006), who found that

conscientiousness is a positive predictor of intrinsic motivation. Komarraju and others (2009) also found that there is a positive correlation between identified as well as introjected motivational regulation and conscientiousness. Moreover, conscientiousness was a positive predictor of extrinsic motivation (measured as identified, introjected and external motivational regulation) in their study. In our study, we replicated the positive relationship between conscientiousness and identified motivational regulation, but our data showed a negative correlation between conscientiousness and introjected avoidance motivation. This diverging result might be explained by the fact that Komarraju et al. (2009) did not differentiate between approach and avoidance introjection. Furthermore, self-determined motivational regulation indicates perceived competence, which relates to conscientiousness (see Nishimura and Suzuki, 2016). This positive correlation between conscientiousness and need satisfaction competence was evident in our data as well. Since it correlates negatively with introjected avoidance regulation, the connection to the need frustration competence meets expectations.

Effects of Chronotype on NWW

Morningness was related to self-efficacy and need satisfaction competence, which, in turn, were shown to correlate with conscientiousness, thus supporting the findings of previous work (Komarraju et al., 2009). Furthermore, morningness has been shown to correlate with conscientiousness (Adan et al., 2012) which could be replicated in this sample. Eveningness relates positively to extraversion (Adan et al., 2012, which could not be replicated in this sample) as well as negatively to intrinsic motivational regulation (in our sample). Our data indicate that the NWW approach might be more suitable for morning types, though this research question should be examined in more detail. The negative effects of NWW discussed in the literature (e.g., missing collegial support and a structured working environment; see theoretical background) might affect evening types more because they are less intrinsically motivated. The absence of extrinsic motivational factors may therefore have a stronger effect on evening types' motivation and on their work and learning success. By contrast, morning types, may benefit more from the opportunities which NWW present (temporal and spatial flexibility) because of the relationship between morningness and characteristics such as self-efficacy and conscientiousness.

CONCLUSION

In this study, we found correlations indicating that the changeover to a remote or distant learning setting during the COVID-19 shutdown phase in Germany affects student teachers' motivational regulation depending on their chronotype and big five personality characteristics. These effects on motivation have implications for students' learning success in these new and probably challenging learning environments. The morning-oriented students dealt with the digital semester better and were more vital during the restrictions than evening-oriented students. Morning orientation further correlated with the personality traits in a distinct pattern. It correlated positively to personality characteristics that strengthen the relationship to intrinsic motivational regulation such as self-efficacy and need satisfaction competence and negatively to characteristics that weaken this connection such as extraversion (Adan et al., 2012). This study could replicate some prior findings in the field of motivational research such as the correlation between conscientiousness and intrinsic motivational regulation. Furthermore, some new findings emerged: 1) Extraversion was a negative predictor of intrinsic motivational regulation. This finding is contrary to that of Komarraju et al. (2009). 2) Whereas the introjected approach motivational regulation seems to be dependent on the students' age, this dependency was not found for the avoidance type of introjected motivational regulation. We nevertheless recommend more testing for reliability which would give a stronger basis for the conclusions.

Strengths and Limitations

In this study, we revealed opportunities and obstacles in terms of remote learning following the restriction measures in Germany. This situation will accompany university teaching and learning further on. Even when the pandemic is over, digital elements may remain present in university teaching as blended learning. Therefore, identifying important predictors of successful learning in digital learning environments might help instructors to redesign these in a beneficial way. We did not limit the data collection to a single theoretical perspective but rather examined many covariables to ensure the results we conclude from this study are not directionally biased. This allowed for a broad perspective at the current motivational characteristics in relation to well-being and personality traits. Nevertheless, the explanatory power of this study is limited due to its exploratory cross-sectional nature. The ongoing pandemic prevented appropriate pre-testing from being carried out. Furthermore, it was not possible to use measurement methods that would complement the self-reports as the data access is restricted by the data protection act and in addition other non-self-report measures could not be applied due to the lockdown situation. We researched a small and narrow sample that refers exclusively to biology-teaching students. With our results, we are able to offer an insight into the relationships of personality dimensions, chronotype, motivational regulation and vitality of biology-teaching students during the first lockdown, even though the results may be less transferable to other groups. In this respect, future studies should expand the sample under consideration. Although this study provided information regarding the life situation of the participants, the situation of the online studies as well as study circumstances should be focused in more detail in future studies as they offer valuable insight and influence the perception of the digital study itself. We discussed conceivable relationships of the variables under consideration with academic achievement which should be investigated in further projects, as we have not included a measure of academic achievement here. Although the measurements used in this study are widely applied in the literature and are validated, the validity of the vitality measurement is limited due to the German translation used here. Moreover, our findings offer a

valuable steppingstone for further research such as longitudinal studies that focus on the long-term effects of the lockdown on students' learning processes.

Implications for Further Research

Future cross-sectional and longitudinal studies might take the subject matter into account since it can be assumed that personality traits can have different effects on experience and behavior (see Mayr, 2014). The present study showed that it could be a worthwhile research desideratum to clarify the connection between NWW and chronotype as well as to identify possible moderators between the two variables. In such studies, students' temporal and spatial flexibility that is offered in their university courses might be surveyed. This flexibility most likely has an impact on students' perception of autonomy and, in turn, their motivation. Students' use of learning strategies has not been assessed in this study. As the use of learning strategies could very well influence the time invested in a course and as such be directly connected to the perception of workload (Kember, 2004; Kember and Leung, 2006) this aspect could be interesting for future studies. Moreover, we believe that it is necessary to investigate whether students have developed more appropriate coping strategies than at the beginning of the COVID-19 crisis which might result in a more self-determined motivation. Such changes and relationships can be clarified by longitudinal or cohort designs.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because the authors still use this dataset for further studies. The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation. Requests to access the datasets should be directed to nadine.grossmann@uni-bielefeld.de.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the ethics comission of Universität Bielefeld, Antrag-Nr.: 2020-200; Az.: 1266. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

AE, NG, MW, and FM, CR conceptualized and designed the study, AE, NG, MW, and FM performed the data collection, CR, NS, and NG made the statistical calculations, CR, NG, and NS wrote the first draft of the manuscript, AE, NG, MW, FM, CR, and NS agreed on the final submission of the study, FM managed and overlooked the whole project.

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REFERENCES

Ackerman, P. L., Bowen, K. R., Beier, M. E., and Kanfer, R. (2001). Determinants of Individual Differences and Gender Differences in Knowledge. *J. Educ. Psychol.* 93 (4), 797–825. doi:10.1037//0022-0663.93.4.79710.1037/0022-0663.93.4.797

Ackerman, P. L., and Heggestad, E. D. (1997). Intelligence, Personality, and Interests: Evidence for Overlapping Traits. *Psychol. Bull.* 121 (2), 219–245. doi:10.1037/0033-2909.121.2.219

Adan, A., and Almirall, H. (1991). Horne & Östberg Morningness-Eveningness Questionnaire: A Reduced Scale. *Personal. Individual Differences* 12 (3), 241–253. doi:10.1016/0191-8869(91)90110-W

Adan, A., Archer, S. N., Hidalgo, M. P., Di Milia, L., Natale, V., and Randler, C. (2012). Circadian Typology: A Comprehensive Review. *Chronobiology Int.* 29 (9), 1153–1175. doi:10.3109/07420528.2012.719971

Arbabi, T., Vollmer, C., Dörfler, T., and Randler, C. (2015). The Influence of Chronotype and Intelligence on Academic Achievement in Primary School Is Mediated by Conscientiousness, Midpoint of Sleep and Motivation. *Chronobiology Int.* 32 (3), 349–357. doi:10.3109/07420528.2014.980508

Assor, A., Vansteenkiste, M., and Kaplan, A. (2009). Identified versus Introjected Approach and Introjected Avoidance Motivations in School and in Sports: The Limited Benefits of Self-worth Strivings. *J. Educ. Psychol.* 101 (2), 482–497. doi:10.1037/a0014236

Baane, R., Houtkamp, P., and Knotter, M. (2011). Het Nieuwe Werken Ontrafeld: Over Bricks, Bytes & Behavior (New Ways of Working Unraveled: About Bricks, Bytes and Behavior). *Tijdschr. Voor HRM* 1, 7–23.

Bandura, A. (1997). *Self-efficacy: The Exercise of Control*. New York, NY: W. H. Freeman and Company.

Benet-Martínez, V., and John, O. P. (1998). Los Cinco Grandes across Cultures and Ethnic Groups: Multitrait-Multimethod Analyses of the Big Five in Spanish and English. *J. Personal. Soc. Psychol.* 75 (3), 729–750. doi:10.1037/0022-3514.75.3.729

Borkenau, P., and Ostendorf, F. (2008). *NEO-FFI: NEO-Fünf-Faktoren-Inventar nach Costa und McCrae*. 2nd ed.. Göttingen, Germany: Manual, Hogrefe.

Budde, J. (2008). Jungen, Männlichkeit und Schule [Boys, masculinity, and school]. In *Bildungsministerium für Bildung und Forschung Bildungs(miss)erfolge von Jungen und Berufswahlverhalten bei Jungen/männlichen Jugendlichen*, (pp. 39–45). Bonn, Berlin, Germany.

Cellini, N., Canale, N., Mioni, G., and Costa, S. (2020). Changes in Sleep Pattern, Sense of Time and Digital media Use during COVID-19 Lockdown in Italy. *J. Sleep Res.* 29. doi:10.1111/jsr.13074

Chamorro-Premuzic, T., and Furnham, A. (2005). Intellectual Competence. *Psychol.* 18 (6), 352–354.

Chamorro-Premuzic, T., and Furnham, A. (2006). Intellectual Competence and the Intelligent Personality: A Third Way in Differential Psychology. *Rev. Gen. Psychol.* 10 (3), 251–267. doi:10.1037/1089-2680.10.3.251

Corazzini, L., D'Arrigo, S., Millemaci, E., and Navarra, P. (2020). The Influence of Personality Traits on University Performance: Evidence from Italian Freshmen

Students. Venice, Italy: University Ca'Foscari of Venice, *Dept. Of Economics Research Paper Series No*, 19. doi:10.2139/ssrn.3764500

Costa, P. T., and McCrae, R. R. (1995). Domains and Facets: Hierarchical Personality Assessment Using the Revised NEO Personality Inventory. *J. Pers Assess.* 64, 21–50. doi:10.1207/s15327752jpa6401_2

Demerouti, E., Derks, D., Ten Brummelhuis, L. L., and Bakker, A. B. (2014). "New Ways of Working: Impact on Working Conditions, Work-Family Balance, and Well-Being," in *The Impact of ICT on Quality of Working Life*. Editors C. Karunka and P. Hoonakker (Berlin, Germany: Springer), 123–141. doi:10.1007/978-94-017-8854-0_8

Demirhan, E., Randler, C., and Horzum, M. B. (2016). Is Problematic mobile Phone Use Explained by Chronotype and Personality?. *Chronobiology Int.* 33 (7), 821–831. doi:10.3109/07420528.2016.1171232

Deniz, M. E., and Satici, S. A. (2017). The Relationships between Big Five Personality Traits and Subjective Vitality. *An Psicol-spain* 33 (2), 218–224. doi:10.6018/analesps.33.2.261911

DeYoung, C. G., Hasher, L., Djikic, M., Criger, B., and Peterson, J. B. (2007). Morning People Are Stable People: Circadian Rhythm and the Higher-Order Factors of the Big Five. *Personal. Individual Differences* 43, 267–276. doi:10.1016/j.paid.2006.11.030

Di Milia, L., Adan, A., Natale, V., and Randler, C. (2013). Reviewing the Psychometric Properties of Contemporary Circadian Typology Measures. *Chronobiology Int.* 30 (10), 1261–1271. doi:10.3109/07420528.2013.817415

Dietze, J., Gehlhaar, K.-H., and Klepel, G. (2005). "Untersuchungen zum Entwicklungsstand von Biologieinteressen bei Schülerinnen und Schülern der Sekundarstufe II [Investigations on the state of development of student interest in biology at the secondary level]," in *Lehr- und Lernforschung in der Biologiedidaktik*. Editors R. Klee, A. Sandmann, and H. Vogt (Innsbruck, Austria: Studien Verlag), 133–145.

Eccles, J. S., and Wigfield, A. (2002). Motivational Beliefs, Values, and Goals. *Annu. Rev. Psychol.* 53 (1), 109–132. doi:10.1146/annurev.psych.53.100901.135153

Fallan, L., and Opstad, L. (2016). Student Self-Efficacy and Gender-Personality Interactions. *Ijhe* 5 (3), 32–44. doi:10.5430/ijhe.v5n3p32

Fleig, D., and Randler, C. (2009). Association between Chronotype and Diet in Adolescents Based on Food Logs. *Eat. Behaviors* 10 (2), 115–118. doi:10.1016/j.eatbeh.2009.03.002

Furnham, A., Chamorro-Premuzic, T., and McDougall, F. (2003). Personality, Cognitive Ability, and Beliefs about Intelligence as Predictors of Academic Performance. *Learn. Individual Differences* 14 (1), 47–64. doi:10.1016/j.lindif.2003.08.002

Furnham, A., and Chamorro-Premuzic, T. (2004). Personality and Intelligence as Predictors of Statistics Examination Grades. *Personal. Individual Differences* 37 (5), 943–955. doi:10.1016/j.paid.2003.10.016

Gajendran, R. S., and Harrison, D. A. (2007). The Good, the Bad, and the Unknown about Telecommuting: Meta-Analysis of Psychological Mediators and Individual Consequences. *J. Appl. Psychol.* 92, 1524–1541. doi:10.1037/0021-9010.92.6.1524

Gao, C., and Scullin, M. K. (2020). Sleep Health Early in the Coronavirus Disease 2019 (COVID-19) Outbreak in the United States: Integrating Longitudinal, Cross-Sectional, and Retrospective Recall Data. *Sleep Med.* 73, 1–10. doi:10.1016/j.sleep.2020.06.032

Gariépy, G., Doré, I., Whitehead, R. D., and Elgar, F. J. (2019). More Than Just Sleeping in: A Late Timing of Sleep Is Associated with Health Problems and Unhealthy Behaviours in Adolescents. *Sleep Med.* 56, 66–72. doi:10.1016/j.sleep.2018.10.029

Goff, M., and Ackerman, P. L. (1992). Personality-intelligence Relations: Assessment of Typical Intellectual Engagement. *J. Educ. Psychol.* 84 (4), 537–552. doi:10.1037/0022-0663.84.4.537

Goldstein, D., Hahn, C. S., Hasher, L., Wiprzycka, U. J., and Zelazo, P. D. (2007). Time of Day, Intellectual Performance, and Behavioral Problems in Morning versus Evening Type Adolescents: Is There a Synchrony Effect?. *Personal. Individual Differences* 42 (3), 431–440. doi:10.1016/j.paid.2006.07.008

Großmann, N., Hofferber, N., Wilde, M., and Basten, M. (2019). Students' Flow-Experience and Quality of Motivation in Biology Lessons – Can the Gender gap Be Reduced by Teaching Behavior?. Manuscript submitted for publication in: *Motivation and Emotion*.

Guay, F., Vallerand, R. J., and Blanchard, C. (2000). On the Assessment of Situational Intrinsic and Extrinsic Motivation: The Situational Motivation Scale (SIMS). *Motiv. Emot.* 24 (3), 175–213. doi:10.1023/A:1005614228250

Halford, S. (2005). Hybrid Workspace: Re-spatialisations of Work, Organisation and Management. *New Tech. Work Empl* 20, 19–33. doi:10.1111/j.1468-005X.2005.00141.x

Heissel, A., Pietrek, A., Flunger, B., Fydrich, T., Rapp, M. A., Heinzel, S., et al. (2018). The Validation of the German Basic Psychological Need Satisfaction and Frustration Scale in the Context of Mental Health. *Eur. J. Health Psychol.* 25 (4), 119–132. doi:10.1027/2512-8442/a000017

Horne, J. A., and Östberg, O. (1976). A Self-Assessment Questionnaire to Determine Morningness-Eveningness in Human Circadian Rhythms. *Int. J. Chronobiol* 4, 97–110. doi:10.1111/j.1468-005X.2005.00141.x

Horzum, M. B., Önder, İ., and Beşoluk, Ş. (2014). Chronotype and Academic Achievement Among Online Learning Students. *Learn. Individual Differences* 30, 106–111. doi:10.1016/j.lindif.2013.10.017

Huang, C. (2013). Gender Differences in Academic Self-Efficacy: A Meta-Analysis. *Eur. J. Psychol. Educ.* 28 (1), 1–35. doi:10.1007/s10212-011-0097-y

Hutcheson, G., and Sofroniou, N. (1999). *The Multivariate Social Scientist: Introductory Statistics Using Generalized Linear Models*. Thousand Oaks: Sage Publications. doi:10.4135/9780857028075

Jerusalem, M., and Schwarzer, R. (1986). "Selbstwirksamkeit [Self-Efficacy]," in Skalen zur Befindlichkeit und Persönlichkeit *(Forschungsbericht 5*. Editor R. Schwarzer (Freie Universität, Institut für Psychologie), 15–28.

John, O. P., Naumann, L. P., and Soto, C. J. (2008). "Paradigm Shift to the Integrative Big Five Trait Taxonomy: History, Measurement, and Conceptual Issues," in *Handbook of Personality: Theory and Research*. Editors O. P. John, R. W. Robins, and L. A. Pervin (New York, NY: The Guilford Press), 114–158.

Jovanovski, D., and Bassili, J. N. (2007). The Relationship between Morningness - Eveningness Preference and Online Learning. *Biol. Rhythm Res.* 38 (5), 355–365. doi:10.1080/09291010600950149

Judge, T. A., Jackson, C. L., Shaw, J. C., Scott, B. A., and Rich, B. L. (2007). Self-efficacy and Work-Related Performance: The Integral Role of Individual Differences. *J. Appl. Psychol.* 92 (1), 107–127. doi:10.1037/0021-9010.92.1.107

Kadzikowska-Wrzosek, R. (2020). Insufficient Sleep Among Adolescents: the Role of Bedtime Procrastination, Chronotype and Autonomous vs. Controlled Motivational Regulations. *Curr. Psychol.* 39 (3), 1031–1040. doi:10.1007/s12144-018-9825-7

Kauderer, S., and Randler, C. (2013). Differences in Time Use Among Chronotypes in Adolescents. *Biol. Rhythm Res.* 44 (4), 601–608. doi:10.1080/09291016.2012.721687

Kerkhof, G. A., and Van Dongen, H. P. A. (1996). Morning-type and Evening-type Individuals Differ in the Phase Position of Their Endogenous Circadian Oscillator. *Neurosci. Lett.* 218 (3), 153–156. doi:10.1016/s0304-3940(96)13140-2

Kirmizi, O. (2015). The Interplay Among Academic Self-Concept, Self-Efficacy, Self-Regulation and Academic Achievement of Higher Education L2 Learners. *Hig* 5 (1), 32–40. doi:10.5961/jhes.2015.107

Kolomeichuk, S. N., Randler, C., Shabalina, I., Fradkova, L., and Borisenkov, M. (2016). The Influence of Chronotype on the Academic Achievement of Children and Adolescents - Evidence from Russian Karelia. *Biol. Rhythm Res.* 47 (6), 873–883. doi:10.1080/09291016.2016.1207352

Komarraju, M., Karau, S. J., and Schmeck, R. R. (2009). Role of the Big Five Personality Traits in Predicting College Students' Academic Motivation and Achievement. *Learn. Individual Differences* 19 (1), 47–52. doi:10.1016/j.lindif.2008.07.001

Leone, M. J., Sigman, M., and Golombek, D. A. (2020). Effects of Lockdown on Human Sleep and Chronotype during the COVID-19 Pandemic. *Curr. Biol.* 30 (16), R930–R931. doi:10.1016/j.cub.2020.07.015

Martela, F., DeHaan, C. R., and Ryan, R. M. (2016). "On Enhancing and Diminishing Energy through Psychological Means," in *Self-regulation and Ego Control*. Editors E. R. Hirt, J. J. Clarkson, and L. Jia (Amsterdam, Netherlands: Elsevier Academic Press), 67–85. doi:10.1016/B978-0-12-801850-7.00004-4

Mayr, J. (2014). "Der Persönlichkeitsansatz in der Forschung zum Lehrerberuf – Konzepte, Befunde und Folgerungen [The personality approach in research on the teaching profession – Concepts, findings and conclusions]," in *Handbuch der Forschung zum Lehrerberuf*. Editors E. Terhart, H. Bennewitz, and M. Rothland (Waxmann), Münster, Germany 189–215.

Moosbrugger, H., and Kelava, A. (2012). *Testtheorie und Fragebogenkonstruktion [Test theory and test instrument design]*. 2nd ed. Berlin: Springer.

Müller, F. H., Palekčić, M., Beck, M., and Wanninger, S. (2006). Personality, Motives and Learning Environment as Predictors of Self-Determined Learning Motivation. *Rev. Psychol.* 12 (2), 75–86.

Nijp, H. H., Beckers, D. G. J., van de Voorde, K., Geurts, S. A. E., and Kompier, M. A. J. (2016). Effects of New Ways of Working on Work Hours and Work Location, Health and Job-Related Outcomes. *Chronobiology Int.* 33 (6), 604–618. doi:10.3109/07420528.2016.1167731

Nijp, H. H., Beckers, D. G., Kompier, M. A., van den Bossche, S. N., and Geurts, S. A. (2015). Worktime Control Access, Need and Use in Relation to Work-home Interference, Fatigue, and Job Motivation. *Scand. J. Work Environ. Health* 41 (4), 347–355. doi:10.5271/sjweh.3504

Nishimura, T., and Suzuki, T. (2016). Basic Psychological Need Satisfaction and Frustration in Japan: Controlling for the Big Five Personality Traits. *Jpn. Psychol. Res.* 58 (4), 320–331. doi:10.1111/jpr.12131

O'Connor, M. C., and Paunonen, S. V. (2007). Big Five Personality Predictors of post-secondary Academic Performance. *Personal. Individual Differences* 43 (5), 971–990. doi:10.1016/j.paid.2007.03.017

Önder, İ., Beşoluk, Ş., İskender, M., Masal, E., and Demirhan, E. (2014). Circadian Preferences, Sleep Quality and Sleep Patterns, Personality, Academic Motivation and Academic Achievement of university Students. *Learn. Individual Differences* 32, 184–192. doi:10.1016/j.lindif.2014.02.003

Pekrun, R., Goetz, T., Titz, W., and Perry, R. P. (2002). Academic Emotions in Students' Self-Regulated Learning and Achievement: A Program of Qualitative and Quantitative Research. *Educ. Psychol.* 37 (2), 91–105. doi:10.1207/S15326985EP3702_4

Pekrun, R. (1992). Kognition und Emotion in studienbezogenen Lern-und Leistungssituationen: Explorative Analysen [Cognition and emotion in study-related learning and performance situations: Explorative analyses]. *Unterrichtswissenschaft* 20 (4), 308–324.

Poropat, A. E. (2009). A Meta-Analysis of the Five-Factor Model of Personality and Academic Performance. *Psychol. Bull.* 135 (2), 322–338. doi:10.1037/a0014996

Pritchard, R. D., and Payne, S. C. (2003). "Performance Management Practices and Motivation," in *The New Workplace: A Guide to the Human Impact of Modern Working Practices*. Editors D. Holman, T. D. Wall, C. W. Clegg, P. Sparrow, and A. Howard (Hoboken, NJ: Wiley & Sons), 219–244.

Przepiórka, A., Błachnio, A., and Siu, N. Y.-F. (2019). The Relationships between Self-Efficacy, Self-Control, Chronotype, Procrastination and Sleep Problems in Young Adults. *Chronobiology Int.* 36 (8), 1025–1035. doi:10.1080/07420528.2019.1607370

Rammstedt, B., and John, O. P. (2007). Measuring Personality in One Minute or Less: A 10-item Short Version of the Big Five Inventory in English and German. *J. Res. Personal.* 41 (1), 203–212. doi:10.1016/j.jrp.2006.02.001

Rammstedt, B., Kemper, C., Klein, M. C., Beierlein, C., and Kovaleva, A. (2013). Eine kurze Skala zur Messung der fünf Dimensionen der Persönlichkeit: big-five-inventory-10 (BFI-10). *Methoden, Daten, Analysen (mda)* 7 (2), 233–249. doi:10.12758/mda.2013.013

Randler, C., and Engelke, J. (2019). Gender Differences in Chronotype Diminish with Age: a Meta-Analysis Based on Morningness/chronotype Questionnaires. *Chronobiology Int.* 36 (7), 888–905. doi:10.1080/07420528.2019.1585867

Randler, C., and Frech, D. (2006). Correlation between Morningness - Eveningness and Final School Leaving Exams. *Biol. Rhythm Res.* 37 (3), 233–239. doi:10.1080/09291010600645780

Randler, C., Freyth-Weber, K., Rahafar, A., Florez Jurado, A., and Kriegs, J. O. (2016a). Morningness-eveningness in a Large Sample of German Adolescents and Adults. *Heliyon* 2 (11), e00200. doi:10.1016/j.heliyon.2016.e00200

Randler, C. (2013). German Version of the Reduced Morningness-Eveningness Questionnaire (rMEQ). *Biol. Rhythm Res.* 44 (5), 730–736. doi:10.1080/09291016.2012.739930

Randler, C., and Saliger, L. (2011). Relationship between Morningness-Eveningness and Temperament and Character Dimensions in Adolescents. *Personal. Individual Differences* 50, 148–152. doi:10.1016/j.paid.2010.09.016

Randler, C., and Schaal, S. (2010). Morningness-eveningness, Habitual Sleep-Wake Variables and Cortisol Level. *Biol. Psychol.* 85 (1), 14–18. doi:10.1016/j.biopsycho.2010.04.006

Randler, C., Wolfgang, L., Matt, K., Demirhan, E., Horzum, M. B., and Beşoluk, Ş. (2016b). Smartphone Addiction Proneness in Relation to Sleep and Morningness-Eveningness in German Adolescents. *J. Behav. Addict.* 5 (3), 465–473. doi:10.1556/2006.5.2016.056

Reeve, J. (2002). "Self-determination Theory Applied to Educational Settings," in *Handbook of Self-Determination Research*. Editors E. L. Deci and R. M. Ryan (Rochester, NY: University of Rochester Press), 183–203.

Renaud-Dubé, A., Taylor, G., Lekes, N., Koestner, R., and Guay, F. (2010). Adolescents' Motivation toward the Environment: Age-Related Trends and Correlates. *Can. J. Behav. Sci./Revue canadienne des Sci. du comportement* 42 (3), 194–199. doi:10.1037/a0018596

Richardson, M., Abraham, C., and Bond, R. (2012). Psychological Correlates of university Students' Academic Performance: A Systematic Review and Meta-Analysis. *Psychol. Bull.* 138 (2), 353–387. doi:10.1037/a0026838

Roberts, R. E., Roberts, C. R., and Duong, H. T. (2009). Sleepless in Adolescence: Prospective Data on Sleep Deprivation, Health and Functioning. *J. Adolescence* 32 (5), 1045–1057. doi:10.1016/j.adolescence.2009.03.007

Roenneberg, T., Wirz-Justice, A., and Merrow, M. (2003). Life between Clocks: Daily Temporal Patterns of Human Chronotypes. *J. Biol. Rhythms* 18 (1), 80–90. doi:10.1177/0748730402239679

Rothstein, M. G., Paunonen, S. V., Rush, J. C., and King, G. A. (1994). Personality and Cognitive Ability Predictors of Performance in Graduate Business School. *J. Educ. Psychol.* 86 (4), 516–530. doi:10.1037/0022-0663.86.4.516

Ryan, R. M., Bernstein, J. H., and Brown, K. W. (2010). Weekends, Work, and Well-Being: Psychological Need Satisfactions and Day of the Week Effects on Mood, Vitality, and Physical Symptoms. *J. Soc. Clin. Psychol.* 29 (1), 95–122. doi:10.1521/jscp.2010.29.1.95

Ryan, R. M., and Connell, J. P. (1989). Perceived Locus of Causality and Internalization: Examining Reasons for Acting in Two Domains. *J. Personal. Soc. Psychol.* 57 (5), 749–761. doi:10.1037/0022-3514.57.5.749

Ryan, R. M., and Deci, E. L. (2002). "Overview of Self-Determination Theory. An Organismic Dialectical Perspective," in *Handbook of Self-Determination Research*. Editors E. L. Deci and R. M. Ryan (Rochester, NY: University Of Rochester Press), 3–33.

Ryan, R. M., and Deci, E. L. (2017). *Self-determination Theory – Basic Psychological Needs in Motivation, Development, and Wellness*. New York, NY: The Guilford Press.

Ryan, R. M., and Frederick, C. (1997). On Energy, Personality, and Health: Subjective Vitality as a Dynamic Reflection of Well-Being. *J. Personal.* 65 (3), 529–565. doi:10.1111/j.1467-6494.1997.tb00326.x

Ryan, R. M., Rigby, C. S., and Przybylski, A. (2006). The Motivational Pull of Video Games: A Self-Determination Theory Approach. *Motiv. Emot.* 30 (4), 344–360. doi:10.1007/s11031-006-9051-8

Şahin, F., and Çetin, F. (2017). The Mediating Role of General Self-Efficacy in the Relationship between the Big Five Personality Traits and Perceived Stress: A Weekly Assessment Study. *Psychol. Stud.* 62 (1), 35–46. doi:10.1007/s12646-016-0382-6

Shimura, A., Hideo, S., Takaesu, Y., Nomura, R., Komada, Y., and Inoue, T. (2018). Comprehensive Assessment of the Impact of Life Habits on Sleep Disturbance, Chronotype, and Daytime Sleepiness Among High-School Students. *Sleep Med.* 44, 12–18. doi:10.1016/j.sleep.2017.10.011

Sinha, M., Pande, B., and Sinha, R. (2020). Impact of COVID-19 Lockdown on Sleep-Wake Schedule and Associated Lifestyle Related Behavior: A National Survey. *J. Public Health Res.* 9 (3). doi:10.4081/jphr.2020.1826

Staller, N., and Randler, C. (2020). Changes in Sleep Schedule and Chronotype Due to CoVID-19 Restrictions and home Office. *Somnologie* 25, 131–137. doi:10.1007/s11818-020-00277-2

Stevens, J. P. (2002). *Applied Multivariate Statistics for the Social Sciences*. 4th ed. Hillsdale: Erlbaum.

Tavernier, R., Hill, G. C., and Adrien, T. V. (2019). Be Well, Sleep Well: An Examination of Directionality between Basic Psychological Needs and Subjective Sleep Among Emerging Adults at university. *Sleep health* 5 (3), 288–297. doi:10.1016/j.sleh.2019.02.007

Ten Brummelhuis, L. L., Bakker, A. B., Hetland, J., and Keulemans, L. (2012). Do new Ways of Working foster Work Engagement?. *Psicothema* 24, 113–120.

Thomas, A. E., Müller, F. H., and Bieg, S. (2018). Entwicklung und Validierung der Skalen zur motivationalen Regulation beim Lernen im Studium (SMR-LS). *Diagnostica* 64 (3), 145–155. doi:10.1026/0012-1924/a000201

Thun, E., Bjorvatn, B., Osland, T., Martin Steen, V., Sivertsen, B., Johansen, T., et al. (2012). An Actigraphic Validation Study of Seven Morningness-Eveningness Inventories. *Eur. Psychol.* 17 (3), 222–230. doi:10.1027/1016-9040/a000097

Tonetti, L., Fabbri, M., and Natale, V. (2009). Relationship between Circadian Typology and Big Five Personality Domains. *Chronobiology Int.* 26, 337–347. doi:10.1080/07420520902750995

Tonetti, L., Natale, V., and Randler, C. (2015). Association between Circadian Preference and Academic Achievement: A Systematic Review and Meta-Analysis. *Chronobiology Int.* 32 (6), 792–801. doi:10.3109/07420528.2015.1049271

Valentine, J. C., Dubois, D. L., and Cooper, H. (2004). The Relation between Self-Beliefs and Academic Achievement: A Meta-Analytic Review. *Educ. Psychol.* 39, 111–133. doi:10.1207/s15326985ep3902_3

Vallerand, R. J., and Ratelle, C. F. (2002). "Intrinsic and Extrinsic Motivation. A Hierarchical Model," in *Handbook of Self-Determination Research.* Editors E. L. Deci and R. M. Ryan (Rochester, NY: University of Rochester Press), 37–63.

Vansteenkiste, M., Ryan, R. M., and Soenens, B. (2020). Basic Psychological Need Theory: Advancements, Critical Themes, and Future Directions. *Motiv. Emot.* 44 (1), 1–31. doi:10.1007/s11031-019-09818-1

Wittmann, M., Dinich, J., Merrow, M., and Roenneberg, T. (2006). Social Jetlag: Misalignment of Biological and Social Time. *Chronobiology Int.* 23 (1-2), 497–509. doi:10.1080/07420520500545979

Zajacova, A., Lynch, S. M., and Espenshade, T. J. (2005). Self-efficacy, Stress, and Academic success in College. *Res. High Educ.* 46, 677–706. doi:10.1007/s11162-004-4139-z

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Increases in Anxiety and Depression During COVID-19: A Large Longitudinal Study From China

Shizhen Wu[1], Keshun Zhang[2], Elizabeth J. Parks-Stamm[3], Zhonghui Hu[2], Yaqi Ji[4] and Xinxin Cui[2]*

[1] Student Counselling and Mental Health Center, Qingdao University, Qingdao, China, [2] Department of Psychology, Normal College, Qingdao University, Qingdao, China, [3] Department of Psychology, University of Southern Maine, Portland, ME, United States, [4] Department of Psychology, School of Social Science, The University of Manchester, Manchester, United Kingdom

Although accumulating evidence suggests the COVID-19 pandemic is associated with costs in mental health, the development of students' mental health, including the change from their previous levels of depression and anxiety and the factors associated with this change, has not been well-studied. The present study investigates changes in students' anxiety and depression from before the pandemic to during the lockdown and identifies factors that are associated with these changes. 14,769 university students participated in a longitudinal study with two time points with a 6-month interval. Students completed the Anxiety and Depression subscales of the Symptom Checklist 90 (SCL-90) before the COVID-19 outbreak (October 2020, Time 1), and the Self-rating Anxiety Scale (SAS) and Self-rating Depression Scale (SDS) during the pandemic (April 2020, Time 2). The prevalence of anxiety and depression symptoms were 1.44 and 1.46% at Time 1, and 4.06 and 22.09% at Time 2, respectively, showing a 181.94% increase in anxiety and a 1413.01% increase in depression. Furthermore, the increases in anxiety and depression from pre-pandemic levels were associated with students' gender and the severity of the pandemic in the province where they resided. This study contributes to the gap in knowledge regarding changes in students' mental health in response to the pandemic and the role of local factors in these changes. Implications for gender and the Typhoon Eye effect are discussed.

Keywords: COVID-19, anxiety, depression, university students, longitudinal study

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***Correspondence:**
Keshun Zhang
keshun.zhang@qdu.edu.cn

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INTRODUCTION

The COVID-19 global pandemic caused a large number of infections and deaths (Cucinotta and Vanelli, 2020). To contain the virus, China initiated a series of emergency management steps at the beginning of March 2020, including shutting down schools and initiating online learning for close to 30 million university students across the country (i.e., Suspending Classes without Stopping Learning, http://www.moe.gov.cn/). Researchers around the world have called for researchers to examine the impact of the pandemic and school closures on students' anxiety, depression, and other outcomes (Holmes et al., 2020). Research suggests that the combined psychological pressure caused by the pandemic and the quarantine heightened anxiety and depression, particularly among university students (e.g., Brooks et al., 2020; Peng et al., 2020; Zhang et al., 2021).

Research around the world has reported high prevalence rates of anxiety and depression symptoms during the COVID-19 outbreak (Ahmed et al., 2020; Peng et al., 2020; Xiong et al., 2020). In a survey conducted from January 31 to February 3, 2020, nearly 30% of university students reported anxiety symptoms and more than 20% reported depression symptoms (Chang et al., 2020). A systematic review and meta-analysis conducted by Salari et al. (2020) estimated that the worldwide prevalence of anxiety and depression in the general population after the outbreak of COVID-19 was 31.9 and 33.7%, respectively. The costs of this heightened anxiety and depression for students are manifold, including impacts on students' thinking, motivation, interpersonal communication, and physical health; and could lead to sleep disturbances, loss of appetite, and even self-harm (e.g., Ystgaard et al., 1999; Gotlib and Hammen, 2008; Felger et al., 2015; Oxford, 2015).

Research conducted early in the pandemic suggested that individuals' level of anxiety and depression may be related to the province where they lived, and especially to the number of confirmed cases in the city (e.g., Ho et al., 2020; Xiong et al., 2020; Zhao et al., 2020). Past theorizing on the psychological effects of proximity to disaster offers predictions about how individuals' residence should impact their psychological well-being. Based on the impact of the Wenchuan earthquake on individuals' concerns about safety and health, Li et al. (2009, 2010) coined the term "Psychological Typhoon Eye" effect. This term refers to a pattern—like being in the eye of a storm—in which individuals who are closest to the center of the devastated area paradoxically show the least damaging psychological effects (Li et al., 2009, 2010). This pattern of results has been observed in negative correlations between schoolchildren's proximity to Ground Zero following the 9–11 attacks and their psychological well-being (Hoven et al., 2005) and between the level of exposure to SARS and anxiety (Xie et al., 2011). Zhang et al. (2020) found support for the Typhoon Eye effect in individuals' psychological responses to the COVID-19 pandemic, showing a negative correlation between the exposure level in 31 provinces in China and reported cases of mental health problems. However, others have found contradictory results. Zhao et al. (2020) reported that people who lived in high epidemic areas (provinces with more than 800 confirmed cases before Feb. 6, 2020) showed *greater* increases in anxiety from a baseline measure than those in low epidemic areas (i.e., other provinces in mainland China). Thus, in the present study we enter this debate by examining the relationship between the severity of the epidemic in the provinces where university students live (while completing classes remotely) and their anxiety and depression, controlling for their pre-pandemic levels.

A second factor that may influence anxiety and depression during the COVID-19 pandemic is gender (Ben-Ezra et al., 2020; Duan et al., 2020; Tang et al., 2020). Previous studies have found significant gender differences in anxiety and depression levels during the pandemic (Elbay et al., 2020; Mazza et al., 2020). A systematic review and meta-analysis found women suffered more severe anxiety and depression symptoms than men during the COVID-19 epidemic (Salari et al., 2020). Zhu et al. (2020), on the other hand, reported that males were more likely to experience depression in response to the pandemic. Other studies have found no significant differences in anxiety and depression levels between men and women (Chi et al., 2020; Van Rheenen et al., 2020). Therefore, this study will test how gender influences the development of anxiety and depression among college students in response to the COVID-19 epidemic, from before the start of the pandemic to during the lockdown. We further explore demographic factors previously known to be risk factors for anxiety and depression among college students, including economic status and medical conditions (e.g., Eisenberg et al., 2007; Xiong et al., 2020; Xu et al., 2020; Zhao et al., 2020).

In sum, our study has two aims. Using a longitudinal design, we first estimate the changes in anxiety and depression experienced by students from before the pandemic to during lockdown. Second, we examine whether the level of epidemic severity in students' geographic location, along with demographic variables like gender, economic status, and medical status, impact the change observed in anxiety and depression during the pandemic, as a test of the Typhoon Eye effect.

METHOD

Ethical Statement

This study complied with the ethical standards of the Declaration of Helsinki. All procedures were approved by our university's Research Ethics Committee. All participants willingly gave their informed consent to participate after being informed about the purpose of the study. All analyses were based on anonymous data.

Participants and Design

Longitudinal data were collected via a Chinese online research panel, Wenjuanxing (https://www.wjx.cn/). Twenty-four thousand six hundred ninety-six university students participated in Time 1 (T1) assessment, and 14,769 of these participants took part in the Time 2 (T2) assessment (8,060 female, 6,709 male), with a 40.14% attrition rate. Anxiety and depression did not differ between those who completed the second assessment and those who did not. The age of participants ranged from 17 to 34 years ($M = 20.76$, $SD = 1.97$).

T1 took place in October 2019 (before the COVID-19 outbreak) and T2 took place in April 2020 (when students were completing remote learning from home due to the pandemic). Both T1 and T2 focused on students' anxiety and depression. Different instruments for anxiety and depression were used at the two time points.

Measures

Anxiety and Depression of Symptom Checklist 90 (SCL-90)

We applied the subscale of the SCL-90 (Derogatis et al., 1973; Wang, 1984) to assess anxiety and depression in T1, which contains 10 items and 13 items, respectively. The items were rated along a 5-point response scale with 1-5 representing the severity as follows: "1 = no", "2 = light", "3 = moderate," "4 = quite heavy," and "5 = severe." A standardized scoring algorithm is used to define anxiety symptoms, with a total score range of 10–50. Individuals were categorized as experiencing anxiety symptoms if the anxiety subscale score was >20. A standardized

scoring algorithm was similarly used to define depression symptoms, with a total score range of 13–65. Individuals were categorized as experiencing depression symptoms if the depression subscale score was >26. The anxiety and depression subscales were internally consistent (Cronbach's $\alpha_{t1} = 0.85$ and 0.89, respectively).

Zung Self-Rating Anxiety Scale

Anxiety at T2 was measured by the Chinese version of the SAS (Zung, 1971; Wu, 1999). The scale covers both psychological (e.g., "I feel afraid for no reason at all") and somatic (e.g., "My arms and legs shake and tremble") aspects of participants' anxiety symptoms. The items were rated along a 4-point response scale ranging from 1 (a little of the time) to 4 (most of the time). A standardized scoring algorithm is used to define anxiety symptoms, with a total score range of 25–100. Individuals were categorized as experiencing anxiety symptoms if the SAS score was greater than or equal to 50. The scale was internally consistent (Cronbach's $\alpha = 0.77$).

Zung Self-Rating Depression Scale

Depression at T2 was measured by the Chinese version of SDS (Zung, 1965; Shu, 1999). It contains 20 items (e.g., "I have trouble sleeping at night," "I get tired for no reason") based on the diagnostic criteria of depression. Participants responded using a 4-point Likert scale ranging from 1 (a little of the time) to 4 (most of the time). A standardized scoring algorithm was used to define depression symptoms, with a total score range of 25–100. Individuals were categorized as experiencing depression symptoms if the SDS score was greater than or equal to 50. The scale was internally consistent (Cronbach's $\alpha = 0.86$).

Epidemic Area

The epidemic area was defined as the cumulative number of confirmed cases in the province through the end of April 2020. Areas with 1–99 confirmed cases were labeled low (Level 1), areas with 100–999 confirmed cases were labeled middle (Level 2), and areas with more than 1,000 confirmed cases were labeled high epidemic areas (Level 3).

Demographics

Demographics included general demographic variables and economic status. The general demographic variables included gender and age. The economic status-related variables included per capita disposable income, per capita consumption expenditure, and the general public healthcare budget of each province. The data used was retrieved from the 2019 China Statistical Yearbook, which was published by China Statistics Press (http://www.stats.gov.cn/tjsj/ndsj/2019/indexch.htm).

Data Analysis

The statistical analyses were performed using SPSS Version 25.0 and Python. The stats. ks_2samp method was used to test the distribution of variables (Hodges, 1958; The Scipy Community, 2020). The 95% bias-corrected confidence interval (95% CI) was set, and the statistical significance level was set at $p < 0.05$. Latent profile analyses (LPA) were conducted in R (version 4.10.1) using the package tidyLPA, dplyr, and tidyverse to classify anxiety and depression in T1 and T2. Akaike information criterion (AIC), Bayesian information criterion (BIC), and entropy (range from 0 to 1) were applied as criteria (Schwarz, 1978; Akaike, 1987). Lower AIC and BIC values indicate better model fit, while higher entropy values indicate greater certainty.

TABLE 1 | The proportion of different levels of anxiety and depression.

	T1				T2			
	M	***SD***	**n**	**%**	***M***	***SD***	**n**	**%**
No anxiety	13.60	3.91	14,556	98.56	35.10	6.21	14,170	95.94
Anxiety	33.69	4.10	212	1.44	57.06	5.95	599	4.06
No depression	17.59	5.42	14,553	98.54	37.84	6.47	11,507	77.91
Depression	44.35	5.53	216	1.46	58.91	5.33	3,262	22.09

TABLE 2 | Summary of AIC, BIC, and Entropy values for latent profile models.

Variable	Number of profiles	AIC	BIC	Entropy
T1 anxiety	1	41915.61	41930.81	1.00
	2	36883.89	36914.29	0.94
	3	36887.89	36933.50	0.42
T2 anxiety	1	41915.61	41930.81	1.00
	2	40537.86	40568.26	0.92
	3	40541.82	40587.42	0.36
T1 depression	1	41915.61	41930.81	1.00
	2	36746.11	36776.51	0.92
	3	36750.13	36795.74	0.42
T2 depression	1	41915.61	41930.81	1.00
	2	39663.58	39693.98	0.79
	3	39226.52	39272.12	0.71

AIC, Akaike's information criterion; BIC, Bayesian information criterion; Entropy values range from 0 to 1.

RESULTS

Common Method Biases

All the participant variables involved in this study were collected by online questionnaire, and a Harman single-factor test was used to diagnose the common method bias (Podsakoff et al., 2003). The results of principal component factor analysis without rotation showed that there were 22 factors whose eigenvalues were >1. The variance explained by the first factor was 20.15%, which falls below the threshold of 40%. This result indicates that there is no serious common method bias in this study.

Descriptive Statistics and Correlations

The descriptive results for anxiety and depression are shown in **Table 1**. The prevalence rate of anxiety and depression symptoms were 1.44 and 1.46% at T1, and 4.06 and 22.09% at T2, respectively, which represented a 181.94% increase in anxiety and a 1413.01% increase in depression.

A latent profile analysis (LPA) was conducted to explore anxiety and depression as categorical variables. The LPA results indicated that two profiles of anxiety and depression can be best

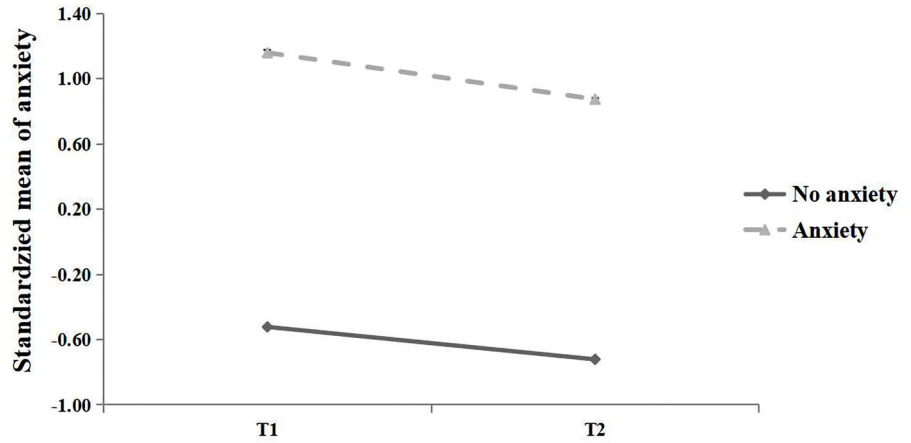

FIGURE 1 | Standardized mean of anxiety for two latent profiles at T1 and T2.

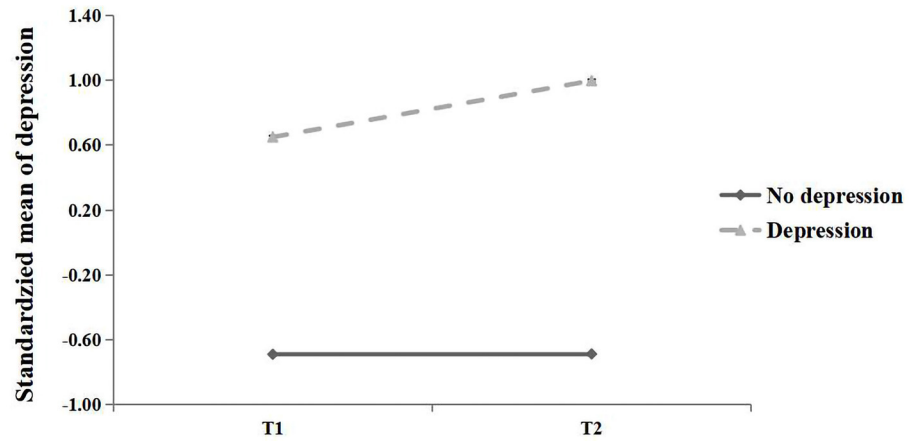

FIGURE 2 | Standardized mean of depression for two latent profiles at T1 and T2.

distinguished with best class model fittings (**Table 2**). **Figure 1** presents the standardized mean of anxiety of two profiles at T1 and T2. Profile 1 was characterized by significantly lower mean cores than Profile 2 at both time points, and were thus labeled *no anxiety* and *anxiety,* respectively. **Figure 2** presents the standardized mean of depression of two profiles at T1 and T2. Profile 1 was characterized by significantly lower mean cores than Profile 2 at both time points, and were thus labeled *no depression* and *depression,* respectively.

Pearson correlations between variables are displayed in **Table 3**. Anxiety and depression were correlated with each other at T1 ($r = 0.83, p < 0.01$) and at T2 ($r = 0.73, p < 0.01$). Per capita disposable income and per capita consumption expenditure were negatively correlated with anxiety and depression at T1 and T2 ($rs = -0.08 \sim -0.04$, $ps < 0.01$). General public healthcare budget was negatively correlated with T2 anxiety ($r = -0.02$, $p < 0.01$). Men reported lower levels of depression than women at T1 ($t = 3.23, p < 0.01$) and higher levels of anxiety than women at T2 ($t = -4.97, p < 0.001$).

Anxiety

All continuous variables were standardized in the repeated analysis. The results indicated that students reported higher levels of anxiety at T2 than T1 ($\beta = 0.080$, $F = 5.95$, $p < 0.05$, 95% CI [0.016, 0.144]), with significantly different distributions of anxiety (Kolmogorov-Smirnov test; $Z = 0.198$, $p < 0.001$).

The effect of time on anxiety was significantly moderated by epidemic area level ($F = 3.67$, $p < 0.05$; **Figure 3**). In line with the Typhoon Eye effect, the mean increase in anxiety from T1 to T2 was significantly lower in the areas with the highest severity level ($MD_{(T2-T1)} = 0.004$, $p = 0.682$, 95% CI [−0.017, 0.025]) than the increase among those in the lowest severity areas ($MD_{(T2-T1)} = 0.229$, $p < 0.01$, 95% CI [0.060, 0.398]), qualified by significantly different distribution at T2 (Kolmogorov-Smirnov test; $Z = 0.15$, $p < 0.001$; **Figure 4**), and not significantly different from areas with a moderate severity level ($MD_{(T2-T1)} = 0.016$, $p = 0.730$, 95% CI [−0.074, 0.106]).

The effect of gender on anxiety was significantly moderated by time ($F = 30.35$, $p < 0.001$; **Figure 5**). At T1, no gender

TABLE 3 | Correlation between variables of this study ($N = 14769$).

	M	*SD*	1	2	3	4	5	6	7	8
T1 anxiety	13.89	4.59	–							
T1 depression	17.98	6.30	0.83**	–						
T2 anxiety	35.99	7.56	0.21**	0.24**	–					
T2 depression	42.50	10.73	0.19**	0.24**	0.74**	–				
Gender	–	–	−0.02	−0.03**	0.04**	0.01	–			
Per capita disposable income	28512.20	4369.83	−0.05**	−0.05**	−0.04**	−0.04**	0.07**	–		
Per capita consumption expenditure	37488.64	10924.20	−0.06**	−0.07**	−0.06**	−0.08**	0.06**	0.36**	–	
General public budget of health care	490.63	158.69	−0.01	−0.10	−0.02*	−0.02	0.03**	0.47**	−0.01	–

*$p < 0.05$, **$p < 0.01$. T1 anxiety range from 10 to 50. T1 depression range from 13 to 65. T2 anxiety range from 25 to 90. T2 depression range from 25 to 100. Per capita disposable income ranges from 17286.1 to 64182.6. Per capita consumption expenditure ranges from 11520.2 to 43351.3. General public budget of health care ranges from 105.55 to 1407.51. The unit of per capita disposable income and per capita consumption expenditure is yuan. The unit of general public budget of health care is thousand yuan.*

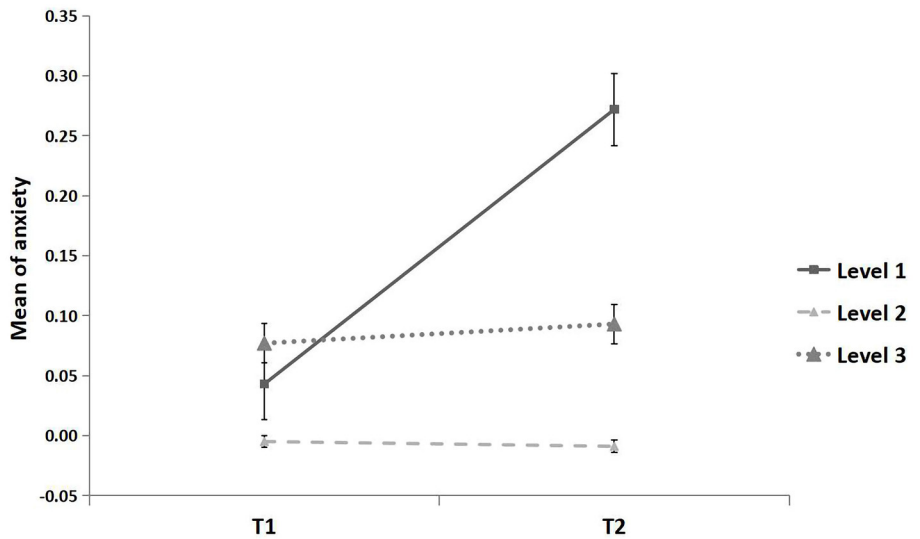

FIGURE 3 | Mean of anxiety for three epidemic areas. All continuous variables were standardized. The epidemic area was defined as the cumulative number of confirmed cases in each province until the end of April 2020, i.e., low epidemic area (level 1): 1–99 cases, middle epidemic area (level 2): 100–999 cases, high epidemic area (level 3): ≥1,000 cases. Error bar is the standard error.

differences in anxiety were found ($t = 1.85$, $p = 0.06$). At T2, males reported significantly higher anxiety than females ($\beta = 0.082$, $p < 0.001$, 95% CI [0.050, 0.114]).

We used logistic regression to assess the effects of T1 anxiety, T1 depression, epidemic level of the area, economic-related variables, and gender on T2 anxiety (**Table 4**). T1 anxiety (profile 1: no anxiety = 0; profile 2: anxiety = 1), T1 depression (profile 1: no depression = 0; profile 2: depression = 1), T2 anxiety (profile 1: no anxiety = 0; profile 2: anxiety = 1), the gender (male = 1, female = 0), and epidemic area (comparing Level 1 vs. Level 3 [Level 1_3]: Level 1 = 1, level 3 = 0; comparing Level 2 vs. Level 3 [Level 2_3]: Level 2 = 1, Level 3 = 0) were dummy coded. The regression model was significant, [$F_{(8,14760)} = 55.73$, $p < 0.001$, $R^2 = 0.029$]. The regression coefficients of T1 anxiety ($\beta = 0.083$, $t = 7.94$, $p < 0.001$), T1 depression ($\beta = 0.096$, $t = 0.93$, $p < 0.001$), gender ($\beta = 0.044$, $t = 5.39$, $p < 0.001$), per capita consumption ($\beta = -0.022$, $t = -4.20$, $p < 0.001$) and Level 1 vs. 3 ($\beta = 0.081$, $t = 2.04$, $p < 0.05$) were significant.

Depression

All continuous variables were standardized in the repeated analysis. The results showed that students were more depressed at T2 than T1 ($\beta = 0.075$, $F = 5.35$, $p < 0.05$, 95% CI [0.11, 0.138]), with significantly different distributions of depression (Kolmogorov-Smirnov test; $Z = 0.265$, $p < 0.001$).

The effect of time on depression was significantly moderated by the area epidemic level ($F = 2.98$, $p = 0.05$; see **Figure 6**). Again, in line with the Typhoon Eye effect, the mean increase in depression from T1 to T2 was significantly lower in the areas with the highest severity level ($MD_{(T2-T1)} = 0.051$, $p = 0.264$, 95% CI [−0.038, 0.139]) than the increase in the lowest severity level ($MD_{(T2-T1)} = 0.179$, $p < 0.05$, 95% CI [0.012, 0.345]), although this was not significant in term of distribution

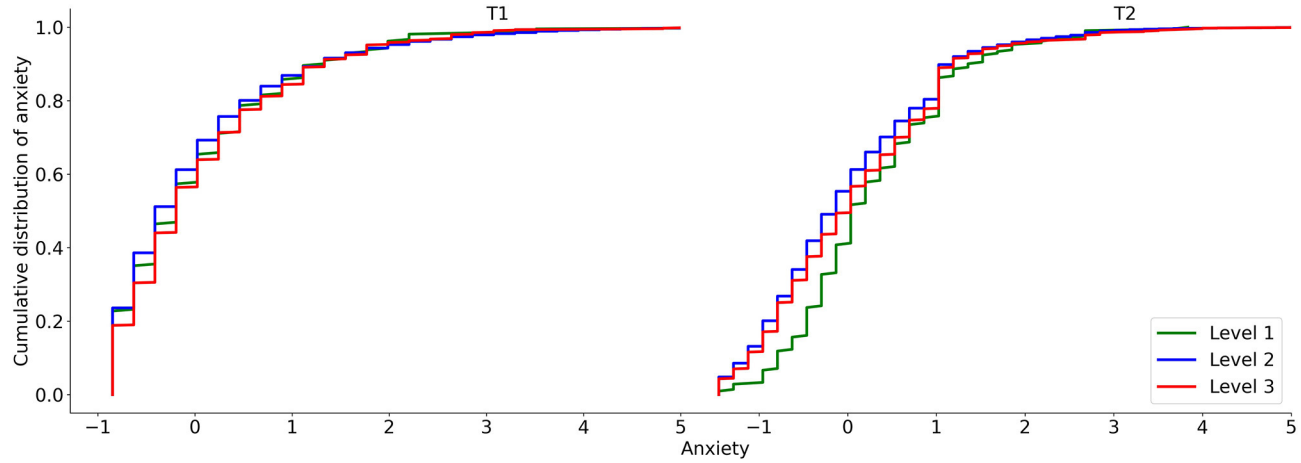

FIGURE 4 | The cumulative distribution of anxiety for the three epidemic areas.

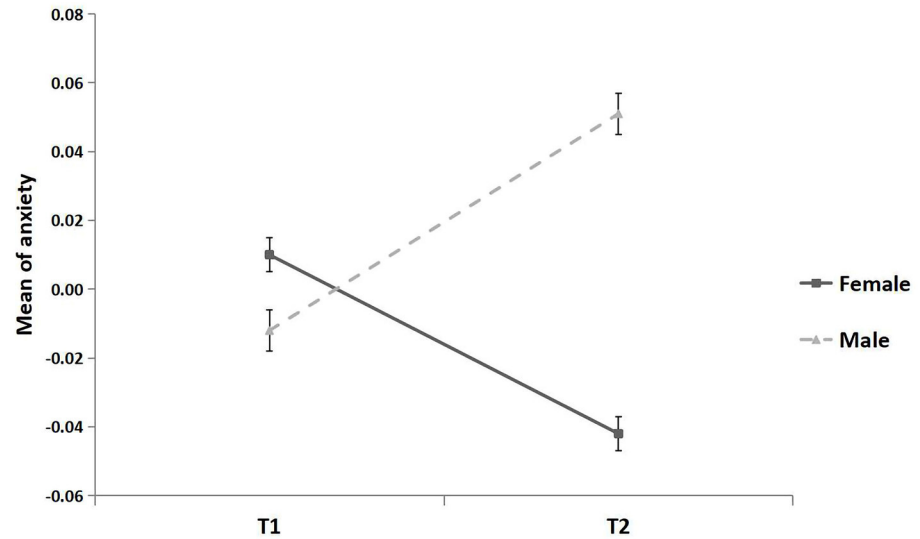

FIGURE 5 | Mean of anxiety for females and males. All continuous variables were standardized. Error bar is the standard error.

TABLE 4 | The regression model of T2 anxiety.

	B	*SE*	*t*	*p*	95% CI
Constant	0.362	0.022	16.517	<0.001	[0.319, 0.405]
T1 depression	0.096	0.010	9.928	<0.001	[0.077, 0.115]
T1 anxiety	0.083	0.010	7.941	<0.001	[0.063, 0.104]
Level 1_3	0.081	0.040	2.039	<0.05	[0.003, 0.158]
Level 2_3	−0.008	0.022	−0.351	0.726	[−0.050, 0.035]
Gender	0.044	0.008	5.385	<0.001	[0.028, 0.060]
Per capita disposable income	0.002	0.005	0.358	0.720	[−0.009, 0.012]
Per capita consumption expenditure	−0.022	0.005	−4.203	<0.001	[−0.033, −0.012]
General public healthcare budget	−0.010	0.005	−2.041	0.041	[−0.019, 0.000]

All continuous variables were standardized; T1 anxiety: no anxiety = 0, anxiety = 1, T1 depression: no depression = 0, depression = 1, T2 anxiety: no anxiety = 0, anxiety = 1; Level 1_3: Level 1 = 1, level 3 = 0; Level 2_3: Level 2 = 1, Level 3 = 0.

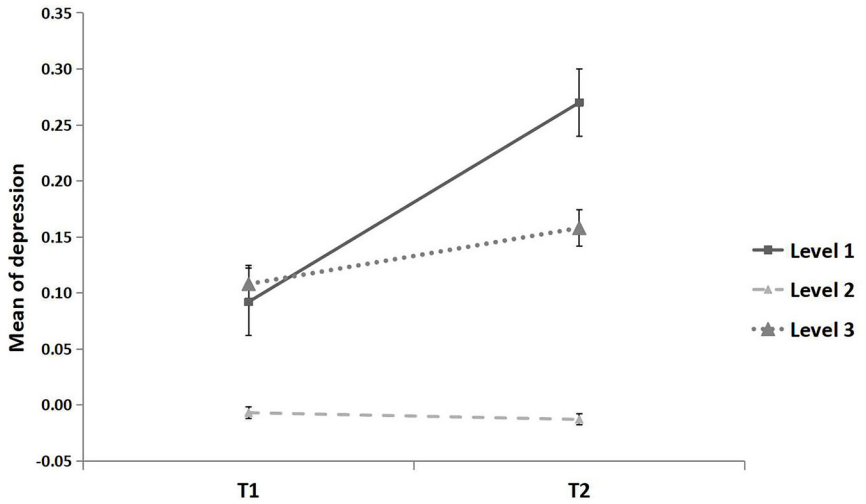

FIGURE 6 | Mean of depression for three epidemic areas. All continuous variables were standardized. The epidemic area was defined as the cumulative number of confirmed cases in each province until the end of April 2020, i.e., low epidemic area (level 1): 1–99 cases, middle epidemic area (level 2): 100–999 cases, high epidemic area (level 3): ≥1,000 cases. Error bar is the standard error.

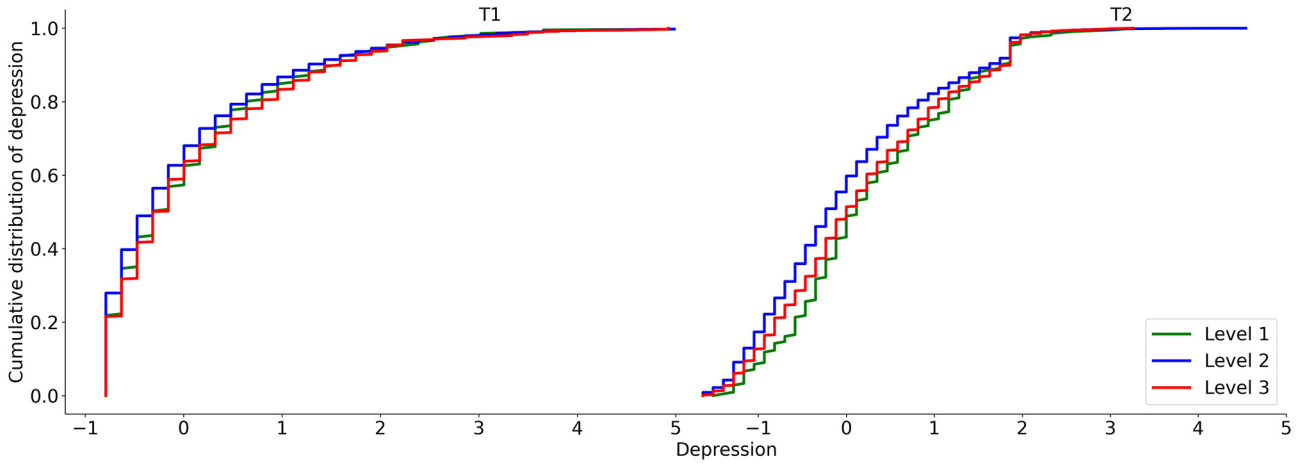

FIGURE 7 | The cumulative distribution of depression for the three epidemic areas.

(Kolmogorov-Smirnov test; $Z = 0.08$, $p = 0.20$; **Figure 7**), and was not significantly different from areas with a moderate severity level ($MD_{(T2-T1)} = -0.005$, $p = 0.603$, 95% CI [−0.026, 0.015]).

The effect of gender on depression was significantly moderated by time ($F = 10.52$, $p < 0.001$; see **Figure 8**). At T1, females reported higher levels of depression than males ($\beta = 0.054$, $p < 0.005$, 95% CI [0.021, 0.086]). At T2, the mean levels of depression did not differ between male and female ($t = -0.64$, $p = 0.52$).

We used logistic regression to assess the effects of T1 anxiety, T1 depression, epidemic level of the area, economic-related variables, and gender on T2 depression (**Table 5**). T1 anxiety (profile 1: no anxiety = 0; profile 2: anxiety = 1), T1 depression (profile 1: no depression = 0; type 2: depression = 1), T2 depression (profile 1: no depression = 0; profile 2: depression = 1), the gender (male = 1, female = 0), and epidemic area (comparing Level 1 vs. Level 3 [Level 1_3]: Level 1 = 1, level 3 = 0; comparing Level 2 vs. Level 3 [Level 2_3]: Level 2 = 1, Level 3 = 0) were dummy coded. The regression was significant, [$F_{(8,14760)} = 66.48$, $p < 0.001$, $R^2 = 0.035$]. As shown in **Table 4**, the regression coefficients of T1 depression ($\beta = 0.126$, $t = 13.15$, $p < 0.001$), T1 anxiety ($\beta = 0.068$, $t = 6.64$, $p < 0.001$) and per capita consumption ($\beta = -0.026$, $t = -5.02$, $p < 0.001$) were significant.

DISCUSSION

Through measures of anxiety and depression both before and after the pandemic outbreak, we found that the prevalence of university students with anxiety and depression symptoms

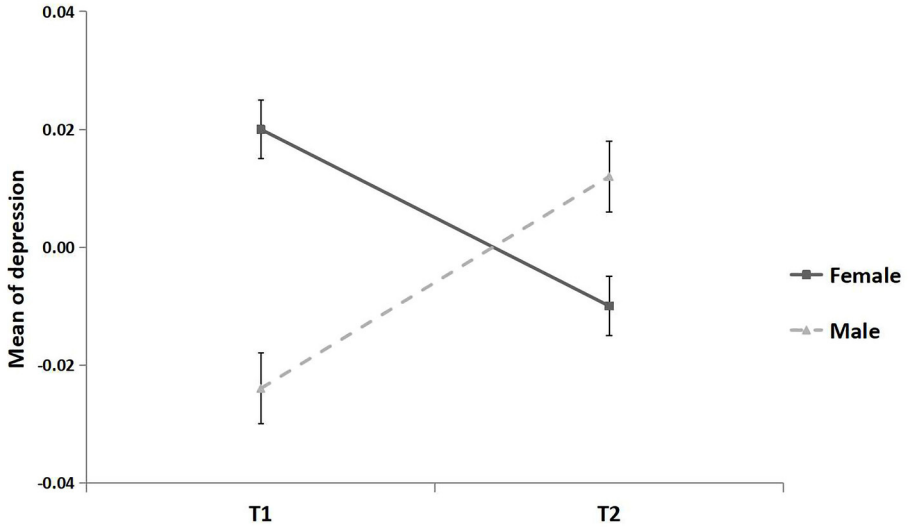

FIGURE 8 | Mean of depression for females and males. All continuous variables were standardized. Error bar is the standard error.

TABLE 5 | The regression model of T2 depression.

	B	*SE*	*t*	*p*	95% CI
Constant	0.337	0.022	15.618	<0.001	[0.295, 0.380]
T1 depression	0.126	0.010	13.148	<0.001	[0.107, 0.144]
T1 anxiety	0.068	0.010	6.636	<0.001	[0.048, 0.089]
Level 1_3	0.018	0.039	0.472	0.637	[−0.058, 0.095]
Level 2_3	−0.022	0.021	−1.029	0.303	[−0.064, 0.020]
Gender	0.011	0.008	1.377	0.169	[−0.005, 0.027]
Per capita disposable income	0.000	0.005	0.058	0.954	[−0.010, 0.011]
Per capita consumption expenditure	−0.026	0.005	−5.018	<0.001	[−0.036, −0.016]
General public healthcare budget	−0.003	0.005	−0.640	0.522	[−0.012, 0.006]

All continuous variables were standardized; T1 anxiety: no anxiety = 0, anxiety = 1, T1 depression: no depression = 0, depression = 1, T2 depression: no depression = 0, depression = 1; Level 1_3: Level 1 = 1, level 3 = 0; Level 2_3: Level 2 = 1, Level 3 = 0.

above the standardized threshold increased 2.62 and 20.63%, respectively, to 4.06 and 22.09%. Furthermore, the increases in anxiety and depression were significantly moderated by both the severity level of the COVID-19 pandemic of the province where they lived and with their gender. In line with the Typhoon Eye effect, students living in areas with the least cases reported the greatest increase in anxiety and depression. In a second major finding, men's anxiety and depression increased more than women's during the lockdown.

The significant increase in the prevalence of both anxiety and depression symptoms were consistent with our expectations regarding the impact of the COVID-19 outbreak on university students' mental health. Other researchers have found that anxiety and depression have been heightened during the pandemic, particularly among quarantined individuals (Tang et al., 2020; Wang Y. et al., 2020). The shift to remote learning may have been especially challenging for university students, as living in a dorm has been found to be a protective factor for mental health problems (Eisenberg et al., 2007). In line with research showing the negative effects of reduced social support on alcohol abuse during remote learning (Lechner et al., 2020), removing students from this important source of social support may have exacerbated the effect of the pandemic on college students' mental health. The latent profile analysis additionally showed that it was the most vulnerable students—those who reported higher levels of anxiety and depression at time 1—who showed the greatest increases in these symptoms during remote learning.

The current study breaks new ground in examining how the severity of the pandemic in one's geographic region impacts students' anxiety and depression. Our results support the Psychological Typhoon Eye effect in that individuals' mental state in the areas with the highest epidemic level—the eye of the storm–was relatively calm (Li et al., 2010; Wang G. et al., 2020). This mechanism underlying this important finding should be examined by future research. Our study highlights a potential explanation for this seemingly paradoxical effect: individuals' perception of public and governmental support. For example, citizens living in high epidemic areas such as Wuhan received medical staff and facility support from all over China, whereas

citizens in the low epidemic areas such as Tibet, Inner Mongolia, and Guangxi province may have perceived their medical support systems to be more vulnerable. This could dampen the level of anxiety and depression in high epidemic areas but exacerbate them in low epidemic areas (Xie et al., 2011; Zheng et al., 2015; Zhang et al., 2020). In our results, we see this in the negative relationship between the public healthcare budget in an area and citizens' levels of anxiety during the pandemic. Another mechanism that may explain the higher anxiety and depression outside the "eye" of the pandemic is the role of social media and news for university students. Consuming social media and news related to the pandemic has been found to worsen individuals' anxiety and depression (Gao et al., 2020; Li et al., 2020), whereas having direct experience with a hazard makes it appear less risky (Maderthaner et al., 1978). By studying the Typhoon Eye effect among a large sample of university students with pre-pandemic measures of anxiety and depression, the present study contributes important knowledge to a question that had previously shown contradictory results in the COVID-19 pandemic (Zhang et al., 2020; Zhao et al., 2020).

Gender has previously been identified as one of the predictive factors of mental health during the pandemic. In recent studies examining the general population, including individuals involved in retail, the service industry, and healthcare, women tended to be more likely to develop symptoms of anxiety and depression than men (e.g., Lei et al., 2020; Xiong et al., 2020). However, our results indicated that the increase in anxiety and depression during the lockdown was greater for male students than female students. We suggest two potential explanations for these findings. First, the switch to remote learning for university students during the lockdown means that students must live in a relatively closed environment with their parents while completing their online learning tasks, leading to parent-child conflict (Luo, 2020). Several lines of research indicate that male students experience more parent-child conflict than female students (Burt et al., 2006; Dotterer et al., 2008; Juang et al., 2012), and that parent-child conflict is associated with depression and anxiety (Marmorstein and Iacono, 2004; Lamis and Jahn, 2013). During the home quarantine, parent-child conflict and long-term exposure to adverse family emotional environments could be sources that caused the gender differences in mental health (Dunsmore and Halberstadt, 1997; Weymouth et al., 2016). A second potential explanation relates to gender differences in resiliency and coping. From an emotional coping perspective, a large number of previous studies have shown that men exhibit less expressive emotional behaviors than women (Barrett et al., 1998; Hess et al., 2000; Parkins, 2012; Chaplin and Aldao, 2013). Compared with men, women report more emotion-focused coping methods, including venting, emotional expression, and seeking social support (Billings and Moos, 1984; Ptacek et al., 1994), which may have enabled female students to adapt to the stressful environment more effectively (Cohen, 2004). Within the Chinese culture, males are also expected to exhibit greater expressive suppression than females (Cheng et al., 2009; Flynn et al., 2010; Zhao et al., 2014). Although expressive suppression can reduce the expression of negative emotions, it can have negative effects on cognition and emotion and is not an effective approach to emotion regulation (Gross and Levenson, 1997; Richards and Gross, 2000). Future research should explore how parent-child conflict and emotional suppression/expression differentially impacts male and female university students' coping with stress. The present findings imply that decisions to shut universities (to shift to remote learning e.g., in times of crisis) may be particularly harmful for male university students' mental health.

There are also important practical implications of the present work, which could be applied by universities and mental health counselors. The present study indicated that the pandemic has a negative impact on the anxiety and depression symptoms of university students, especially for male students and students who are not directly exposed to the highest levels of the epidemic. During the pandemic, university students showed a high level of interest in receiving psychological knowledge and interventions, especially for information that could help them alleviate negative psychological effects (Wang Z. et al., 2020). As adaptability has been identified as a key factor in protecting students from anxiety and depression during the Covid-19 pandemic (Zhang et al., 2021), fostering psychological flexibility could be a beneficial approach to addressing the negative consequences of pandemic on mental health (Kashdan and Rottenberg, 2010). Psychological flexibility is defined as the capacity to adapt one's behavior in a manner that incorporates conscious and open contact with thoughts and feelings (Scott et al., 2014). In the context of the pandemic, recent research has demonstrated that psychological flexibility plays a moderating role in the effects of the lockdown, relating to better mental health in a wide range of contexts, and that inflexibility is a risk factor for anxiety and depression (Hayes et al., 2006; Pakenham et al., 2020). This indicates that government, university, and mental health counselors should pay more attention to students with symptoms of anxiety and depression, as well as their related cognitive issues. It also essential for authorities to provide psychological knowledge, such as common symptoms of anxiety and depression, methods for alleviating negative psychological effects, and contact information for counseling services, to university students. Our findings highlight the increased burden of remote learning for the mental health of certain individuals (e.g., male students, students with pre-existing symptoms of anxiety and depression, and residents of areas with lower epidemic levels and healthcare budgets), which should be taken into account as well.

There are some limitations of the current study. First, data collection was completed by online research with self-report scales, which may limit the objectivity of the data. Second, although the university students came from more than 34 provinces, they all came from China, so the generalizability to populations in other cultures should be made with caution. Future research should replicate this model in other regions of the world. Third, in order to avoid carry-over effects and potential boredom from survey repetition, our participants completed two different measures of anxiety and depression at the two time points. Although both sets of measurements are highly reliable and validated by previous research (e.g., Liu et al., 2021), it can be problematic when studies use different

measurements to measure the same construct (e.g., Feuer et al., 1999). However, based on recommendations to calculate outcome variables based on a common metric (Marcoulides and Grimm, 2017), we applied the standardized values of these two measurements (e.g., Ayubi et al., 2021). We acknowledge, however, that this was a limiting factor for our conclusions.

CONCLUSION

The present longitudinal study investigated the changes in the mental health status of college students in mainland China during the epidemic of COVID-19. The findings confirmed a significant increase in anxiety and depression among students. Results suggested that the increase of anxiety and depression was related to gender, pre-existing levels of anxiety and depression, and the severity of the epidemic in their geographic region.

DATA AVAILABILITY STATEMENT

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found below: https://osf.io/64aw7/?view_only=fc4a64aca2a7481a866434d7da631a9d.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Qingdao University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

SW and KZ: conceived and designed the survey, performed the survey, and contributed materials/analysis tools. KZ and ZH: analyzed the data. SW, KZ, EP-S, ZH, YJ, and XC: wrote the paper. KZ, EP-S, ZH, YJ, and XC: literature research. All authors contributed to the article and approved the submitted version.

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REFERENCES

Ahmed, M. Z., Ahmed, O., Aibao, Z., Hanbin, S., Siyu, L., and Ahmad, A. (2020). Epidemic of COVID-19 in China and associated psychological problems. *Asian J. Psychiatry* 51:102092. doi: 10.1016/j.ajp.2020.102092

Akaike, H. (1987). Factor analysis and AIC. *Psychometrika* 52, 317235–317332. doi: 10.1007/BF02294359

Ayubi, E., Bashirian, S., and Khazaei, S. (2021). Depression and anxiety among patients with cancer during COVID-19 pandemic: a systematic review and meta-analysis. *J. Gastrointest. Cancer* 52, 499–507. doi: 10.1007/s12029-021-00643-9

Barrett, L. F., Robin, L., Pietromonaco, P. R., and Eyssell, K. M. (1998). Are women the "more emotional" sex? evidence from emotional experiences in social context. *Cogn. Emot.* 12, 555–578. doi: 10.1080/026999398379565

Ben-Ezra, M., Sun, S., Hou, W. K., and Goodwin, R. (2020). The association of being in quarantine and related COVID-19 recommended and non-recommended behaviors with psychological distress in Chinese population. *J. Affect. Disord.* 275, 66–68. doi: 10.1016/j.jad.2020.06.026

Billings, A. G., and Moos, R. H. (1984). Coping, stress, and social resources among adults with unipolar depression. *J. Pers. Soc. Psychol.* 46:877. doi: 10.1037/0022-3514.46.4.877

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., and Greenberg, N., et al. (2020). The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet* 395, 912–920. doi: 10.1016/S0140-6736(20)30460-8

Burt, S. A., McGue, M., Iacono, W. G., and Krueger, R. F. (2006). Differential parent-child relationships and adolescent externalizing symptoms: cross-lagged analyses within a monozygotic twin differences design. *Dev. Psychol.* 42:1289. doi: 10.1037/0012-1649.42.6.1289

Chang, J., Yuan, Y., and Wang, D. (2020). Mental health status and its influencing factors among college students during the epidemic of COVID-19. *J. South Med. Univ. (Chinese)* 40, 171–176. doi: 10.12122/j.issn.1673-4254.2020.02.06

Chaplin, T. M., and Aldao, A. (2013). Gender differences in emotion expression in children: a meta-analytic review. *Psychol. Bull.* 139:735. doi: 10.1037/a0030737

Cheng, L., Yyan, J. J., He, Y. Y., and Li, H. (2009). Emotion regulation strategies: cognitive reappraisal is more effective than expressive suppression. *Adv. Psychol. Sci.* 17:730.

Chi, X., Becker, B., Yu, Q., Willeit, P., Jiao, C., and Huang, L., et al. (2020). Prevalence and psychosocial correlates of mental health outcomes among Chinese college students during the coronavirus disease (COVID-19) pandemic. *Front. Psychiatry* 11:803. doi: 10.3389/fpsyt.2020.00803

Cohen, S. (2004). Social relationships and health. *Am. Psychol.* 59:676. doi: 10.1037/0003-066X.59.8.676

Cucinotta, D., and Vanelli, M. (2020). WHO declares COVID-19 a pandemic. *Acta Biomed*. 91, 157–160. doi: 10.23750/abm.v91i1.9397

Derogatis, L. R., Lipman, R. S., and Covi, L. (1973). SCL-90: an outpatient psychiatric rating scale–preliminary report. *Psychopharmacol. Bull.* 9, 13–28.

Dotterer, A. M., Hoffman, L., Crouter, A. C., and McHale, S. M. (2008). A longitudinal examination of the bidirectional links between academic achievement and parent–adolescent conflict. *J. Fam. Issues* 29, 762–779. doi: 10.1177/0192513X07309454

Duan, L., Shao, X., Wang, Y., Huang, Y., Miao, J., and Yang, X., et al. (2020). An investigation of mental health status of children and adolescents in china during the outbreak of COVID-19. *J. Affect. Disord.* 275, 112–118. doi: 10.1016/j.jad.2020.06.029

Dunsmore, J. C., and Halberstadt, A. G. (1997). How does family emotional expressiveness affect children's schemas? *New Dir. Child Dev*. 1997, 45–68. doi: 10.1002/cd.23219977704

Eisenberg, D., Gollust, S. E., Golberstein, E., and Hefner, J. L. (2007). Prevalence and correlates of depression, anxiety, and suicidality among university students. *Am. J. Orthopsychiatry* 77, 534–542. doi: 10.1037/0002-9432.77.4.534

Elbay, R. Y., Kurtulmuş, A., Arpacioglu, S., and Karadere, E. (2020). Depression, anxiety, stress levels of physicians, and associated factors in Covid-19 pandemics. *Psychiatry Res.* 290:113130. doi: 10.1016/j.psychres.2020.113130

Felger, J. C., Haroon, E., and Miller, A. H. (2015). Risk and resilience: animal models shed light on the pivotal role of inflammation in individual differences in stress-induced depression. *Biol. Psychiatry* 78, 7–9. doi: 10.1016/j.biopsych.2015.04.017

Feuer, M. J., Holland, P. W., Green, B. F., Bertenthal, M. W., and Hemphill, F. C. (1999). *Uncommon Measures: Equivalence and Linkage among Educational Tests*. Washington, DC: National Academy Press.

Flynn, J. J., Hollenstein, T., and Mackey, A. (2010). The effect of suppressing and not accepting emotions on depressive symptoms: is suppression

different for men and women? *Pers. Individ. Dif.* 49, 582–586. doi: 10.1016/j.paid.2010.05.022

Gao, J., Zheng, P., Jia, Y., Chen, H., Mao, Y., and Chen, S., et al. (2020). Mental health problems and social media exposure during COVID-19 outbreak. *PLoS ONE* 15:e0231924. doi: 10.1371/journal.pone.0231924

Gotlib, I. H., and Hammen, C. L. E. (2008). *Handbook of Depression*. New York, NY: Guilford Press.

Gross, J. J., and Levenson, R. W. (1997). Hiding feelings: the acute effects of inhibiting negative and positive emotion. *J. Abnorm. Psychol.* 106:95. doi: 10.1037/0021-843X.106.1.95

Hayes, S. C., Luoma, J. B., Bond, F. W., Masuda, A., and Lillis, J. (2006). Acceptance and commitment therapy: model, processes and outcomes. *Behav. Res. Ther.* 44, 1–25. doi: 10.1016/j.brat.2005.06.006

Hess, U., Senécal, S., Kirouac, G., Herrera, P., Philippot, P., and Kleck, R. E. (2000). Emotional expressivity in men and women: stereotypes and self-perceptions. *Cogn. Emot.* 14, 609–642. doi: 10.1080/02699930050117648

Ho, C. S. H., Chee, C. Y., and Ho, R. C. M. (2020). Mental health strategies to combat the psychological impact of coronavirus disease (COVID-19) beyond paranoia and panic. *Ann. Acad. Med. Singap.* 49, 155–160. doi: 10.47102/annals-acadmedsg.202043

Hodges, J. L. (1958). The significance probability of the Smirnov two-sample test. *Ark. Mat.* 3, 469–486. doi: 10.1007/BF02589501

Holmes, E. A., O'Connor, R. C., Perry, V. H., Tracey, I., Wessely, S., and Arseneault, L., et al. (2020). Multidisciplinary research priorities for the COVID-19 pandemic: a call for action for mental health science. *Lancet Psychiatry* 7, 547–560. doi: 10.1016/S2215-0366(20)30168-1

Hoven, C. W., Duarte, C. S., Lucas, C. P., Wu, P., Mandell, D. J., and Goodwin, R. D., et al. (2005). Psychopathology among New York City public school children 6 months after September 11. *Arch. Gen. Psychiatry* 62, 545–551. doi: 10.1001/archpsyc.62.5.545

Juang, L. P., Syed, M., and Cookston, J. T. (2012). Acculturation-based and everyday parent–adolescent conflict among Chinese American adolescents: longitudinal trajectories and implications for mental health. *J. Fam. Psychol.* 26:916. doi: 10.1037/a0030057

Kashdan, T. B., and Rottenberg, J. (2010). Psychological flexibility as a fundamental aspect of health. *Clin. Psychol. Rev.* 30, 865–878. doi: 10.1016/j.cpr.2010.03.001

Lamis, D. A., and Jahn, D. R. (2013). Parent–child conflict and suicide rumination in college students: the mediating roles of depressive symptoms and anxiety sensitivity. *J. Am. Coll. Health.* 61, 106–113. doi: 10.1080/07448481.2012.754758

Lechner, W. V., Laurene, K. R., Patel, S., Anderson, M., Grega, C., and Kenne, D. R. (2020). Changes in alcohol use as a function of psychological distress and social support following COVID-19 related university closings. *Addict. Behav.* 110:106527. doi: 10.1016/j.addbeh.2020.106527

Lei, L., Huang, X., Zhang, S., Yang, J., Yang, L., and Xu, M. (2020). Comparison of prevalence and associated factors of anxiety and depression among people affected by versus people unaffected by quarantine during the covid-19 epidemic in southwestern China. *Med. Sci. Monit.* 26:e924609. doi: 10.12659/MSM.924609

Li, J., Yang, Z., Qiu, H., Wang, Y., Jian, L., and Ji, J., et al. (2020). Anxiety and depression among general population in China at the peak of the COVID-19 epidemic. *World Psychiatry* 19, 249–250. doi: 10.1002/wps.20758

Li, S., Rao, L.-L., Ren, X.-P., Bai, X.-W., Zheng, R., and Li, J.-Z., et al. (2009). Psychological typhoon eye in the 2008 Wenchuan earthquake. *PLoS ONE* 4:e4964. doi: 10.1371/journal.pone.0004964

Li, S., Rao, L. L., Bai, X. W., Zheng, R., Ren, X. P., and Li, J. Z., et al. (2010). Progression of the "psychological typhoon eye" and variations since the Wenchuan earthquake. *PLoS ONE* 3:e9727. doi: 10.1371/journal.pone.0009727

Liu, D., Baumeister, R. F., and Zhou, Y. (2021). Mental health outcomes of coronavirus infection survivors: a rapid meta-analysis. *J. Psychiatr. Res.* 137, 542–553. doi: 10.1016/j.jpsychires.2020.10.015

Luo, R. (2020). Relationship between social isolation and parent-child conflicts of college students during COVID-19. *J. Wenzhou Polytech.* 20, 21–25. doi: 10.13669/j.cnki.33-1276/z.2020.041

Maderthaner, R., Guttmann, G., Swaton, E., and Otway, H. J. (1978). Effect of distance upon risk perception. *J. Appl. Psychol.* 63:380. doi: 10.1037/0021-9010.63.3.380

Marcoulides, K. M., and Grimm, K. J. (2017). Data integration approaches to Longitudinal Growth Modeling. *Educ. Psychol. Meas.* 77, 971–989. doi: 10.1177/0013164416664117

Marmorstein, N. R., and Iacono, W. G. (2004). Major depression and conduct disorder in youth: associations with parental psychopathology and parent–child conflict. *J. Child Psychol. Psychiatry* 45, 377–386. doi: 10.1111/j.1469-7610.2004.00228.x

Mazza, M. G., De Lorenzo, R., Conte, C., Poletti, S., Vai, B., and Bollettini, I., et al. (2020). Anxiety and depression in COVID-19 survivors: role of inflammatory and clinical predictors. *Brain. Behav. Immun.* 89, 594–600. doi: 10.1016/j.bbi.2020.07.037

Oxford, R. L. (2015). Ritual, depression and beyond, and on the death of Sophia. *J. Poet. Ther.* 28, 53–61. doi: 10.1080/08893675.2015.980064

Pakenham, K. I., Landi, G., Boccolini, G., Furlani, A., Grandi, S., and Tossani, E. (2020). The moderating roles of psychological flexibility and inflexibility on the mental health impacts of COVID-19 pandemic and lockdown in Italy. *J. Contextual Behav. Sci.* 17, 109–118. doi: 10.1016/j.jcbs.2020.07.003

Parkins, R. (2012). *Gender and Emotional Expressiveness: An Analysis of Prosodic Features in Emotional Expression*. Nathan, QLD; Griffith University.

Peng, M., Mo, B., Liu, Y., Xu, M., Song, X., and Liu, L., et al. (2020). Prevalence, risk factors, and clinical correlates of depression in quarantined population during the COVID-19 outbreak. *J. Affect. Disord.* 275, 119–124. doi: 10.1016/j.jad.2020.06.035

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., and Podsakoff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *J. Appl. Psychol.* 88, 879–903. doi: 10.1037/0021-9010.88.5.879

Ptacek, J. T., Smith, R. E., and Dodge, K. L. (1994). Gender differences in coping with stress: when stressor and appraisals do not differ. *Pers. Soc. Psychol. Bull.* 20, 421–430. doi: 10.1177/0146167294204009

Richards, J. M., and Gross, J. J. (2000). Emotion regulation and memory: the cognitive costs of keeping one's cool. *J. Pers. Soc. Psychol.* 79:410. doi: 10.1037/0022-3514.79.3.410

Salari, N., Hosseinian-Far, A., Jalali, R., Vaisi-Raygani, A., Rasoulpoor, S., and Mohammadi, M., et al. (2020). Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: a systematic review and meta-analysis. *Glob. Health* 16:57. doi: 10.1186/s12992-020-00589-w

Schwarz, G. (1978). Estimating the dimension of a model. *Ann. Stat.* 6, 461–464. doi: 10.1214/aos/1176344136

Scott, W., McCracken, L. M., and Trost, Z. (2014). A psychological flexibility conceptualisation of the experience of injustice among individuals with chronic pain. *Br. J. Pain* 8, 62–71. doi: 10.1177/2049463713514736

Shu, L. (1999). Self-rating depression scale, SDS. *Chinese Ment. Health J. (Chinese)* 13, 194–196.

Tang, W., Hu, T., Hu, B., Jin, C., Wang, G., and Xie, C., et al. (2020). Prevalence and correlates of PTSD and depressive symptoms one month after the outbreak of the COVID-19 epidemic in a sample of home-quarantined Chinese university students. *J. Affect. Disord.* 274, 1–7. doi: 10.1016/j.jad.2020.05.009

The Scipy Community (2020). *SciPy Scipy v1.6.0 Reference Guide*. Available online at: https://docs.scipy.org/doc/scipy/reference/generated/scipy.stats.kstest.html (accessed April 25, 2021).

Van Rheenen, T. E., Meyer, D., Neill, E., Phillipou, A., Tan, E. J., and Toh, W. L., et al. (2020). Mental health status of individuals with a mood-disorder during the COVID-19 pandemic in Australia: initial results from the COLLATE project. *J. Affect. Diord.* 275, 69–77. doi: 10.1016/j.jad.2020.06.037

Wang, G., Zhang, Y., Xie, S., Wang, P., Lei, G., and Bian, Y., et al. (2020). Psychological typhoon eye effect during the COVID-19 outbreak. *Front. Public Health* 8:883. doi: 10.3389/fpubh.2020.550051

Wang, Y., Wang, C., Liao, Z., Zhang, X., and Zhao, M. (2020). A comparative analysis of anxiety and depression level among people and epidemic characteristics between COVID-19 and SARS. *Life Sci. Res. (Chinese)* 24, 180–186. doi: 10.16605/j.cnki.1007-7847.2020.03.002

Wang, Z. (1984). The self-report symptom inventory, symptom checklist-90, SCL-90. *Shanghai Arch. Psychiatry (Chinese)* 2, 68–70.

Wang, Z., Yang, H., Yang, Y., Liu, D., Li, Z., and Zhang, X., et al. (2020). Prevalence of anxiety and depression symptom, and the demands for psychological knowledge and interventions in college students during

COVID-19 epidemic: a large cross-sectional study. *J. Affect. Disord.* 275, 188–193. doi: 10.1016/j.jad.2020.06.034

Weymouth, B. B., Buehler, C., Zhou, N., and Henson, R. A. (2016). A meta-analysis of parent–adolescent conflict: disagreement, hostility, and youth maladjustment. *J. Fam. Theory Rev.* 8, 95–112. doi: 10.1111/jftr.12126

Wu, W. (1999). Self-rating anxiety scale, SAS. *Chinese Ment. Health J. (Chinese)* 13, 235–238.

Xie, X.-F., Stone, E., Zheng, R., and Zhang, R.-G. (2011). The "Typhoon eye effect": determinants of distress during the SARS epidemic. *J. Risk Res.* 14, 1091–1107. doi: 10.1080/13669877.2011.571790

Xiong, J., Lipsitz, O., Nasri, F., Lui, L. M., Gill, H., and Phan, L., et al. (2020). Impact of COVID-19 pandemic on mental health in the general population: a systematic review. *J. Affect. Disord.* 277, 55–64. doi: 10.1016/j.jad.2020.08.001

Xu, X., Ai, M., Hong, S., Wang, W., Chen, J., and Zhang, Q., et al. (2020). The psychological status of 8817 hospital workers during COVID-19 epidemic: a cross-sectional study in Chongqing. *J. Affect. Disord.* 276, 555–561. doi: 10.1016/j.jad.2020.07.092

Ystgaard, M., Tambs, K., and Dalgard, O. S. (1999). Life stress, social support, and psychological distress in late adolescence: a longitudinal study. *Soc. Psychiatry Psychiatr. Epidemiol.* 34, 12–19. doi: 10.1007/s001270050106

Zhang, K., Wu, S., Xu, Y., Cao, W., Goetz, T., and Parks-Stamm, E. (2021). Adaptability promotes student engagement under COVID-19: the multiple mediating effects of academic emotion. *Fron. Psychol.* 11:3785. doi: 10.3389/fpsyg.2020.633265

Zhang, L., Ma, M., Li, D., and Xin, Z. (2020). The psychological typhoon eye effect during the COVID-19 outbreak in China: the role of coping efficacy and perceived threat. *Glob. Health* 16, 1–10. doi: 10.1186/s12992-020-00626-8

Zhao, H., He, X., Fan, G., Li, L., Huang, Q., and Qiu, Q., et al. (2020). COVID-19 infection outbreak increases anxiety level of general public in China: involved mechanisms and influencing factors. *J. Affect. Disord.* 276, 446–452. doi: 10.1016/j.jad.2020.07.085

Zhao, X., Zhang, R., and Zheng, K. (2014). Gender differences in emotion regulation strategies in adolescents. *Chin. J. Clin. Psychol.* 22, 849–854. doi: 10.16128/j.cnki.1005-3611.2014.05.067

Zheng, R., Rao, L.-L., Zheng, X.-L., Cai, C., Wei, Z.-H., and Xuan, Y.-H., et al. (2015). The more involved in lead-zinc mining risk the less frightened: a psychological typhoon eye perspective. *J. Environ. Psychol.* 44, 126–134. doi: 10.1016/j.jenvp.2015.10.002

Zhu, J., Sun, L., Zhang, L., Wang, H., Fan, A., and Yang, B., et al. (2020). Prevalence and influencing factors of anxiety and depression symptoms in the first-line medical staff fighting against COVID-19 in Gansu. *Front. Psychiatry* 11:386. doi: 10.3389/fpsyt.2020.00386

Zung, W. W. K. (1965). A self-rating depression scale. *Arch. Gen. Psychiatry* 12, 63–70. doi: 10.1001/archpsyc.1965.01720310065008

Zung, W. W. K. (1971). A rating instrument for anxiety disorders. *Psychosom* 12, 371–379. doi: 10.1016/S0033-3182(71)71479-0

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Relationships Between Anxiety, Perceived Vulnerability to Disease, and Smartphone Use During Coronavirus Disease 2019 Pandemic in a Sample of Italian College Students

Concetta De Pasquale[1,2], *Maria Luisa Pistorio*[2], *Federica Sciacca*[1]* *and Zira Hichy*[1]

[1] *Department of Educational Sciences, University of Catania, Catania, Italy,* [2] *Department of General Surgery and Medical-Surgical Specialties, University Hospital of Catania, Catania, Italy*

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***Correspondence:**
Federica Sciacca
federica.sciacca@phd.unict.it

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Introduction: As of March 2020, coronavirus disease 2019 (COVID-19) has been declared a "pandemic" by the WHO. This has led to the need for governments around the world to implement restrictive containment and isolation measures to stem the spread of the virus; these measures have included social distancing, isolation, and quarantine. The fear of contagion has been indicated as one of the causes of stress, anxiety, depression, and insomnia in the general population. With respect to the response of young people to the pandemic, the category of University students deserves further attention. The sudden change in "University" habits (i.e., poor interaction with teachers and colleagues, disturbing learning environment, and difficulty in adapting to online learning), the consequent loss of a social network, and the economic problems in their families have seriously affected the psychophysical well-being of University students. The aim of this study was to explore, in a sample of Italian University students, the relationships among anxiety, perceived vulnerability to disease, and smartphone use during the COVID-19 pandemic.

Methods: A sample of 194 volunteer college students (i.e., 86 males and 108 females) aged between 18 and 30 years ($M = 21.74$; $SD = 2.39$) were recruited to participate in this study. Participants were recruited through an online questionnaire sent to students of the University of Catania, Italy, and distributed from September 2020 to January 2021. The volunteer participants were given an online protocol that included the Fear of COVID-19 Scale (FCV-19S) for the evaluation of fear, the Perceived Vulnerability to Disease (PVD) for the evaluation of perceived vulnerability to disease, the State-Trait Anxiety Inventory (STAI) for the evaluation of trait and state anxiety, and the Smartphone Addiction Scale Short Version for Adolescents and Young Adults (SAS-SV) for the evaluation of use, abuse, or addiction of smartphone use.

Results: The fear of COVID-19 did not reach an intensity such as to be defined as serious (i.e., fear score: 15.53) in the whole sample. Both men and women showed a

high risk of smartphone addiction (i.e., score of males: 28.33 and score of females: 26.88) in SAS-SV. University students showed moderate trait and state anxiety [i.e., a score of 51.60 in Trait Anxiety Inventory (TAI) and a score of 47.21 in State Anxiety Inventory (SAI)] in STAI. In addition, students showed moderate perceived vulnerability to disease (i.e., a score of 51.51) in PVD. The results showed that fear of COVID-19 and trait anxiety appear to be the predictors of SAI and PVD but not the predictors of risk of smartphone addiction (SAS-SV).

Conclusions: The data highlighted the presence of a perception of vulnerability to infections in subjects in which there was also a moderate anxiety, both state and trait, associated with the fear of the COVID-19 pandemic. It is hoped that a large part of the population will soon be vaccinated, including University students, and therefore, it would be desirable to carry out further assessments in the post-vaccine phase to highlight any differences in the state of anxiety and the perception of vulnerability to infections. The possible positive role of the use of smartphones in maintaining social contacts should also be emphasized.

Keywords: anxiety, perceived vulnerability, smartphone addiction, college students, fear COVID-19

INTRODUCTION

Coronavirus disease 2019 (COVID-19) has rapidly expanded in Europe, North America, Asia, and the Middle East. Based on the alarming levels of prevalence and severity, the Director-General of the WHO on March 11, 2020 called the COVID-19 situation a pandemic (Bedford et al., 2020). To respond to this pandemic, many countries have taken containment measures to reduce the demand for hospitalization and protect those most vulnerable to infection (De Coninck et al., 2020). To stop the spread of the diseases, a vaccine is needed. But, in the absence of the vaccine, people should maintain social distancing. To maintain social distancing, they should obey the modeling rule (Khajanchi and Sarkar, 2020; Samui et al., 2020; Sarkar et al., 2020).

The lack of immunity and vaccines against the virus, its exponential spread, and high mortality rate have contributed to the perception of a largely uncontrollable and unpredictable threat, causing emotional distress up to full-blown psychopathology (Asmundson et al., 2020; Fiorillo et al., 2020).

In this context, an important factor is the impact of the effect of media. The COVID-19 dynamics have changed due to the incorporation of media-related awareness such as the use of face masks, non-pharmaceutical interventions, and hand sanitization (Rai et al., 2021).

Is there any experimental data to validate the mathematical model? Subhas et al. (2021) described the basic reproduction number R_0 and its impact on the COVID-19 pandemic in India. The basic reproduction number R_0 is one of the most crucial quantities in infectious diseases, as R_0 measures how contagious a disease is. For $R\_0 < 1$, the disease is expected to stop spreading, but for $R\_0 = 1$, an infected individual can infect on an average of 1 person, that is, the spread of the disease is stable. The disease can spread and become epidemic if R_0 must be >1.

Overall, the importance of possible negative effects of COVID-19 at the emotional level on the population has been documented by several surveys.

The study carried out in China found moderate-to-severe anxiety in about one-third of the sample examined, a high prevalence of sleep disorders, and generalized symptoms of anxiety disorder, especially in young people and health professionals (Huang and Ning, 2020; Wang et al., 2020a).

A study carried out on the Italian population showed a high rate of post-traumatic stress symptoms, depression, anxiety, insomnia, and adaptation disorder symptoms, with higher probabilities in young women (Rossi et al., 2020).

Furthermore, several studies have shown that the COVID-19 infection in association with infodemia increased the risk of psychiatric/psychological disorders by stimulating the hypothalamus–pituitary–adrenal (HPA) axis and has shown how dangerous this is for the public, especially for pregnant women and disabled people (Khan et al., 2020, 2021; Nabi et al., 2020).

In addition, Wang et al. (2020b) showed that the deprivation of social interaction, such as that occurred during the COVID-19 pandemic, can stimulate the HPA axis, resulting in an increased secretion of stress hormones and a decreased secretion of social hormones and causing the dysregulation of social behaviors in people.

Although a significant correlation has been shown between perceived vulnerability to disease (PVD) and emotional distress, individuals can cope better with the psychological and social threats of the pandemic if they can manage anxiety and depression, despite the high levels of fear of the pandemic infection (Jungmann and Witthöft, 2020; Li et al., 2021).

The study by Stangier et al. (2021) highlighted how the perceived vulnerability to infections predicted an increase in preventive behavior, while the aversion to germs predicted an increase in preventive behavior and a decrease in risky behavior.

With respect to the response of young people to the pandemic, the category of University students deserves further attention. The sudden change in "University" habits (i.e., poor interaction with teachers and colleagues, disturbing learning environment, and difficulty in adapting to online learning), the consequent loss of a social network, and the economic problems in their families have seriously affected the psychophysical well-being of University students (Stangier et al., 2021).

Huckins et al. (2020) studied the impact of COVID-19 on mental health and behavior in a sample of 217 American college students. The authors highlighted how the fear associated with the pandemic caused an increase in the symptoms of anxiety, depression, and some behaviors to watch out for such as continued smartphone use in the young people examined.

The study by Kleiman et al. (2020) was conducted on 140 college students in the United States and highlighted the increased desire to drink and use drugs in the most anxious and depressed subjects due to COVID-19.

In the study by Elhai et al. (2020) conducted on 908 subjects in China, it was found that COVID-19 anxiety was related to the severity of problematic smartphone use (PSU), depression, and anxiety; however, COVID-19 anxiety did not predict a greater severity of PSU. To what extent can a pandemic lead to risky behavior? However, the predictive value of the levels of anxiety and stress of PSU has been highlighted by the international literature even in the periods preceding the pandemic (De Pasquale et al., 2015, 2018, 2019; Vahedi and Saiphoo, 2018).

Based on these premises, the aim of this study was to explore, in a sample of Italian University students, the relationships between anxiety, perceived vulnerability to disease, and smartphone use during the COVID-19 pandemic.

METHODS

Participants

A sample of 194 volunteer college students (i.e., 86 males and 108 females) aged between 18 and 30 years ($M = 21.74$; $SD = 2.39$) were recruited to participate in this study. Participants were recruited through an online questionnaire sent to students of the University of Catania, Italy, and distributed from September 2020 to January 2021. The survey was also shared on the Facebook page of the Department of Educational Sciences of the University of Catania. All participants provided online informed consent and answered the questionnaire anonymously.

Measures

The volunteer participants were given an online protocol that included the Fear of COVID-19 Scale (FCV-19S) for the evaluation of fear, the Perceived Vulnerability to Disease (PVD) for the evaluation of perceived vulnerability to disease, the State-Trait Anxiety Inventory (STAI) for the evaluation of trait and state anxiety, and the Smartphone Addiction Scale Short Version for Adolescents and Young Adults (SAS-SV) for the evaluation of use, abuse, or addiction of smartphone use.

The FCV-19S (Ahorsu et al., 2020) is a questionnaire composed of 7 items (e.g., "I'm very afraid of coronavirus-19," "It makes me uncomfortable to think about coronavirus-19," and "I can't sleep because I worry about getting coronavirus-19"), with a 5-point Likert response scale (i.e., 1 = strongly disagree to 5 = strongly agree), which assesses the fear of COVID-19. The scale showed a reliability score of 0.874. The score ranges from 7 to 35, with higher scores correlated with higher fear.

The Perceived Vulnerability to Disease (PVD; Park and Justin, 2009) is a questionnaire for the evaluation of individual differences in perceived vulnerability of disease and emotional distress in the presence of potential transmission of diseases. It is composed of 15 items with a 7-point response scale (i.e., 1 = strongly disagree to 7 = strongly agree), divided into two subscales or factors. The first factor [i.e., Perceived Infectability (PI)] is composed of seven items to evaluate beliefs about immunological functioning and personal susceptibility to infectious diseases. The second factor [i.e., Germ Aversion (GA)] is composed of eight items to evaluate aversive affective responses to situations that connote a relatively high probability of transmission of pathogens. The subscale scores are computed as the mean of all items within a factor. Higher scores indicate greater perceived vulnerability to disease (Park and Justin, 2009). The 15 items showed an acceptable level of internal consistency, i.e., Cronbach's alpha = 0.82. For the seven items on the PI factor, Cronbach's alpha = 0.87. For the eight items on the GA factor, Cronbach's alpha = 0.74.

The State-Trait Anxiety Inventory (STAI; Spielberger and Sydeman, 1994) is a questionnaire that shows how strong the feelings of anxiety of a person are. It is composed of two scales, one to evaluate state anxiety [i.e., State Anxiety Inventory (SAI)] and the other to evaluate trait anxiety [i.e., Trait Anxiety Inventory (TAI)]. State anxiety refers to the state of mind (i.e., fear, nervousness, and discomfort) of a person at the time of a perceived threat and is considered temporary, while trait anxiety refers to the feelings of stress, worry, and discomfort that one can experience in typical situations of everyday life. Each scale asks 20 questions and is rated on a 4-point scale (i.e., 1 = not at all to 4 = very much so) (Grös et al., 2007). Scores range from 20 to 80, with higher scores correlating with greater anxiety. In this study, TAI showed a reliability score of 0.532, while SAI showed a reliability score of 0.588.

The Smartphone Addiction Scale Short Version for Adolescents and Young Adults (SAS-SV; De Pasquale et al., 2017) is a questionnaire to identify the risk of smartphone addiction. It distinguishes the high-risk group from the addicted group. The questionnaire includes 10 items describing daily life disturbance, positive anticipation, withdrawal, cyberspace-oriented relationships, overuse, and tolerance. For each item, participants expressed their opinion on a 6-point scale (i.e., 1 = strongly disagree to 6 = strongly agree). The scale is used to identify the different ranges for men and women. Men were addicted to scores above 31, with a high risk of addiction on scores between 22 and 31, and women were addicted to scores above 33, with a high risk of addiction on scores between 22 and 33 (Kwon et al., 2013; De Pasquale et al., 2017). In this study, SAS-SV showed high reliability (Cronbach's alpha = 0.79).

TABLE 1 | Gender differences in FCV-19S, PVD, PI, GA, SAI, TAI, and SAS-SV measured using the *t*-test of independent samples.

	Gender	Mean	SD	*t*	*p*-value (*df* = 191)	Mean difference	SE difference	95% CI of the difference	
								Lower	Upper
SAS-SV	M	28.33	9.00	1.13	0.257	1.44	1.27	−1.06	3.96
	F	26.88	8.66						
PI	M	19.76	5.55	−0.28	0.773	−0.23	0.80	−1.81	1.35
	F	20.00	5.56						
GA	M	31.39	5.65	−0.56	0.572	−0.49	0.87	−2.21	1.22
	F	31.88	6.32						
PVD	M	51.05	8.52	−0.64	0.519	−0.83	1.28	−3.36	1.70
	F	51.88	9.18						
FCV-19S	M	14.01	5.80	−3.12	0.002	−2.73	0.87	−4.46	−1.01
	F	16.75	6.24						
SAI	M	46.40	5.37	−1.76	0.080	−1.44	0.82	−3.06	0.17
	F	47.85	5.91						
TAI	M	51.01	6.04	−1.20	0.228	−1.07	0.88	−2.82	0.67
	F	52.08	6.20						

M, Male; F, Female; FCV-19S, Fear of COVID-19 Scale; PVD, Perceived Vulnerability to Disease, PI, Perceived Infectability; GA, Germ Aversion; TAI, Trait Anxiety Inventory; SAI, State Anxiety Inventory; and SAS-SV, Smartphone Addiction Scale Short Version for Adolescents and Young Adults.

Data Analysis

We performed a set of statistical analyses on our data (i.e., descriptive analyses, factors correlation, linear regression, and instrument reliability with Cronbach's alpha) using SPSS software version 26.

RESULTS

The results did not show significant gender differences in PVD, STAI (i.e., SAI and TAI versions), and SAS-SV scales calculated through the *t*-test of independent samples (**Table 1**). There were gender differences only in FCV-19S, and women showed more fear of COVID-19 than men. Nevertheless, the fear of COVID-19 (i.e., FCV-19S) did not reach an intensity such as to be defined as serious (i.e., fear score: 15.53) in the whole sample. Both men and women showed a high risk of smartphone addiction (i.e., score of males: 28.33 and score of females: 26.88) in SAS-SV (for the range of scores, see "Measures" section). University students showed moderate trait and state anxiety (i.e., a score of 51.60 in TAI and a score of 47.21 in SAI) in STAI (for the range of scores, see "Measures" section). In addition, students showed moderate perceived vulnerability to disease (i.e., a score of 51.51) in PVD (for the range of scores, see "Measures" section).

The Pearson's correlations are shown in **Table 2**. GA, PI, and SAI were significantly correlated with fear of COVID-19 (i.e., FCV-19S) and trait anxiety (i.e., TAI). In contrast, they were not correlated with the risk of smartphone addiction (i.e., SAS-SV).

Table 3 reports the results of the linear regression between the independent variables (i.e., FCV-19S and TAI) and dependent variables (i.e., SAI, SAS-SV, and PVD). The results showed that fear of COVID-19 and trait anxiety appear to be the predictors of state anxiety (i.e., SAI) and PVD, but not the predictors of risk of smartphone addiction (i.e., SAS-SV).

DISCUSSION AND CONCLUSIONS

The data from this study did not show significant differences regarding gender in the various assessment tests performed, except in the fear of COVID-19, in which women showed greater fear. Both male and female students showed a significant score for a high risk of smartphone addiction at SAS-SV, while the fear of COVID-19 did not reach a level to be defined as severe. Both state and trait anxieties showed a level of moderate severity, as well as a moderate perception of vulnerability to infections. Although the fear of COVID-19 cannot be defined as serious in the examined students, the correlations showed how, as the fear of the pandemic increased, both the aversion to germs and the perception of infections increased.

Furthermore, the same variables (i.e., FCV-19S and PVD) were also positively correlated with trait anxiety (i.e., TAI). We hypothesized that the trait anxiety highlighted in the examined subjects could have encouraged preventive and control behaviors toward the fear of contagion. It is significant to note that, although the use of smartphones can be defined as having a high risk of addiction, no significant correlations emerged between the latter and the other dimensions examined. Among other things, the PSU did not appear to depend on the fear of COVID-19.

This seems to be in line with some other studies carried out on student samples during the COVID-19 pandemic. For example, the study by David and Roberts (2021) conducted on 400 college students found that smartphone use mitigated the negative impact of social distancing on social connection and well-being. Therefore, contrary to a popular opinion regarding the negative influence of smartphone use on well-being, its increased use during the pandemic could foster social connection and well-being.

Moreover, some other studies on young adults showed that, although depression and social anxiety were the determinants of

TABLE 2 | Pearson's correlation (*r*) among FCV-19S, STAI, PVD, and SAS-SV.

	PI	GA	PVD	FCV-19S	SAI	TAI	SAS-SV
PI	1	0.172*	0.590**	0.148*	0.194**	0.239**	−0.008
GA	0.172*	1	0.804**	0.322**	0.316**	0.211**	0.036
PVD	0.590**	0.804**	1	0.400**	0.408**	0.352**	0.011
FCV-19S	0.148*	0.322**	0.400**	1	0.523**	0.223**	0.010
SAI	0.194**	0.316**	0.408**	0.523**	1	0.386**	−0.017
TAI	0.239**	0.211**	0.352**	0.223**	0.386**	1	0.004
SAS-SV	−0.008	0.036	0.011	0.010	−0.017	0.004	1

FCV-19S, Fear of COVID-19 Scale; PVD, Perceived Vulnerability to Disease, PI, Perceived Infectability; GA, Germ Aversion; TAI, Trait Anxiety Inventory; SAI, State Anxiety Inventory; and SAS-SV, Smartphone Addiction Scale Short Version for Adolescents and Young Adults.
**Significance $p < 0.05$.*
***Significance $p < 0.01$.*

TABLE 3 | Linear regression model between the independent variables (i.e., FCV-19S and TAI) and dependent variables (i.e., SAI, SAS-SV, and PVD) with 95% bias-corrected and CIs.

	Standardized coefficients	*t*	*p*-value	95% CI for Regression coefficients (B)	
	β			Lower bound	Upper bound
	SAI				
Constant		9.55	<0.001	21.43	32.59
FCV-19S	0.46	7.68	<0.001	0.31	0.53
TAI	0.28	4.74	<0.001	0.15	0.37
	SAS-SV				
Constant		5.02	<0.001	16.51	37.89
FCV-19S	0.00	0.12	<0.001	−0.19	0.22
TAI	0.00	0.02	<0.001	−0.20	0.21
	PVD				
Constant		4.88	<0.001	13.91	32.76
FCV-19S	0.33	5.20	<0.001	0.30	0.67
TAI	0.27	4.25	<0.001	0.21	0.58

t, t-test; p, p-value; FCV-19S, Fear of COVID-19 Scale; PVD, Perceived Vulnerability to Disease, PI, Perceived Infectability; GA, Germ Aversion; TAI, Trait Anxiety Inventory; SAI, State Anxiety Inventory; and SAS-SV, Smartphone Addiction Scale Short Version for Adolescents and Young Adults.

the risk for a greater PSU, particular categories of technological applications were positively correlated with psychophysical well-being (De Pasquale et al., 2020; Pera, 2020).

Another significant finding that emerged from this study concerns the predictive value of fear of COVID-19 and trait anxiety on the perception of vulnerability to infections. Therefore, knowing in advance the psychological traits of the subjects, it is possible to intervene in time, preventing the negative influences of a particularly stressful event from becoming serious.

This study has some limitations. In particular, the study reveals some methodological shortcomings, as the perception scales of vulnerability to disease have not typically been designed for clinical diagnostic purposes, diminishing their suitability for clinical research. Further study needs to be conducted to explore further phenomena that could be predicted by the constructs evaluated by the PVD. Furthermore, the sample of subjects examined is relatively small and concerns only a portion of University students in the city of Catania, even if the results of the study are quite consistent with the study carried out so far on University students in other countries during the COVID-19 pandemic. Another important limitation to consider concerns the fact that the state of the emotional well-being of these subjects is not known before the pandemic period, and therefore, we do not know for sure if the moderate state of anxiety found depends only on the effects of the pandemic or also on other variables. It is not possible to exclude states of anxiety and the presence of a certain degree of perception of vulnerability to infections preceding the pandemic due to the absence of evaluation.

The data highlighted the presence of the perception of vulnerability to infections in subjects with moderate anxiety, both state and trait, to be associated with the fear of the COVID-19 pandemic. It is hoped that a large part of the population will soon be vaccinated, including University students, and therefore, it would be desirable to carry out further assessments in the post-vaccine phase to highlight any differences in the state of anxiety and the perception of vulnerability to infections. The possible

positive role of the use of smartphones in maintaining social contacts should also be emphasized.

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 Italian Association of Psychology. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CD: conceptualization, methodology, data curation, writing—original draft preparation, writing—review and editing, supervision, and funding acquisition. MLP: methodology, investigation, and writing—original draft preparation. FS: methodology, validation, formal analysis, investigation, and writing—original draft preparation. ZH: writing—review and editing, visualization, and supervision. All authors contributed to the article and approved the submitted version.

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REFERENCES

Ahorsu, D. K., Lin, C. Y., Imani, V., Saffari, M., Griffiths, M. D., and Pakpour, A. H. (2020). The fear of COVID-19 scale: development and initial validation. *Int. J. Mental Health Addict*. doi: 10.1007/s11469-020-00270-8. [Epub ahead of print].

Asmundson, G. J. G., Paluszek, M. M., Landry, C. A., McKay, D., and Taylor, S. (2020). Do pre-existing anxiety related and mood disorders differentially impact COVID-19 stress responses and coping? *J. Anxiety Disord.* 74:102271. doi: 10.1016/j.janxdis.2020.102271

Bedford, J., Enria, D., Giesecke, J., Heymann, D. L., Ihekweazu, C., Kobinger, G., et al. (2020). COVID-19: towards controlling of a pandemic. *Lancet* 395, 1015–1018. doi: 10.1016/S0140-6736(20)30673-5

David, M. E., and Roberts, J. A. (2021). Smartphone use during the COVID-19 pandemic: social versus physical distancing. *Int. J. Environ. Res. Public Health* 18:1034. doi: 10.3390/ijerph18031034

De Coninck, D., d'Haenens, L., and Matthijs, K. (2020). Perceived vulnerability to disease and attitudes towards public health measures: COVID-19 in Flanders, Belgium. *Pers. Individ. Dif.* 166:110220. doi: 10.1016/j.paid.2020.110220

De Pasquale, C., Dinaro, C., and Sciacca, F. (2018). Relationship of internet gaming disorder with dissociative experience in Italian University students. *Ann. Gen. Psychiatry* 17:28. doi: 10.1186/s12991-018-0198-y

De Pasquale, C., Sciacca, F., Conti, D., Dinaro, C., and Di Nuovo, S. (2019). Personality and dissociative experiences in smartphone users. *Life Span Disability* 22, 129–146. Available online at: http://shura.shu.ac.uk/id/eprint/24788

De Pasquale, C., Sciacca, F., and Hichy, Z. (2015). Smartphone addiction and dissociative experience: an investigation in italian adolescent aged between 14 and 19 Years. *Int. J. Psychol. Behav. Anal.* 1:109. doi: 10.15344/2455-3867/2015/109

De Pasquale, C., Sciacca, F., and Hichy, Z. (2017). Italian validation of smartphone addiction scale short version for adolescents and young adults (SAS-SV). *Psychology* 8, 1513–1518. doi: 10.4236/psych.2017.810100

De Pasquale, C., Sciacca, F., Martinelli, V., Chiappedi, M., Dinaro, C., and Hichy, Z. (2020). Relationship of internet gaming disorder with psychopathology and social adaptation in italian young adults. *Int. J. Environ. Res. Public Health* 17:8201. doi: 10.3390/ijerph17218201

Elhai, J. D., Yang, H., McKay, D., and Asmundson, G. J. G. (2020). COVID-19 anxiety symptoms associated with problematic smartphone use severity in Chinese adults. *J. Affect. Disord.* 274, 576–582. doi: 10.1016/j.jad.2020.05.080

Fiorillo, A., Sampogna, G., Giallonardo, V., Del Vecchio, V., Luciano, M., Albert, U., et al. (2020). Effects of the lockdown on the mental health of the general population during the COVID-19 pandemic in Italy: results from the COMET collaborative network. *Eur. Psychiatry* 63:e87. doi: 10.1192/j.eurpsy.2020.89

Grös, D. F., Antony, M. M., Simms, L. J., and McCabe, R. E. (2007). Psychometric properties of the state-trait inventory for cognitive and somatic anxiety (STICSA): comparison to the state-trait anxiety inventory (STAI). *Psychol. Assess.* 19, 369–381. doi: 10.1037/1040-3590.19.4.369

Huang, Y., and Ning, Z. (2020). Generalized anxiety disorder, depressive symptoms and sleep quality during COVID-19 epidemic in China: a web-based cross-sectional survey. *medRxiv*. 288:112954. doi: 10.1101/2020.02.19.20025395

Huckins, J. F., daSilva, A. W., Wang, W., Hedlund, E., Rogers, C., Nepal, S. K., et al. (2020). Mental health and behavior of college students during the early phases of the covid-19 pandemic: longitudinal smartphone and ecological momentary assessment study. *J. Med. Internet Res.* 22:e20185. doi: 10.2196/20185

Jungmann, S. M., and Witthöft, M. (2020). Health anxiety, cyberchondria, and coping in the current COVID-19 pandemic: which factors are related to coronavirus anxiety? *J. Anxiety Disord.* 73:102239. doi: 10.1016/j.janxdis.2020.102239

Khajanchi, S., and Sarkar, K. (2020). Forecasting the daily and cumulative number of cases for the COVID-19 pandemic in India. *Chaos* 30:071101. doi: 10.1063/5.0016240

Khan, S., Siddique, R., Bai, Q., Shabana, L.iu, and Y., Xue, M., et al. (2020). Coronaviruses disease 2019 (COVID-19): causative agent, mental health concerns, and potential management options. *J. Infect. Public Health* 13, 1840–1844. doi: 10.1016/j.jiph.2020.07.010

Khan, S., Siddique, R., Xiaoyan, W., Zhang, R., Nabi, G., Sohail, M. A., et al. (2021). Mental health consequences of infections by coronaviruses including severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). *Brain Behav.* 11:e01901. doi: 10.1002/brb3.1901

Kleiman, E. M., Yeager, A. L., Grove, J. L., Kellerman, J. K., and Kim, J. S. (2020). Real-time mental health impact of the COVID-19 pandemic on college students: ecological momentary assessment study. *JMIR Ment Health* 7:e24815. doi: 10.2196/24815

Kwon, M., Kim, D. J., Cho, H., and Yang, S. (2013). The smartphone addiction scale: development and validation of a short version for adolescents. *PLoS ONE* 8:e83558. doi: 10.1371/journal.pone.0083558

Li, R., Yang, B., Penn, J., Houghtaling, B., Chen, J., Prinyawiwatkul, W., et al. (2021). Perceived vulnerability to COVID-19 infection from event attendance: results from Louisiana, USA, two weeks preceding the national emergency declaration. *BMC Public Health* 20:1922. doi: 10.1186/s12889-020-10035-6

Nabi, G., Siddique, R., Xiaoyan, W., Ullah, R., Nawsherwan, Xue M., et al. (2020). COVID-19 induced psychosocial stressors during gestation: possible maternal and neonatal consequences. *Curr. Med. Res. Opin.* 36, 1633–1634. doi: 10.1080/03007995.2020.1815003

Park, M., and Justin, H. (2009). Perceived vulnerability to disease: development and validation of a 15-item self-report instrument. *Pers. Individ. Dif.* 47, 541–546. doi: 10.1016/j.paid.2009.05.001

Pera, A. (2020). The psychology of addictive smartphone behavior in young adults: problematic use, social anxiety, and depressive stress. *Front. Psychiatry* 11:573473. doi: 10.3389/fpsyt.2020.573473

Rai, R. K., Khajanchi, S., Tiwari, P. K., Venturino, E., and Misra, A. K. (2021). Impact of social media advertisements on the transmission dynamics of COVID-19 pandemic in India. *J. Appl. Math Comput*. doi: 10.1007/s12190-021-01507-y. [Epub ahead of print].

Rossi, R., Socci, V., Talevi, D., Mensi, S., Niolu, C., Pacitti, F., et al. (2020). COVID-19 pandemic and lockdown measures impact on mental health among the general population in Italy. An N= 18147 web-based survey. *medRxiv*. 11:790. doi: 10.1101/2020.04.09.20057802

Samui, P., Mondal, J., and Khajanchi, S. A. (2020). Mathematical model for COVID-19 transmission dynamics with a case study of India. *Chaos Solitons Fractals* 140:110173. doi: 10.1016/j.chaos.2020.110173

Sarkar, K., Khajanchi, S., and Nieto, J. J. (2020). Modeling and forecasting the COVID-19 pandemic in India. *Chaos Solitons Fractals* 139:110049. doi: 10.1016/j.chaos.2020.110049

Spielberger, C. D., and Sydeman, S. J. (1994). "State-trait anxiety inventory and state-trait anger expression inventory," in *The Use of Psychological Testing for Treatment Planning and Outcome Assessment*, ed M. E. Maruish (Hillsdale, NJ: Lawrence Erlbaum Associates), 292–321.

Stangier, U., Kananian, S., and Schüller, J. (2021). Perceived vulnerability to disease, knowledge about COVID-19, and changes in preventive behavior during lockdown in a German convenience sample. *Curr. Psychol*. doi: 10.1007/s12144-021-01456-6. [Epub ahead of print].

Subhas, K., Sovan, B., and Tapan, K. R. (2021). Mathematical analysis of the global dynamics of a HTLV-I infection model, considering the role of cytotoxic T-lymphocytes. *Math. Comput. Simul.* 180, 354–378. doi: 10.1016/j.matcom.2020.09.009

Vahedi, Z., and Saiphoo, A. (2018). The association between smartphone use, stress, and anxiety: a meta-analytic review. *Stress Health* 34, 347–358. doi: 10.1002/smi.2805

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C. S., et al. (2020a). Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *Int. J. Environ. Res. Public Health* 17:1729. doi: 10.3390/ijerph17051729

Wang, L., Nabi, G., Zhang, T., Wu, Y., and Li, D. (2020b). Potential neurochemical and neuroendocrine effects of social distancing amidst the COVID-19 pandemic. *Front. Endocrinol.* 11:582288. doi: 10.3389/fendo.2020.582288

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Relations Between Mood States and Eating Behavior During COVID-19 Pandemic in a Sample of Italian College Students

Concetta De Pasquale[1], Federica Sciacca[2], Daniela Conti[3], Maria Luisa Pistorio[4], Zira Hichy[2], Rosa Loredana Cardullo[2] and Santo Di Nuovo[2]*

[1] Vascular Surgery and Organ Transplant Unit, Department of Educational Sciences, University of Catania, Catania, Italy, [2] Vascular Surgery and Medical-Surgical Specialties, Department of Educational Sciences, University Hospital of Catania, Catania, Italy, [3] College of Business, Technology and Engineering, Sheffield Hallam University, Sheffield, United Kingdom, [4] Department of General Surgery and Medical-Specialties, University Hospital of Catania, Catania, Italy

The fear of contagion during the COVID-19 pandemic has been indicated as a relevant cause of psychological pathologies occurring in this period. Food represents a compensating experience, distracting from the experiences of uncertainty, fear and despair, causing alterations in eating habits and behaviors. The study aims at evaluating the relations between fear of a pandemic, mood states and eating disorders in Italian college students, taking into account gender differences. During the lockdown for the pandemic, a sample of 469 college students equally distributed by gender, was recruited online using a questionnaire including the FCV-19S for the assessment of fear of COVID-19, the profile of mood states (POMS) for the evaluation of different emotional states, the eating disorder inventory-2 (EDI-2) and the binge eating scale (BES) to evaluate the presence of the levels of eating disorders. As expected, all emotive states measured by POMS (tension, depression, anger, tiredness, confusion) resulted significantly correlated with the fear of COVID-19. Women were more exposed to fear of COVID-19 showing greater tension, fatigue, depression and confusion, and a significantly higher total mood disturbance score than males. Regarding the EDI-2 and BES variables, tension and anxiety resulted significantly correlated also with bulimic behavior, while depression with interoceptive awareness, impulsivity, and binge eating behaviors, without gender differences. In conclusion, the negative impact of the fear of COVID-19 on the emotional profile and eating behavior suggests the need to implement strategies against psychological distress during the pandemic emergency, and to design psycho-educational interventions aimed at modifying the lifestyle for preventing risks of mental disorders fostering health-oriented behaviors.

Keywords: mood profile, eating disorder, college students, gender differences, fear of COVID-19

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****Correspondence:***
Daniela Conti
d.conti@shu.ac.uk

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INTRODUCTION

As of March 2020, coronavirus disease SARS-CoV-2 (COVID-19) has been declared a "pandemic" by the world health organization (WHO). This has led to the need for governments around the world to implement restrictive containment and isolation measures to stem the spread of the virus; these measures have provided for social distancing, isolation and quarantine, shifting mainly online social relations, and educational processes.

The consequences on mental health from the COVID-19 pandemic, because of the containment measures adopted, are comparable to the psychopathology pictures described in similar epidemic situations. Recent reviews of epidemiological studies related to the 2003 SARS epidemic highlighted the presence of post-traumatic symptoms, depression, stress, irritability, anxiety, insomnia, anger and emotional exhaustion, due to the impact of containment measures on mental health (Brooks et al., 2020; Mengin et al., 2020). These syndromic pictures appear almost confirmed by studies on the new pandemic carried out in different parts of the world. A study by Jungmann and Witthöft (2020) showed an increase in virus-related anxiety, especially in subjects with higher health anxiety traits. Furthermore, in a sample of 256 adults Lee and Crunk (2020) showed that hypochondria was among the fear factors that predict pandemic-related psychopathology.

Results of another study (Wang et al., 2020), carried out with 1210 respondents from 194 cities in China and conducted in the early stages of the epidemic, found that 53.8% of respondents rated the psychological impact of the epidemic as moderate or severe; 16.5% reported moderate to severe depressive symptoms; 28.8% reported moderate to severe anxiety symptoms, and 8.1% reported moderate to severe stress levels. Most of the respondents spent 20–24 h a day at home (84.7%); they were concerned about their family members who contracted COVID-19 (75.2%) and were satisfied with the amount of health information available (75.1%). Female gender, student status, specific physical symptoms (e.g., myalgia, dizziness), and poor health were significantly associated with a greater psychological impact of the epidemic and higher levels of stress, anxiety, and depression (Wang et al., 2020).

The literature on eating disorders has affirmed that these have a significant prevalence in women compared to men (McDonald and Thompson, 1992; Striegel-Moore et al., 2009). Although recent research has shown that prevalence in men was previously underestimated, these disorders have a clear female preponderance (Andersen and Yager, 2009). More recently, the study by Yu et al. (2018) analyzed the sexual differences in eating disorders among college students, highlighting that the female gender was a predictor of eating disorders and food addiction. The research on university students by Sonneville and Lipson (2018) showed that women, more than men, are diagnosed and treated for the symptoms of eating disorders and perceive, more than men, a need for treatment. Conversely, men are less likely to recognize that they have symptoms related to eating disorders and are therefore diagnosed and treated less than women.

An Italian study showed a high rate of post-traumatic stress symptoms, depression, anxiety, insomnia, perceived stress and adjustment disorder symptoms, with higher probabilities in young women. The duration of the quarantine, the fear of being infected, the frustration and boredom, related to the reduction or suspension of the daily activities in which everyone was engaged, the fear of not having enough supplies or possibility of supply were the causes of greater psychological stress, as well as the confusion surrounding the often inadequate information on the pandemic (Rossi et al., 2020).

At the beginning of the lockdown an interesting feature highlighted in various studies with an Italian sample, concerned the observation of abnormal and irrational behaviors such as the purchase and accumulation of many basic foods (e.g., sugar, wheat, milk, yeast) and the alteration of eating habits, given the growing flow of news on food uncertainty (Touyz et al., 2020). The most recognized causes of changes in eating habits with the increase in restrictive diets due to the concern related to weight and shape, and/or phases of binge eating seem to be: greater sedentary lifestyle, restrictions on outdoor activities, reduction of physical exercise, alterations in the sleep-wake rhythm and fear of contagion (Fernández-Aranda et al., 2020; Rodgers et al., 2020).

Furthermore, there is an extensive literature identifying that depression is associated during the isolation with an increased risk of overeating (Baenas et al., 2020; Mengin et al., 2020). Recent studies have confirmed the relationship between depressed mood and "pathological" eating habits, depression would be associated with an increased risk of overeating (Trojanowski and Fischer, 2018; Mills et al., 2019, 2020).

The research conducted by Termorshuizen et al. (2020) showed that during the COVID-19 pandemic and the consequent lockdown, the subjects with anorexia nervosa had increased the restrictions, as well as the subjects with bulimia nervosa and/or with binge eating disorder, had increased the binges. However, the same subjects had noticed the positive effects of staying in the family, of having more time for themselves, and were more motivated to stay in the hospital (Termorshuizen et al., 2020).

Regarding the effect of COVID-19 on patients with eating disorders, the severity of the symptoms of these disorders may increase unless a treatment according to guidelines can be started (Peckmezian and Paxton, 2020). The relation between eating behaviors and mood in persons without overt pathologies remains less known.

A particular population affected by mood and eating problems are university students. This population experienced during the pandemic a profound change in attitudes and behavioral habits, due to the shift in distance learning and the need, for many off-site students, to return to the family and the place of origin. With the consequence that they had to move from the university residences of the city center and the lifestyle acquired during the attendance of the courses. This change in behavioral habits could have different influences on the two genders.

In Italy, eating disorders affect more than three million people, of which 95.9% are women and 4.1% are men. The greater vulnerability found in females, adolescence or young adulthood, seems to indicate that these disorders are linked to difficulties in the transition from childhood to adult life. These appear to be triggered by specific physical and hormonal changes characteristic of puberty in females. However, epidemiological research also shows an increase in the male population.

The recent study by Guerdjikova et al. (2019) showed that unlike other eating disorders, the women/men ratio in the binge eating disorder (BED) is more balanced. BED occurs in conjunction with other psychiatric disorders, most commonly mood disorders and anxiety. BED is also associated with obesity and its many

complications. Although BED is similar in men and women in treatment presentation and outcomes, some key neurobiological differences should be considered when personalizing treatment.

Understanding sexual differences is a crucial aspect of the prevention and treatment of diet-related disorders.

Recently, various studies have investigated the relationship between COVID-19 and eating habits. Specifically, Amatori et al. (2020) examined a group of 176 college students and highlighted the negative impact of COVID-19 on mood states and healthy eating habits. Huber et al. (2020) found that the COVID-19 pandemic lockdown significantly affected eating habits in 1964 college students. The authors concluded that further investigation is needed to evaluate comorbidities and long-term effects on weight change.

Aims and Hypotheses

The aim of the present study was to investigate, in a sample of Italian college students, the relations between mood states and eating behavior during the current COVID-19 pandemic, deepening also the analysis of gender differences. Specifically, the main hypothesis is that negative emotive states could be correlated with the fear of COVID-19, prevalently in women. High scores in anxiety and depression are expected to be significantly correlated with a tendency to bulimic behavior. Furthermore, it is hypothesized that the gender variable moderates the impact of COVID-19 on mood states and eating behaviors.

MATERIALS AND METHODS

Participants

A sample of 469 college students (N = 221 males, N = 248 females) aged between 18 and 34 years (M = 22.47; SD = 2.70) were recruited via an online questionnaire, using the google form platform. The questionnaire was sent to students of the University of Catania (Italy) and distributed from March 2020 to February 2021. Specifically, only the questionnaires received during the periods and areas of lockdown were used for the purposes of the research. The survey was also shared on the Facebook page of the Department of Educational Sciences. All volunteer participants provided online informed consent and answered the questionnaire anonymously. The students involved in the research lived mainly with families.

This study was approved by the Ethic Committee of the Department of Educational Sciences of the University of Catania (Italy).

Measures

The participants were given an online protocol that included the Fear of COVID-19 scale (FCV-19S) for the evaluation of fear, the Profile of mood states (POMS) for the assessment of emotional states, the Eating disorder inventory-2 (EDI-2) and the Binge eating scale (BES) to evaluate the presence of eating disorders (APA, 2013).

Fear of COVID-19 Scale

The Fear of COVID-19 scale (FCV-19S) (Ahorsu et al., 2020) is a one-dimensional questionnaire composed of seven items (e.g., "I'm very afraid of coronavirus-19"; "It makes me uncomfortable to think about coronavirus-19"; "I can't sleep because I worry about getting coronavirus-19"), with a 5-point response scale (1 = strongly disagree to 5 = strongly agree) which assesses fear of COVID-19 and its consequences. The score is obtained by adding the scores to the questions. The scale showed good reliability ($\alpha = 0.87$).

Profile of Mood States (POMS)

The POMS (Grove and Prapavessis, 1992) is a widespread instrument that measures mood and identifies problematic affective states. The measure is a self-report questionnaire, and it is mainly used in the context of clinical psychology, psychotherapy, and medicine. The questionnaire consists of 58 adjectives that define six mood states: tension-anxiety (T), which describes an increase in somatic tension that may not be observable from the outside or may concern visible psychomotor manifestations; depression (D), which indicates a state of depression accompanied by a sense of personal inadequacy, the uselessness of effort, a sense of emotional isolation, melancholy and guilt; aggression-anger (A), which describes anger and dislike toward others; vigor-activity (V), adjectives that suggest exuberance, energy, euphoria, and optimism; tiredness-indolence (TI), which represents boredom, low energy, and physical fatigue; confusion (C), characterized by a sense of disturbance and linked to the organization-disorganization dimension, anxiety and the feeling of cognitive inefficiency.

The intensity with which a mood is experienced is measured on a 5-point Likert scale (0 = not at all, 1 = a little bit, 2 = moderately, 3 = quite a bit, and 4 = extremely). A TMD can be calculated by adding the scores for tension, depression, anger, tiredness, confusion and then subtracting the score for vigor. The scoring range goes from 0 to 250 $\pm$ 40 for the total scale (TMD), from 0 to 36 for the tension scale, from 0 to 60 for the depression scale, from 0 to 48 for the anger scale, from 0 to 32 for the strength scale, from 0 to 28 for the fatigue scale, and from 0 to 28 for the confusion scale. In this study, POMS showed good reliability ($\alpha = 0.85$). Also POMS subscales T, D, A, V, S, and C showed good reliability ($\alpha = 0.89$; $\alpha = 0.94$; $\alpha = 0.71$; $\alpha = 0.69$; $\alpha = 0.62$; $\alpha = 0.77$).

Eating Disorder Inventory-2 (EDI-2)

The EDI-2 (Garner, 1991; Espelage et al., 2003; Waldherr et al., 2008; De Pasquale et al., 2013) has been used for the clinical evaluation of the social and behavioral aspects associated with eating disorders. It is also used as a screening tool in non-clinical populations. Specifically, it consists of 11 subscales, for a total of 91 items, where only two scales directly measure eating behavior: drive to thinness (DT), and bulimia (B); the other scales concern the relationship with the body, experiences of inadequacy and other more specifically social areas: body dissatisfaction (BD), ineffectiveness (I), interoceptive awareness (IA), perfectionism (P), interpersonal distrust (ID), maturity fears (MF), asceticism (A), impulsivity (I), and social insecurity (SI). The score for

each question is given on a 6-point Likert scale (0 = never, to 6 = always). Higher scores indicated the presence of dysfunctional eating behaviors. In this study EDI-2 showed good reliability (α = 0.89). Also, the subscales of EDI-2 showed good reliability (α ranging from 0.68 to 0.95).

Binge Eating Behaviors (BES)

The BES (Gormally et al., 1982) is a sixteen-question questionnaire used to assess the presence and the level of binge eating behaviors indicative of an eating disorder. The questions are based on behavioral characteristics (e.g., the amount of food consumed) and emotional, cognitive, guilt, or shame response. Each question has three/four separate answers which are assigned a numerical value. The scoring range is from 0 to 46: no-binging for values less than or equal to 17, moderate binging for values between 18 and 26, and strong binging for values equal to or greater than 27. In this study, the BES showed good reliability (α = 0.90).

Data Analysis

We ran on our data a set of basic statistical analyses, *t* for groups differences, correlation, linear regression, and also three moderation analyses to understand if the relationship between two variables is moderated by the value of a third variable. SPSS version no. 26 was used for the analyses. The data satisfied the assumptions of normality of the distribution, suitable for parametric analyses.

RESULTS

Table 1 shows the mean and standard deviation of FCV-19S, POMS, EDI-2, and BES. The sample in the whole was found to be no-binging (mean total BES score of 8.04, much lower than the critical value of 17), as well as no pathological alterations in mood was evidenced (total mood disturbance score – TMD of the sample: 60.08). Furthermore, the dimensions explored with EDI-2 did not show significant disease scores. These results confirmed the substantial non-pathological condition of the sample, allowing the results to be interpreted as usual dynamics in a condition of "normal" distress for the isolation due to the pandemic.

Table 2 shows the gender differences in FCV-19S, POMS, EDI-2, and BES calculated through the *t*-test of independent samples. The results presented significant differences concerning gender in some variables: FCV-19S total score, interoceptive awareness of EDI-2, BES total score and T, TI, D, C, TMD of POMS. Specifically, women were more exposed to fear of COVID-19 showing significantly higher levels of tension, fatigue, depression and confusion and a higher total mood disturbance score than males. Furthermore, Cohen's *d* was calculated to indicate the effect size. In detail, the effects of gender differences are larger for FVC-19S, IA, TMD (total score and several sub-scores).

Pearson's correlations are shown in **Table 3**. All the emotional states and the mood total score (TMD) measured with POMS, were significantly correlated with fear of COVID-19 (FCV-19S). Furthermore, the difficulty of maintaining responsible and maturity behavior (MF), bulimic behavior (B), drive to thinness (DT), difficulty in recognize and identify emotions (IA), assessed with EDI-2, up to possible binge eating behaviors (BES), were correlated with fear of COVID-19 Scale (FCV-19S). The emotional states (T, A, and D) assessed with POMS were significantly correlated with bulimic behavior (B), interoceptive awareness (IA), ineffectiveness (I) of EDI-2, and binge eating behaviors (BES).

Table 4 reports the results of the linear regression between the independent variable (FCV-19S) and dependent variables (TMD, EDI-2 total score, and BES). The results show that fear of COVID-19 appears to be a predictor of mood changes (TMD) and of disordered eating behavior (assessed by EDI-2 and BES).

Three moderation analyses were conducted in which fear of COVID-19 was considered as a predictor variable, sex as a moderator variable and EDI-2, BES, and TMD as dependent variables, respectively.

These analyses revealed significant effect of fear of COVID-19:

-For eating disorders measured by EDI-2 (β = 1.10, $SE = 0.34$, $p < 0.01$) but not by sex (β = −2.10, $SE = 8.0$, $p = 0.79$). The interaction effect was also not significant (β = 0.29, $SE = 0.46$, $p = 0.53$).

-For binge eating disorders measured by BES (β = 0.27, $SE = 0.08$, $p < 0.01$) but not by Sex (β = 2.50, $SE = 2.00$, $p = 0.20$). The interaction effect was also not significant (β = −0.08, $SE = 0.11$, $p = -0.72$).

-Mood changes (TMD) (β = 2.10, $SE = 0.44$, $p < 0.01$) but not by Sex (β = −2.10, $SE = 10$, $p = 0.83$). The interaction effect was also not significant (β = 0.57, $SE = 0.61$, $p = 0.35$).

DISCUSSION AND CONCLUSION

The data from this study are consistent with the current literature regarding the impact of COVID-19 on the emotional states and eating behaviors of young people.

Studies carried out before the COVID-19 period had already analyzed the link between eating behaviors and

TABLE 1 | Mean and standard deviation of FCV-19S, POMS, EDI-2, and BES.

	FCV-19 S	BD	DT	MF	B	IA	I	ID	P	BES	T	A	TI	D	C	TMD
M	15.90	28.30	23.50	25.80	15.80	29.10	30.90	24.60	20.90	8.04	13.70	15.10	13.10	18.90	13.10	60.00
SD	6.06	4.68	9.00	5.78	7.539	9.20	5.55	4.15	6.04	7.81	7.52	10.6	6.65	13.8	5.69	42.7

FCV-19S, Fear of COVID-19 Scale; BD, Body Dissatisfaction; DT, Drive for Thinness; MF, Maturity Fears; B, Bulimia; IA, Interoceptive Awareness; I, Ineffectiveness; ID, Interpersonal Distrust; P, Perfectionism; BES, Binge Eating Scale; T, Tension; A, Anger; TI, Tiredness; D, Depression; C, Confusion; TMD, Total Mood Disturbance.

TABLE 2 | Gender differences in FCV-19S, POMS, EDI-2, and BES measured using independent samples *t*-test.

	Gender	*Mean*	*SD*	*t*	*p* (df = 467)	Cohen's *d*	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
FVC-19S	M	15.02	6.02	−2.98	< 0.01	−0.28	−1.65	0.55	−2.75	−0.56
	F	16.68	6.00							
BD	M	28.32	4.79	0.07	0.94	< 0.01	0.03	0.43	−0.82	0.88
	F	28.29	4.58							
DT	M	26.28	5.70	−1.57	0.12	−0.21	−1.09	0.69	−2.46	0.27
	F	25.50	5.84							
MF	M	22.51	8.59	1.44	0.15	0.13	0.77	0.53	−0.27	1.82
	F	24.41	9.29							
B	M	15.29	7.27	−1.57	0.12	−0.15	−1.09	0.69	−0.32	0.36
	F	16.39	7.74							
IA	M	15.29	7.27	−2.95	< 0.01	−0.27	−2.49	0.84	−4.15	−0.83
	F	16.39	7.74							
I	M	27.74	9.12	−0.65	0.52	−0.06	−0.33	0.51	−1.34	0.67
	F	30.24	9.13							
ID	M	30.74	5.46	0.25	0.80	0.02	0.09	0.38	−0.65	0.85
	F	31.07	5.63							
P	M	24.69	3.88	0.54	0.59	0.05	0.30	0.55	−0.79	1.40
	F	24.59	4.38							
BES	M	7.21	7.53	−2.19	0.03	−0.20	−1.58	0.72	−2.99	−0.16
	F	8.79	8.00							
T	M	12.56	7.10	−3.31	< 0.01	−0.31	−2.28	0.68	−3.63	−0.92
	F	14.84	7.73							
A	M	14.38	10.39	−1.51	0.13	−0.14	−1.49	0.98	−3.42	0.43
	F	15.88	10.84							
TI	M	12.24	6.73	−2.74	< 0.01	−0.25	−1.67	0.61	−2.88	−0.47
	F	13.92	6.50							
D	M	17.03	12.53	−2.80	< 0.01	−0.26	−3.56	1.27	−6.06	−1.06
	F	20.59	14.72							
C	M	17.11	7.09	−2.90	< 0.01	−0.27	−1.51	0.52	−2.54	−0.49
	F	14.76	6.93							
TMD	M	12.31	5.39	−2.79	< 0.01	−0.26	−10.96	3.92	−18.67	−3.25
	F	13.83	5.86							

M, Male; F, Female; FCV-19S, Fear of COVID-19 Scale; BD, Body Dissatisfaction; DT, Drive for Thinness; MF, Maturity Fears; B, Bulimia; IA, Interoceptive Awareness; I, Ineffectiveness; ID, Interpersonal Distrust; P, Perfectionism; BES, Binge Eating Scale; T, Tension; A, Anger; TI, Tiredness; D, Depression; C, Confusion; TMD, Total Mood Disturbance.

emotional states. Micanti et al. (2017) showed that eating behavior is connected to an emotional dysregulation connected to some mental dimensions: impulsivity, body image, and anxiety. Where there is an increase in this size, there could be an imbalance in the emotional regulation system. This leads the subjects to adopt dysfunctional eating behaviors (Micanti et al., 2017).

The sample of our study did not show pathological changes in eating behaviors and mood states. Specifically, results confirmed the substantial non-pathological condition of the sample, allowing the results to be interpreted as typical dynamics in a condition of distress for the isolation due to the pandemic. However, it is interesting to note how the fears related to COVID-19 increase with the increase in mood regulation and eating behaviors. Significant correlations were highlighted between the total score of mood states, some dimensions measured with EDI-2 (MF, B, DT, IA) up to possible binge eating behaviors measured with BES and fear of COVID-19.

The regression analysis of the study showed how fear associated with COVID-19 is a predictor of both mood states and eating behaviors. Therefore, a particularly traumatic event such as COVID-19 could make latent discomfort evident. In this period of pandemic, we were "bombed" with news that always associated with the virus, infections, hospitalized in intensive care units, deaths. This led the subjects to "mull over" always on the same topics, even more during the period of isolation, in which many distractions were not possible. This finding is supported by recent literature by Smith et al. (2018). In details, the authors have highlighted how rumination, a cognitive process in which repetitive thoughts

TABLE 3 | Pearson's correlations between FCV-19S, POMS, EDI-2, and BES.

	T	A	TI	D	C	TMD	FCV-19S
FCV-19S	0.41**	0.31**	0.35**	0.33**	−0.15**	0.36**	1.00
EDI-2							
BD	−0.06	−0.01*	−0.04	−0.08	0.22**	−0.04	0.07
DT	0.30**	0.21**	0.36**	0.31**	−0.33**	0.29**	0.12*
MF	0.34**	0.30**	0.27**	0.48**	−0.11*	0.33**	0.28**
B	0.45**	0.37**	0.43**	0.43**	−0.28**	0.369**	0.24**
IA	0.63**	0.57**	0.58**	0.67**	−0.45**	0.60**	0.30**
I	0.34**	0.37**	0.35**	0.55**	−0.13**	0.43**	0.04
ID	0.08	< 0.01	0.04	−0.11*	0.21**	0.04	0.14**
P	0.23**	0.18**	0.17**	0.23**	−0.01	0.17**	−0.03
BES	0.38**	0.33**	0.36**	0.41**	−0.32**	0.31**	0.19**

$^{**}p < 0.01$; $^{*}p < 0.05$.
T, Tension; A, Anger; TI, Tiredness; D, Depression; C, Confusion; TMD, Total Mood Disturbance; FCV-19S, Fear of COVID-19 Scale; EDI-2, Eating Disorder Inventory-2; BD, Body Dissatisfaction; DT, Drive for Thinness; MF, Maturity Fears; B, Bulimia; IA, Interoceptive Awareness; I, Ineffectiveness; ID, Interpersonal Distrust; P, Perfectionism; BES, Binge Eating Scale.

TABLE 4 | Linear model of fear COVID-19 predictor of profile mood state (TMD) and disordered eating behaviors (EDI-2 and BES).

	Standardized coefficients	*t*	*p*	95% confidence interval for B	
	Beta			Lower bound	Upper bound
BES					
Constant		4.25	<0.01	2.27	6.19
FCV-19S	0.19	4.09	<0.01	0.12	0.36
EDI-2					
Constant		38.14	<0.01	142.50	157.90
FCV-19S	0.25	5.60	<0.01	0.84	1.75
TMD					
Constant		3.84	<0.01	9.71	30.00
FCV-19S	0.36	8.31	<0.01	1.93	3.13

about negative experiences and emotions prevail, is implicated in the psychopathology of behaviors and/or eating disorders (Smith et al., 2018).

As showed in a recent study by Sarwer et al. (2019) the impulse control plays a dominant role in eating disorders. Furthermore, this research highlighted how the dimensions of "tension" and "anger" are correlated with bulimic-type eating behaviors.

A recent study (McCuen-Wurst et al., 2018) underlined how eating disorders are associated with some psychopathological dimensions, such as particular anxiety, mood disorders. These data are in line with the results of our study because the subjects examined there were many significant correlations between mood states and eating behaviors.

Several studies report a higher rate of eating disorders in the female gender (Asarian and Geary, 2013; Taha et al., 2018). Moreover, in this study the binge eating disorder showed a gender significant difference, with prevalence in female. As regards the other variables of eating behavior evaluated with EDI-2, no significant gender differences were highlighted. On the other hand, women were more exposed to fear of COVID-19 showing greater tension, fatigue, depression, confusion and a significantly higher total mood disturbance score than males. However, although COVID-19 is found to be a predictor of both mood states and eating behaviors, the moderation analysis highlighted how the gender variable does not significantly intervene in moderating this result, differentiating these results from other previously obtained in conditions of real pathologies.

Finally, a number of important limitations need to be considered. First: it constitutes only a preliminary investigation of some interesting variables examined during the COVID-19 pandemic. Indeed, the study participants do not constitute a sample of subjects diagnosed with eating disorders, so the results are linked to the consequences of the "normal" stress due to the fear of pandemics. Second: a limitation of this study is that the analysis doesn't provide additional comparisons of the three variables altogether with SEM models, which was not in the scope of this study. Third: another important limitation is the lack of available comparisons between pre and post COVID-19 experiences. Indeed, the new findings added by this research concern emotional states and eating behavior during the COVID-19 conditions. This limit is important to keep in mind, as it is not possible to know if the conditions found in our sample would have been highlighted even in the absence of a COVID-19 pandemic. Acknowledging the study's limitations, we note that future longitudinal clinical research could improve this preliminary knowledge. More longitudinal research is therefore needed to provide a deeper understanding of the long-term impact of COVID-19 conditions on eating disorders and mood states, also in non-pathological samples.

The data gives indications relating to the possibility that targeted preventive interventions can be carried out aimed at certain categories of subjects, such as university students, regardless of gender. For example, it would be important to provide support regarding the variables where difficulties have been identified (e.g., the emotional aspects more correlated with the fear of pandemics, as the difficulty in recognize and identify emotions), to avoid that, with a particularly stressful event, more serious discomfort can be revealed.

Considering that alterations in the emotional profile and maladaptive eating behaviors respond well to supportive interventions, we can suggest the need to implement strategies against psychological distress during the health emergency by COVID-19, and to design psycho-educational interventions, in young people too, aimed at modifying the lifestyle and behaviors at risk of mental disorder in favor of health-oriented behaviors. Moreover, as has been suggested (Talevi et al., 2020), evidence about these preventive aims is needed for the future.

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 Ethic Committee of the Department of Educational Sciences of the University of Catania (Italy).

AUTHOR CONTRIBUTIONS

CD, DC, and SD: conceptualization. CD, FS, MP, and ZH: methodology. FS: validation. FS and ZH: formal analysis. MP: investigation. DC: data curation. CD, MP, and FS: writing-original draft preparation. CD, DC, and MP: writing-review and editing. RLC and SD: visualization and supervision. RLC and CD: funding acquisition. All authors contributed to the article and approved the submitted version.

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REFERENCES

Andersen, A. E., and Yager, J. (2009). "Eating disorders," in *Kaplan and Sadock's Comprehensive Textbook of Psychiatry* eds B. J. Sadock, V. A. Sadock, and P. Ruiz. 9th ed. (Philadelphia: Lippincott Williams and Wilkins), 2128–2149. doi: 10.4103/0019-5545.161493

APA (2013). *Diagnostic and Statistical Manual of Mental Disorders (DSM-5§)*. Washington, DC: APA.

Ahorsu, D. K., Lin, C.-Y., Imani, V., Saffari, M., Griffiths, M. D., and Pakpour, A. H. (2020). The fear of COVID-19 scale: development and initial validation. *Int. J. Ment. Health Addict.* 1–9. doi: 10.1007/s11469-020-00270-8

Amatori, S., Donati Zeppa, S., Preti, A., Gervasi, M., Gobbi, E., Ferrini, F., et al. (2020). dietary habits and psychological states during COVID-19 home isolation in italian college students: the role of physical exercise. *Nutrients* 12:3660.

Asarian, L., and Geary, N. (2013). Sex differences in the physiology of eating. *Am. J. Physiol. Regul. Integr. Comp. Physiol.* 305, R1215–R1267. doi: 10.1152/ajpregu.00446.2012

Baenas, I., Caravaca-Sanz, E., Granero, R., Sánchez, I., Riesco, N., Testa, G., et al. (2020). COVID-19 and eating disorders during confinement: analysis of factors associated with resilience and aggravation of symptoms. *Eur. Eat. Disord. Rev.* 28, 855–863. doi: 10.1002/erv.2771

Brooks, S. K., Webster, R. K., Smith, L. E., Woodland, L., Wessely, S., Greenberg, N., et al. (2020). The psychological impact of quarantine and how to reduce it: rapid review of the evidence. *Lancet* 395, 912–920. doi: 10.1016/S0140-6736(20)30460-8

De Pasquale, C., Pistorio, M. L., Tornatore, E., De Berardis, D., and Fornaro, M. (2013). The relationship between drive to thinness, conscientiousness and bulimic traits during adolescence: a comparison between younger and older cases in 608 healthy volunteers. *Ann. Gen. Psychiatry.* 12, 1–5. doi: 10.1186/1744-859X-12-34

Espelage, D. L., Mazzeo, S. E., Aggen, S. H., Quittner, A. L., Sherman, R., and Thompson, R. (2003). Examining the construct validity of the eating disorder inventory. *Psychol. Assess.* 15, 71–80. doi: 10.1037/1040-3590.15.1.71

Fernández-Aranda, F., Casas, M., Claes, L., Bryan, D. C., Favaro, A., Granero, R., et al. (2020). COVID-19 and implications for eating disorders. *Eur. Eat. Disord. Rev.* 28:239. doi: 10.1002/erv.2738

Garner, D. M. (1991). *EDI-2: Eating Disorder Inventory-2*. Odessa: Psychological Assessment Resources.

Gormally, J., Black, S., Daston, S., and Rardin, D. (1982). The assessment of binge eating severity among obese persons. *Addict. Behav.* 7, 47–55. doi: 10.1016/0306-4603(82)90024-7

Grove, J. R., and Prapavessis, H. (1992). Preliminary evidence for the reliability and validity of an abbreviated profile of mood states. *Int. J. Sport Psychol.* 23, 93–109.

Guerdjikova, A. I., Mori, N., Casuto, L. S., and McElroy, S. L. (2019). Update on binge eating disorder. *Med. Clin. North Am.* 103, 669–680. doi: 10.1016/j.mcna.2019.02.003

Huber, B. C., Steffen, J., Schlichter, J., and Brunner, S. (2020). Altered nutrition behavior during COVID-19 pandemic lockdown in young adults. *Eur. J. Nutr.* 32 1–10. doi: 10.1007/s00394-020-02435-6

Jungmann, S. M., and Witthöft, M. (2020). Health anxiety, cyberchondria, and coping in the current COVID-19 pandemic: Which factors are related to coronavirus anxiety? *J. Anxiety Disord.* 73:102239. doi: 10.1016/j.janxdis.2020.102239

Lee, S. A., and Crunk, E. A. (2020). Fear and psychopathology during the COVID-19 crisis: neuroticism, hypochondriasis, reassurance-seeking, and coronaphobia as fear factors. *OMEGA J. Death Dying* 30222820949350. doi: 10.1177/0030222820949350 [Epub ahead of print].

McCuen-Wurst, C., Ruggieri, M., and Allison, K. C. (2018). Disordered eating and obesity: associations between binge eating-disorder, night-eating syndrome, and weight-related co-morbidities. *Ann. N. Y. Acad Sci.* 1411:96. doi: 10.1111/nyas.13467

McDonald, K., and Thompson, J. K. (1992). Eating disturbance, body image dissatisfaction, and reasons for exercising: gender differences and correlational findings. *Int. J. Eat. Disord.* 11, 289–292. doi: 10.1002/1098-108X(199204)11:3<289::AID-EAT2260110314>3.0.CO;2-F

Mengin, A., Allé, M. C., Rolling, J., Ligier, F., Schroder, C., Lalanne, L., et al. (2020). Conséquences psychopathologiques du confinement. *Encephale* 46, S43–S52. doi: 10.1016/j.encep.2020.04.007

Micanti, F., Iasevoli, F., Cucciniello, C., Costabile, R., Loiarro, G., Pecoraro, G., et al. (2017). The relationship between emotional regulation and eating behaviour: a multidimensional analysis of obesity psychopathology. *Eat. Weight Disord.* 22, 105–115. doi: 10.1007/s40519-016-0275-7

Mills, J. G., Larkin, T. A., Deng, C., and Thomas, S. J. (2019). Weight gain in major depressive disorder: linking appetite and disordered eating to leptin and ghrelin. *Psychiatry Res.* 279, 244–251. doi: 10.1016/j.psychres.2019.03.017

Mills, J. G., Thomas, S. J., Larkin, T. A., and Deng, C. (2020). Overeating and food addiction in major depressive disorder: links to peripheral dopamine. *Appetite* 148:104586. doi: 10.1016/j.appet.2020.104586

Peckmezian, T., and Paxton, S. J. (2020). A systematic review of outcomes following residential treatment for eating disorders. *Eur. Eat. Disord. Rev.* 28, 246–259. doi: 10.1002/erv.2733

Rodgers, R. F., Lombardo, C., Cerolini, S., Franko, D. L., Omori, M., Fuller-Tyszkiewicz, M., et al. (2020). The impact of the COVID-19 pandemic on eating disorder risk and symptoms. *Int. J. Eat. Disord.* 53, 1166–1170. doi: 10.1002/eat.23318

Rossi, R., Socci, V., Talevi, D., Mensi, S., Niolu, C., Pacitti, F., et al. (2020). COVID-19 pandemic and lockdown measures impact on mental health among the general population in Italy. *Front. Psychiatry* 11:790.

Sarwer, D. B., Allison, K. C., Wadden, T. A., Ashare, R., Spitzer, J. C., McCuen-Wurst, C., et al. (2019). Psychopathology, disordered eating, and impulsivity as

predictors of outcomes of bariatric surgery. *Surg. Obes. Relat. Dis.* 15, 650–655. doi: 10.1016/j.soard.2019.01.029

Smith, K. E., Mason, T. B., and Lavender, J. M. (2018). Rumination and eating disorder psychopathology: a meta-analysis. *Clin. Psychol. Rev.* 61, 9–23. doi: 10.1016/j.cpr.2018.03.004

Sonneville, K. R., and Lipson, S. K. (2018). Disparities in eating disorder diagnosis and treatment according to weight status, race/ethnicity, socioeconomic background, and sex among college students. *Int. J. Eat. Disord.* 51, 518–526. doi: 10.1002/eat.22846

Striegel-Moore, R. H., Rosselli, F., Perrin, N., DeBar, L., Wilson, G. T., May, A., et al. (2009). Gender difference in the prevalence of eating disorder symptoms. *Int. J. Eat. Disord.* 42, 471–474. doi: 10.1002/eat.20625

Taha, A. A. A. E.-A., Abu-Zaid, H. A., and Desouky, D. E.-S. (2018). Eating disorders among female students of Taif University. *Saudi Arabia. Arch. Iran. Med.* 21, 111–117. doi: 10.3389/fpsyg.2020.586706

Talevi, D., Pacitti, F., Socci, V., Renzi, G., Alessandrini, M. C., Trebbi, E., et al. (2020). The COVID-19 outbreak: impact on mental health and intervention strategies. *J. Psychopathol.* 26, 162–170. doi: 10.36148/2284-0249-393

Termorshuizen, J. D., Watson, H. J., Thornton, L. M., Borg, S., Flatt, R. E., MacDermod, C. M., et al. (2020). Early impact of COVID-19 on individuals with self-reported eating disorders: a survey of 1,000 individuals in the United States and the Netherlands. *Int. J. Eat. Disord.* 53, 1780–1790. doi: 10.1101/2020.05.28.20116301

Touyz, S., Lacey, H., and Hay, P. (2020). Eating disorders in the time of COVID-19. *J. Eat. Disord.* 8:19. doi: 10.1186/s40337-020-00295-3

Trojanowski, P. J., and Fischer, S. (2018). The role of depression, eating disorder symptoms, and exercise in young adults' quality of life. *Eat. Behav.* 31, 68–73. doi: 10.1016/j.eatbeh.2018.08.005

Waldherr, K., Favaro, A., Santonastaso, P., Van Strien, T., and Rathner, G. (2008). Comparison of the eating disorder inventory (EDI) in the Netherlands. *Austria Italy. Eur. Eat. Disord. Rev.* 16, 472–479. doi: 10.1002/erv.881

Wang, C., Pan, R., Wan, X., Tan, Y., Xu, L., Ho, C. S., et al. (2020). Immediate psychological responses and associated factors during the initial stage of the 2019 coronavirus disease (COVID-19) epidemic among the general population in China. *Int. J. Environ. Res. Public Health.* 17:1729. doi: 10.3390/ijerph17051729

Yu, Z., Indelicato, N. A., Fuglestad, P., Tan, M., Bane, L., and Stice, C. (2018). Sex differences in disordered eating and food addiction among college students. *Appetite* 129, 12–18. doi: 10.1016/j.appet.2018.06.028

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BRIEF RESEARCH REPORT
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A Brief Research Report on the Perception and Satisfaction of Italian University Students With Disabilities and Specific Learning Disabilities at the Emergency Remote Teaching During the COVID-19 Lockdown

*Luna Carpinelli, Giorgia Bruno and Giulia Savarese**

Department of Medicine and Surgery, University of Study of Salerno, Baronissi, Italy

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Edited by:
Jesús-Nicasio García-Sánchez, Universidad de León, Spain

Reviewed by:
Caterina Buzzai, Kore University of Enna, Italy
Valentina Lucia La Rosa, University of Catania, Italy

****Correspondence:***
Giulia Savarese
gsavarese@unisa.it

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Introduction: The COVID-19 pandemic has inevitably transformed face-to-face teaching to remote teaching (e-learning or blended) which has had psychological and social impacts on the mental health of university students.

Object: In this study, we surveyed university students with disabilities and specific learning disabilities (SLDs) on their perceptions of and satisfaction with emergency remote teaching (ERT) during the lockdown phase (March–April 2020) and following restrictions due to the COVID-19 pandemic. We compared the responses of students with disabilities and SLDs with those of normotypical students.

Methodology: A questionnaire was completed remotely: five items on the ERT were designed as ad hoc questions and five items were taken from the Short Form 12 Health Survey (SF-12) to evaluate physical and mental self-perceived health. There was a total of 163 students surveyed, 67 students with disabilities and/or SLDs and 96 normotypical students.

Results and Conclusion: Students with disabilities and SLDs were more satisfied with remote teaching than the normotypical students. In fact, only 22% of the students with disabilities or SLDs indicated that they were dissatisfied with the teaching method used due to difficulties encountered, including those related to a weak technological infrastructure. We found that among all the students, important social and emotional aspects emerged as a consequence of the absence of interactions and relationships with both faculty and peer groups.

Keywords: COVID-19, lockdown, emergency remote learning, disabilites, specific learning disabilities

INTRODUCTION

With the COVID-19 pandemic, there have been inevitable and ongoing psychological and social impacts on the mental health of the population (Liu et al., 2020; Marinaci et al., 2020), which necessitates immediate interventions. In particular, the academia in Italy has been affected by the radical freezing of in-person teaching activities.

The transformation from face-to-face to remote teaching under anxious and sudden conditions linked to the outbreak of the pandemic (UNESCO, 2020) was immediate, even in non-telematic university contexts, which are different from those where teaching has been practiced for some time in online (e-learning) or mixed (blended) teaching formats (Pursel et al., 2016; Shale, 2002) or different from real telematic universities (Bates, 2020). The sudden and generalized transformation from the prevailing model of face-to-face teaching to the emergency remote teaching (ERT) modality, coinciding with the start of the second academic semester, was imposed to safeguard the right to study and perform ordinary teaching and research activities. However, the different representations of learning conveyed by the two different models were not considered (Coppola et al., 2015; Marsico, 2018; Teixeira et al., 2019).

A topic of particular relevance that was amplified by the foreclosure of in-person teaching activities is the impact of ERT on students with disabilities and specific learning disabilities (SLDs), which is a steadily growing population in higher education both in Italy and internationally (Pavone, 2018). Under normal conditions, this population is already considered more fragile and demanding (Herburger, 2020).

Bao (2020), who interviewed students about online study, highlighted their concerns especially about Internet connectivity and increased problems with asynchronous teaching. Liu et al. (2020) revealed difficulties related to distance learning, especially due to the weakness of the technological infrastructure of online teaching due to the inexperience of teachers, and the home environment experienced as intrusive to privacy.

In several recent studies (Zhang et al., 2020; Thelwall and Levitt, 2020; Favieri et al., 2020), increased psychological distress associated with social distancing was found in students with and without a disability compared with a normotypical group. Additional study (Toquero, 2020) showed that youth with psychosocial disabilities have suffered more in terms of their mental health during the crisis period. The greatest difficulties found on the educational side are related to accessibility to online learning or communication tools (Zhang et al., 2020). Liu et al. (2020) also noted difficulties related to ERT, mainly due to the weakness of the online teaching technology infrastructure, teachers' inexperience, and the home environment lacking privacy.

Thus, information gained from surveys on this ERT plan can act as a reference for in-depth reflections on the strengths and potential as well as the negative aspects of the distance model for university students, including those with disabilities and/or SLDs.

Hypothesis

We hypothesize that, although the problems related to the COVID-19 pandemic have compromised everyone's psychophysical level, ERT has provided support for students with disabilities through technological tools and the presence, albeit virtual, of online classes.

Aim

We aim at determining the perceptions of university students toward online learning that was implemented in all Italian universities during the COVID-19 lockdown.

Our objective is to highlight the perceptions of students on their experience with ERT and dedicated services (lectures, exams, and tutoring) delivered during the lockdown phase (March–April 2020) in order to monitor the psychological health of students and to understand the strengths and weaknesses of remote teaching. The responses of students with disabilities and SLDs were compared with those of a group of developmentally normotypical students.

METHODS

Procedure

A descriptive and qualitive study was conducted at the end of April 2020, after the students of all institutions had at least 2 months of experience with online learning.

The questionnaire was administered to students enrolled in the Degree Courses of the University of Salerno through an e-mail invitation containing the link to be accessed on the Survey Monkey online platform. After having read and consented to the informed consent that explained the aim of the survey and the processing of personal data, made anonymous, each student accessed the sections to be completed in the questionnaire.

During the national lockdown that occurred in March 2020, the University of Salerno guaranteed material support to all students by delivering PCs and tablets with Internet connection to guarantee similar access to ERT.

Instrument

The questionnaire used in this study consisted of n°10 questions divided into two sections. The first section collected informations about the following anamnestic and socio-demographic characteristics of the participants, such as age (years), sex (male, female), degree course and possible diagnosis of disabilities and/or SLDs. The second section consists of n°5 open-ended and so-called "filter" questions that investigate the perception of the quality of the ERT and related activities and n°5 items taken directly from the Italian version of the Short-Form Health Survey 12-SF-12 (Ware et al., 1995), an abbreviated version of the SF-36, a generic indicator of the quality of life and evaluates the subjective perception of the individual in relation to the concept of health, understood as biopsychosocial well-being and exhibits good psychometric properties in different cohorts of patients (e.g., general and disease-specific populations) (White et al., 2018).

The response modalities were mixed and included dichotomous (yes/no) questions, multiple-choice questions using both 4- and 5-point Likert-type response scales ("always" to "never" and "strongly disagree" to "strongly agree"), and an open-ended response question (item #9).

The online questionnaire was created according to the CHERRIES statement (Eysenbach, 2012).

Participants

Data were collected from all Degree Courses, such as Medicine and surgery, Engineering, Communication sciences, Education sciences, Law, and Economics.

There were a total of 163 participants, of which 67 had disabilities and/or SLDs (M = 36,4%; Mean age = 23 years; SD = 3,5) and 96 had normotypical development (M = 46,9%; Mean age = 25,06 years; SD = 3,74). Specifically, of the students with special education needs, 84% had disabilities and 16% had learning disabilities.

Data Analysis

Our study is part of the "post-event" qualitative feedback survey activities. Data collected were extracted from Survey Monkey by creating a spreadsheet and imported to SPSS (IBM v.26 INC. Chicago, IL, United States). A preliminary check analysis was performed to assess possible errors, outliers, and missing data.

Frequencies, means, and standard deviations were calculated through descriptive statistics and were used to describe the socio-demographic characteristics of the respondents and the elements of the questionnaires.

As a preliminary analysis, the assessment of associations between socio-demographic characteristics and SF-12 was conducted using multivariate regression models expressing standardized estimates (β) and the related 95% confidence intervals (95% CI).

Responses to the questionnaire were compared with percentages to detect the presence and/or absence of the variables being examined and show the number of students who have given a specific answer compared to the total number of the sample who answered the question.

The SF-12 includes both categorical and discrete elements, for which the maximum likelihood and the least squared weighted estimator of adjusted mean and variance has been adopted. The CFA determines how well the theoretical scale model fits the empirical data (structure validity or dimensionality). Following the approach of previous studies (Ware et al., 1995; Okonkwo et al., 2010) referring to different groups with both diagnoses (both patients and healthy subjects), we performed a CFA on the SF-12 responses to confirm the two-factor structure and the factors were allowed to correlate.

An open-ended question analysis was conducted using T-Lab Plus (Lancia, 2004) content analysis software. The pre-processing steps include: text segmentation, automatic lemmatization or stemming, multi-word and stop-word detection, key-term selection. The thematic analysis tools deal mostly with finding patterns of key-words within context units. all analysis units (i.e. words, text segments and documents) have been grouped either by a bottom-up or a top-down approach.

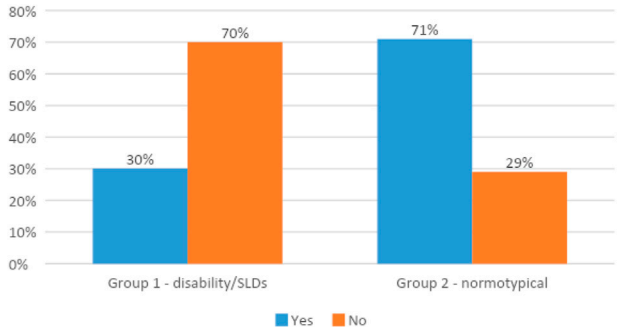

FIGURE 1 | Differences in percentage between groups relative to the item "Did you do your work or activities less carefully than usual?".

Ethical Statement

This study was conducted in accordance with the recommendations of the Associazione Italiana di Psicologia (AIP), and all the participants provided written informed consent in accordance with the Declaration of Helsinki prior to participation. As there is no psychological ethics committee at the University of Salerno, ethical review and approval were not required for a study on human participants in accordance with the local legislation and institutional requirements. The protocol was approved by an independent committee from the Centro di Counseling Psicologico (Psychological Counseling Center) of the University.

RESULTS

The test of the difference $\chi 2$ between the one-factor and two-factor models was found to be significant (TRd = −105.262; Δdf = 1; $p < 0.001$), supporting the hypothesis of an adequate discriminant validity of the two-factor solution that supported the scoring procedure. The internal consistency of the SF-12 in the raw score was adequate, exhibiting a Cronbach's α value of 0.892.

To accurately detect the presence or absence of the variables investigated, the participating students were divided into two groups: Group 1 (67 students with disabilities/SLDs) and Group 2 (96 students with normotypical development). Below, we provide the responses related to the questionnaire administered through a percentage comparison between the participating groups.

The differences between the groups in the responses to the items of the questionnaire administered were moderate and positive ($r = 0.329$; $p < 0.001$) and supports the *a priori* hypotheses of our survey.

In relation to the initial question, which explored whether students made less progress than they would have liked, 71% of Group 2 reported a decrease in concentration during study compared with 30% of students with disabilities/SLDs (Group 1, see **Figure 1**).

With regard to the psychological well-being dimension, we found significant differences in that there was a higher

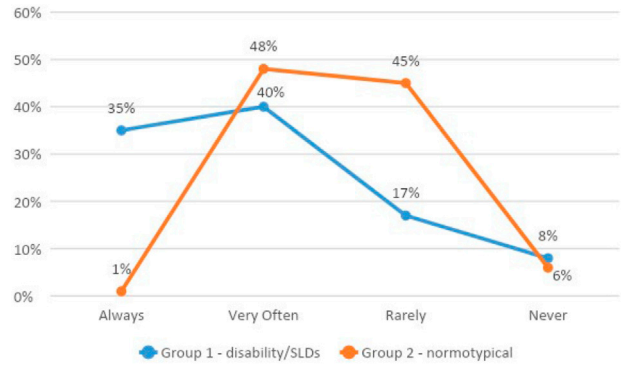

FIGURE 2 | Differences in percentage between groups relative to the item "Have you felt calm and peaceful?".

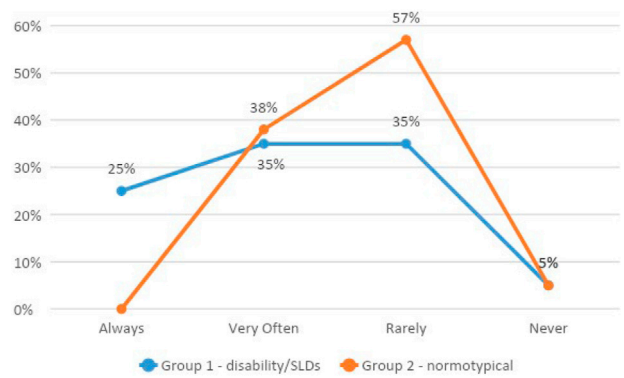

FIGURE 3 | Differences in percentage between groups relative to the item "Did you have a lot of energy?".

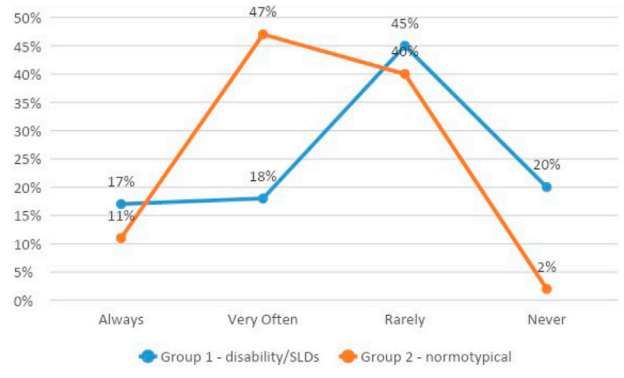

FIGURE 4 | Differences in percentage between groups relative to the item "Have you felt down-hearted and blue?".

vulnerability declared by the normotypical students compared with those in the disability/SLDs group.

In particular, in relation to whether there was a feeling of calm and serenity during the lockdown period, only 1% of Group 2 responded "always" compared with 35% of Group 1, in which, by contrast, 40% stated "very often" (see **Figure 2**).

Of individuals in Group 2, 57% reported that they "rarely" felt energized versus 35% in Group 1, of which 25% indicated "always" as their answer (see **Figure 3**).

Of significance is the data that emerged in relation to the item "Have you felt downhearted and blue?" to which 47% of participants in Group 2 responded "very often" compared with 18% of the students with disabilities/SLDs (**Figure 4**).

Regarding the evaluation of the items related to ERT, the responses of students with disabilities/SLDs were examined, as they were the main object of the survey. Specifically, 82% felt that "distance learning was useful" and 42% stated that "they would like to continue it after returning to face-to-face learning". For 85% of respondents "the University promptly supplied with online teaching".

With respect to the problems encountered, 68% said they experienced at least a few. The analysis of the textual content of the open-ended item #9 showed that students with disabilities/SLDs reported often having problems with their Wi-Fi connection and experienced some difficulties with following the distance tutoring but that, in general, they had had a positive experience; the greatest difficulties concerned not having a physical relationship with teachers; being forced to stay in a closed, although familiar, environment; and, above all, not being able to interact with their peers. In addition, someone highlighted privacy issues, such as feeling shameful after being heard by their fellow students during exams or due to having their home seen through the Microsoft Teams camera.

The ERT experience was evaluated very positively, and useful strengths emerged, such as the ability to record the lecture and listen to it again, having the lecturer's slides and notes in advance, using the computer, and avoiding the stress of traveling to attend lectures. Thirty-two percent of the students with disabilities/SLDs were satisfied with the current method of study.

Some students wished that the online mode will remain in the future as an alternative to provide accommodations for students with special needs. The most negative aspects were mainly related to the absence of comparison with peers and the lack of more continuous and immediate feedback from the teacher, as is generally the case when they are present in the classroom.

DISCUSSION AND CONCLUSION

In this study, we conducted a survey to evaluate the perceptions and satisfaction of university students with disabilities and specific learning disabilities (SLDs) for emergency remote teaching (ERT) during the lockdown phase (March–April 2020) and following restrictions due to the COVID-19 pandemic. We compared the responses of students with disabilities and SLDs with those of normotypical students.

The experiences of interviewed students with disabilities/SLDs with ERT were positive, although some psychological and relational difficulties were mentioned. With respect to concentration problems and, more generally, to the detection of psychological state, as a result of rapid changes in the lifestyles

of most of the student population due to the pandemic, some researchers have highlighted post-lockdown issues, including anxiety, worry, fear, frustration, and insecurity. Duan and Zhu (2020) reported that these experiences may have negatively affected, for some subjects, personal well-being and academic success. Chirikov et al. (2020) obtained the same results.

With regard to social relationships, Novo et al. (2020) highlighted a relationship between students' psychological distress and little or no social participation. Savarese et al. (2020) and Moccia et al. (2021) obtained the same results. These results and the health risk perceptions are very interesting. In a study conducted on Italian adolescents, the perception of health risk was found in only 5% of the adolescents interviewed (Commodari et al., 2020). In fact, Italian adolescents had a low perception of risk of COVID-19, and the susceptibility and perceived seriousness were also very low (Commodari and La Rosa, 2020). Ding et al. (2020) reported that normotypical students' risk perception and the associated factors significantly affect mental health specifically, and that risk perception plays an important role in the mental health of people in a public health crisis, in particular depression, stress/anxiety and emotional distress. Cataudella et al. (2020), in addition to anxiety and distress for SLD students, highlighted low levels of well-being, self-esteem and self-efficacy, due to the lack of online inclusive accessibility standards and a lack of attention to online-specific tools.

By contrast, Miller (2002) studied the dimensions of resilience in a group of students with learning disabilities and found that one of the characteristics of resilient students is the identification of successful experiences and the ability to describe these experiences as deliberate steps in their success. Therefore, they are able to identify activities in which they might find success and use them to achieve even greater success, as in the case of ERT.

One outcome worth noting relates to the compensatory role that technological tools, which are highly valued by respondents with learning disabilities and disorders, can play for students with special needs. We think that the use of these tools led to the positive responses from the students, and as the emergency situation persists, the distance learning experience will continue.

Future Direction of Research

An interesting aspect, and one that we think we should explore in detail in further studies, is the contrasting evaluation of ERT for students with disabilities and learning disabilities compared with normotypical students. Briefly, we think that this can be attributed to the compensatory role normally played by technological tools in the undergraduate study of students with special educational needs.

Limitations

Future possibilities along this line of research are indicated by the limits of this study, such as the small number of students who participated in the survey preventing conducting inferential statistical analyses to generalize the findings to the population. Furthermore, classifying additional variables such as the SES will be useful for verifying whether socio-economic status differences affect the quality of the ERT.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusion 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 University of Salerno-Centro di Counseling psicologico. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

GS defined the hypotheses, the research methodology and the interview program. GS and LC wrote the article and carried out the statistical analyzes. GB contributed to the editing and comments of the final draft of the article. All authors contributed to the final draft of the manuscript and agreed on the final version.

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REFERENCES

Bao, W. (2020). COVID -19 and Online Teaching in Higher Education: A Case Study of Peking University. *Hum. Behav Emerg Tech* 2 (2), 113–115. doi:10.1002/hbe2.191

Bates, T. (2020). Is There a Future for Distance Education?. Available at: https: www.tonybates.ca/2013/10/23/is-there-a-future-for-distance-education (Accessed august 28, 2020).

Cataudella, S., Carta, S., Mascia, M. L., Masala, C., Petretto, D. R., and Penna, M. P. (2020). Psychological Aspects of Students with Learning Disabilities in E-Environments: A Mini Review and Future Research Directions. *Front. Psychol.* 11, 611818. doi:10.3389/fpsyg.2020.611818

Chirikov, I., Soria, K. M., Horgos, B., and Jones-White, D. (2020). *Undergraduate and Graduate Students' Mental Health during the COVID-19 Pandemic*. UC Berkeley: Center for Studies in Higher Education. Available at: https://escholarship.org/uc/item/80k5d5hw.

Commodari, E., and La Rosa, V. L. (2020). Adolescents in Quarantine during COVID-19 Pandemic in Italy: Perceived Health Risk, Beliefs, Psychological Experiences and Expectations for the Future. *Front. Psychol.* 11, 2480. doi:10.3389/fpsyg.2020.559951

Commodari, E., La Rosa, V. L., and Coniglio, M. A. (2020). Health Risk Perceptions in the Era of the New Coronavirus: Are the Italian People Ready for a Novel Virus? A Cross-Sectional Study on Perceived Personal and Comparative Susceptibility for Infectious Diseases. *Public Health* 187, 8–14. doi:10.1016/j.puhe.2020.07.036

Coppola, C., Mollo, M., and Pacelli, T. (2015). "The Development of Logical Tools through Socially Constructed and Culturally Based Activities," in *Educational Contexts and Borders through a Cultural Lens*. Editors G. Marsico, V. Dazzani, M. Ristum, and A. de Souza Bastos (NY:

Springer Cham), 1, 163–176. Cultural Psychology of Education. doi:10.1007/978-3-319-18765-5_12

Duan, L., and Zhu, G. (2020). Psychological Interventions for People Affected by the Covid-19 Epidemic. *Lancet Psychiatry* 7 (4), 300–302. doi:10.1016/S2215-0366(20)30073-0

Eysenbach, G. (2012). Correction: Improving the Quality of Web Surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J. Med. Internet Res.* 14 (1), e8. doi:10.2196/jmir.2042

Favieri, F., Forte, G., Tambelli, R., and Casagrande, M. (2020). The Italians in the Time of Coronavirus: Psychosocial Aspects of Unexpected Covid-19 Pandemic. *Front. Psychiatry* 12, 551924, 2020 . Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3576804. doi:10.2139/ssrn.3576804

Herburger, D. (2020). Considerations for District and School Administrators Overseeing Distance Learning for Students with Disabilities. Crisis Response Resource. Available at: https://files.eric.ed.gov/fulltext/ED606081.pdf (Accessed November 25, 2020).

Lancia, F. (2004). Strumenti per l'analisi dei testi. Introduzione all' uso di T-LAB. FrancoAngeli Edizioni. Available at: https://www.tlab.it/?lang=it.

Liu, X., Liu, J., and Zhong, X. (2020). Psychological State of College Students During COVID-19 Epidemic. *SSRN J.*. doi:10.2139/ssrn.3552814

Marinaci, T., Carpinelli, L., Venuleo, C., Savarese, G., and Cavallo, P. (2020). Emotional Distress, Psychosomatic Symptoms and Their Relationship with Institutional Responses: A Survey of Italian Frontline Medical Staff during the Covid-19 Pandemic. *Heliyon* 6 (12), e05766. doi:10.1016/j.heliyon.2020.e05766

Marsico, G. (2018). The Challenges of the Schooling from Cultural Psychology of Education. *Integr. Psych. Behav.* 52 (3), 474–489. doi:10.1007/s12124-018-9454-6

Miller, M. (2002). Resilience Elements in Students with Learning Disabilities. *J. Clin. Psychol.* 58 (3), 291–298. doi:10.1002/jclp.10018

Moccia, G., Carpinelli, L., Savarese, G., Borrelli, A., Boccia, G., Motta, O., et al. (2021). Perception of Health, Mistrust, Anxiety, and Indecision in a Group of Italians Vaccinated against COVID-19. *Vaccines* 9 (6), 612. doi:10.3390/vaccines9060612

Novo, M., Gancedo, Y., and Vázquez, M. J. (2020). Relationship between Class Participation and Well-Being in university Students and the Effect of Covid-19. Available at: https://www.researchgate.net/profile/Yurena_Gancedo/publication/341272288_Relationship_between_class_participation_and_well_being_in_university_students_and_the_effect_of_COVID-19/links/5eb6e429a6fdcc1f1dcb13df/Relationship-between-class-participation-and-well-being-in-university-students-and-the-effect-of-COVID-19.pdf (Accessed November 25, 2020). doi:10.21125/edulearn.2020.0842

Okonkwo, O. C., Roth, D. L., Pulley, L., and Howard, G. (2010). Confirmatory Factor Analysis of the Validity of the SF-12 for Persons with and without a History of Stroke. *Qual. Life Res.* 19 (9), 1323–1331. doi:10.1007/s11136-010-9691-8

Pavone, M. (2018). "Postfazione. Le università di fronte alla sfida dell'inclusione degli studenti con disabilità," in *Universal Inclusion. Rights and Opportunities for Students with Disabilities in the Academic Context*. Editors S. Pace, M. Pavone, and D. Petrini (Milano: FrancoAngeli), 283–298.

Pursel, B. K., Zhang, L., Jablokow, K. W., Choi, G. W., and Velegol, D. (2016). Understanding MOOC Students: Motivations and Behaviours Indicative of MOOC Completion. *J. Comp. Assist. Learn.* 32, 202–217. doi:10.1111/jcal.12131

Savarese, G., Curcio, L., D'Elia, D., Fasano, O., and Pecoraro, N. (2020). Online University Counselling Services and Psychological Problems Among Italian Students in Lockdown Due to Covid-19. *Healthcare* 8 (4), 440–456. doi:10.3390/healthcare8040440

Shale, D. (2002). The Hybridisation of Higher Education in Canada. *Int. Rev. Res. Open Distance Learn.* 2 (2), 1–12. doi:10.19173/irrodl.v2i2.64

Teixeira, A. M., Bates, T., and Mota, J. (2019). What Future(s) for Distance Education Universities? towards an Open Network-Based Approach. *Ried* 22 (1), 107–126. doi:10.5944/ried.22.1.22288

Thelwall, M., and Levitt, J. M. (2020). Retweeting Covid-19 Disability Issues: Risks, Support and Outrage. *El profesional de la información* 29 (2), 1–12. doi:10.3145/epi.2020.mar.16

Toquero, C. M. D. (2020). Inclusion of People with Disabilities amid COVID-19: Laws, Interventions, Recommendations. *Remie* 10 (2), 158–177. doi:10.17583/remie.2020.5877

UNESCO (2020). News - Emergency for global education, as fewer than half world's students cannot return to school New York: UN. Available at: https://en.unesco.org/themes/education-emergencies/coronavirus-school- closures (Accessed 08 28, 2020).

Ware, J. E., Kosinski, M., and Keller, S. D. (1995). *SF-12: How to Score the SF-12 Physical and Mental Health Summary Scales*. Boston: Health Institute, New England Medical Center. Available at: https://www.researchgate.net/publication/242636950.

White, M. K., Maher, S. M., Rizio, A. A., and Bjorner, J. B. (2018). A Meta-Analytic Review of Measurement Equivalence Study Findings of The SF-36® And SF-12® Health Surveys Across Electronic Modes Compared To Paper Administration. *Quality Life Res.* 27 (7), 1757–1767. doi:10.1007/s11136-018-1851-2

Zhang, H., Nurius, P., Sefidgar, Y., Morris, M., Balasubramanian, S., Brown, J., et al. (2020). How Does COVID-19 Impact Students with Disabilities/Health Concerns?. Available at: https://arxiv.org/abs/2005.05438 (Accessed November 25, 2020).

Ding, Y., Xu, J., Huang, S., Li, P., Lu, C., and Xie, S. (2020). Risk perception and depression in public health crises: Evidence from the COVID-19 crisis in China. *Int. J. Environ. Res. Public Health* 17 (16), 5728. doi:10.3390/ijerph17165728

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Student's Learning Strategies and Academic Emotions: Their Influence on Learning Satisfaction During the COVID-19 Pandemic

Changcheng Wu[1,2†], *Bin Jing*[1†], *Xue Gong*[1], *Ya Mou*[2,3] *and Junyi Li*[4*]

[1] School of Computer Science, Sichuan Normal University, Chengdu, China, [2] Faculty of Artificial Intelligence in Education, Central China Normal University, Wuhan, China, [3] Shuang Liu Middle School, Chengdu, China, [4] School of Psychology, Sichuan Normal University, Chengdu, China

Background: Based on the control-value theory (CVT), learning strategies and academic emotions are closely related to learning achievement, and have been considered as important factors influencing student's learning satisfaction and learning performance in the online learning context. However, only a few studies have focused on the influence of learning strategies on academic emotions and the interaction of learning strategies with behavioral engagement and social interaction on learning satisfaction.

Methods: The participants were 363 pre-service teachers in China, and we used structural equation modeling (SEM) to analyze the mediating and moderating effects of the data.

Results: The main findings of the current study showed that learning strategies influence students' online learning satisfaction through academic emotions. The interaction between learning strategies and behavioral engagement was also an important factor influencing online learning satisfaction.

Conclusions: We explored the internal mechanism and boundary conditions of how learning strategies influenced learning satisfaction to provide intellectual guarantee and theoretical support for the online teaching design and online learning platform. This study provides theoretical contributions to the CVT and practical value for massive open online courses (MOOCs), flipped classrooms and blended learning in the future.

Keywords: online learning, learning satisfaction, academic emotion, learning strategy, behavioral engagement, social interaction

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***Correspondence:**
Junyi Li
junyili@sicnu.edu.cn

[†] *These authors share first authorship*

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INTRODUCTION

During the first half of 2020, the world faced the unprecedented COVID-19 pandemic. This crisis has presented new challenges and opportunities to the global educational system, and these features forced teachers and students to quickly migrate their courses online to prevent the spread of the virus that causes COVID-19 (Hodges et al., 2020). Some researchers have believed that online instruction can lead to the flexibility of teaching at any time and any place. This practice provides a rare opportunity for the development of online learning. However, other studies have shown that the quality of online teaching during the crisis is not high, indicating that this type of learning can

only be used as a special temporary measure, and face-to-face learning should be returned as soon as possible after the crisis (Hodges et al., 2020).

This paradigm is being promoted because during the crisis, most teachers and students are forced to switch to online learning. These stakeholders are not accustomed to this learning setup, leading to low learning satisfaction and even high dropout rates (Dai et al., 2020). Baber (2020) and Chao (2019) indicated that improving learning satisfaction is important to increase the student's intention to continue online learning and reduce dropout rates. Although online learning platform developers have invested a huge amount of money and several types of new technologies, students are not as satisfied as expected (Jiang et al., 2021). In previous studies, the evaluation index of online teaching quality is mainly cognitive learning performance, ignoring learning satisfaction on the psychological level (Méndez-Aguado et al., 2020). Therefore, in this study, we focused on some of the learning process variables to address the forementioned defects. These variables had been proven to influence learning satisfaction and performance. On the one hand, given that academic emotions and the use of learning strategies are important for successful learning, more and more studies have investigated the relationship between these variables (Ahmed et al., 2013; Mariza et al., 2015; de la Fuente et al., 2020; Obergriesser and Stoeger, 2020). However, the exact relationship between students' academic emotions and their use of learning strategies has not been fully understood (Obergriesser and Stoeger, 2020). Most previous studies have explored the influence of academic emotions on learning strategies and achievements (Ahmed et al., 2013; Mariza et al., 2015). A recent study has explored the influence of learning strategies on academic emotions (de la Fuente et al., 2020; Obergriesser and Stoeger, 2020). Thus, we focused on how these two variables influence learning satisfaction. On the other hand, behavioral engagement and social interaction had also been proved to be lacking in online learning (Muilenburg and Berge, 2005; Guo et al., 2019) and to promote learning satisfaction (Gray and DiLoreto, 2016; Nagy, 2018). However, the manner by which they influence learning satisfaction has not been determined yet. In addition, migrating to online instruction requires teachers to clarify the characteristics of learning under the state of separation of time and space and perform corresponding online instructional designs to arrange relevant learning activities (Karakaya, 2021). Hence, such activity necessitates teachers to control more the course design, development, and implementation (Karakaya, 2021). Effective online learning is the result of meticulous planning and instructional design. However, most teachers have not performed well enough at this stage.

Online learning during the COVID-19 pandemic is only a temporary alternative due to the crisis. In an emergency, institutions should not only ensure the safety of teachers and students but also the quality of teaching (Hodges et al., 2020). This situation has put forward higher requirements for future online learning, and instruction should return to educational rationality and may consider providing better support to students (Karakaya, 2021). Therefore, the overall aim of this study is to examine the internal mechanism and boundary conditions on the relationship between learning strategies and satisfaction. This study also provides intellectual guarantee and theoretical support for online learning in the post-pandemic era.

THEORETICAL FRAMEWORK

Learning Satisfaction

Learning satisfaction can be defined as the student's perception of the course or learning experience and of the value of receiving education in an educational institution (Ke and Kwak, 2013). Considering the concerns on the dropout rates (Hew et al., 2020), this study follows the advice of Rabin et al. (2019) to use learning satisfaction as one of the important indicators to measure the success of online learning. Learning satisfaction is also an indispensable result for students because it influences the student's motivation, which is an important psychological factor that influences learning (Hew et al., 2020). In recent years, academic circles have paid increasing attention to the study of learning satisfaction and its potential determinants. According to the *Sloan Consortium*, an American non-profit organization dedicated to improving the quality of online learning, learning satisfaction is one of the most important factors in evaluating the quality of online learning (Moore, 2005). Some studies have also shown that learning satisfaction is a key factor for students to decide whether to continue to choose the course and is a significant predictor of learning grades to improve the sustainability of online learning (Ke and Kwak, 2013; Chao, 2019).

Learning Strategies

Learning strategies are processes to obtain, organize, or transform information (Alexander et al., 1998). In this study, we divided learning strategies into three categories, namely, metacognitive self-regulation, elaboration, and organization strategies. In particular, students use metacognitive self-regulation strategies to mobilize various consciousness and behavior to participate in the learning process, which can help students effectively implement cognitive strategies (Obergriesser and Stoeger, 2020). Using elaboration strategies to establish connections between new materials and visual imagination or semantic knowledge can increase the meaning of new information (Wolters et al., 2005). Organization strategies for establishing relationships between different parts of learning material can help students select and organize information and create meaningful units of information (Obergriesser and Stoeger, 2020). Studies have shown that the student's use of these strategies has a significant and positive correlation with learning satisfaction (Choi, 2016; Kasalak and Dagyar, 2020). Students who flexibly use learning strategies have also been shown to better perceive the control of the learning process (Obergriesser and Stoeger, 2020). This phenomenon influences the student's self-efficacy, academic emotions, and learning outcome (Pekrun et al., 2011; Murayama et al., 2013; Pekrun and Perry, 2014). These conclusions are supported by the affective dynamics model of D'Mello and Graesser (2012). This model assumes that during learning, by effectively using learning strategies to eliminate learning obstacles, negative emotions

will be reduced, and students will enjoy their learning. That is, learning strategies can promote the enhancement of student's positive emotions and reduce their negative emotions (Muis et al., 2015a). However, some studies have shown that although the application of learning strategies has no significant influence on the student's positive emotions, it can significantly reduce negative emotions (Obergriesser and Stoeger, 2020). Previous studies mainly focused on the influence of academic emotions on learning strategies (Ahmed et al., 2013; Mariza et al., 2015), while few studies have explored the influence of learning strategies on academic emotions and their two-way influence. Hence, no consensus on how the learning strategies influence the student's academic emotions during online learning is available.

Academic Emotions

Academic emotions are directly related to the learning process and results. A relatively stable and long-term emotional state and a complex subjective experience of students are involved through the whole learning process (Pekrun, 2006). According to valence, academic emotions can be divided into positive and negative emotions (Pekrun et al., 2011). In this study, we focused on activity-related emotions, namely, enjoyment (i.e., positive emotions), boredom, and frustration (i.e., negative emotions) (Pekrun et al., 2011). Studies have shown that academic emotions will influence learning satisfaction (Artino and Jones, 2012; Lee et al., 2021). Moreover, under the traditional face-to-face teaching model, academic emotions are important predictors of the learning process and results (Pekrun et al., 2009). Positive emotions can stimulate intrinsic and extrinsic motivation and have a positive influence on academic performance in most cases. Negative emotions have the opposite effects (Pekrun et al., 2011). Sewart (1993) showed that if teachers and online learning platforms fail to timely detect the emotional changes of students and provide relevant emotional support, students will easily suffer from negative emotions, such as boredom and frustration, gradually lose interest in learning, and even drop out from learning. However, some studies have found that negative emotions have positive effects on the use of metacognitive self-regulation strategies and the development of online group activities during online learning (Artino and Jones, 2012; Noteborn et al., 2012). Hence, the mechanism by which the student's academic emotions influence their learning satisfaction needs further study.

Behavioral Engagement

In recent decades, learning engagement has been paid increasing attention. Learning engagement is depicted as a "meta" construct, consisting of three dimensions, namely, behavioral, cognitive, and emotional engagement (Luo et al., 2019). In this study, we focused on behavioral engagement, which is described as the time, effort, attention, and perseverance of students to complete tasks. Behavioral engagement is positively related to emotional engagement, such as learning interest or satisfaction (Fredricks et al., 2004). Previous studies have shown that behavioral engagement is closely related to learning satisfaction (Gray and DiLoreto, 2016; Luo et al., 2019). If students can be fully engaged in learning activities, their learning satisfaction will be correspondingly improved. With the rapid development of information technology, the study on behavioral engagement has transformed from focusing on the individual behavior and efforts of students to an important factor to improve the quality of online education.

Social Interaction

In learning activities, social interaction is also an essential link. The process of interaction is not only the process of learning but also of improving social skills. Moore (1989) proposed that social interaction includes the interaction between students and teachers, students and students, and students and learning content. Studies have shown that the interaction between students has a stronger influence on online learning satisfaction than that between students and teachers (Jung et al., 2002; Nagy, 2018). In online learning, students interact with other students through various communication channels, such as danmakus, comments, and replies. In the current study, we focused on danmakus, a kind of behavior of students sending messages on the screen. As a new type of social interaction, this behavior is widely favored by teenagers, especially for providing real-time communication for students. This behavior can stimulate their interest in learning and improve their learning satisfaction (Leng et al., 2016; Wu et al., 2019). However, the latest studies have shown that during video teaching, danmakus can both promote and hinder learning satisfaction (Yang et al., 2019). Danmakus related to learning content may improve learning satisfaction, which may be reduced by unrelated danmakus (Zhang et al., 2019).

The Control-Value Theory

Given that control and value appraisals can be postulated to be precursors of emotions, Pekrun (2006) proposed the CVT to analyze the causes and consequences that influence academic emotions (**Figure 1**).

The CVT is used to analyze the relationship among academic emotions, learning environment, and cognitive evaluation factors. This theory provides a theoretical basis for the methodology of academic emotions (Pekrun, 2006). Control refers to the student's perception and judgment of the controllability of the learning process and results. Value describes the value that students give to the learning task or results, such as how important the learning task is to themselves (Pekrun, 2006). Theoretically, a dynamic cycle of interaction exists among environment, appraisal, emotion, and learning achievement; that is, the influence between academic emotions and learning strategies is a two-way relationship (Pekrun, 2006; Pekrun and Perry, 2014). Learning strategies are also some of the important factors influencing academic emotions, which will further influence the learning process and results.

Hypotheses

Hence, learning strategies, academic emotions, behavioral engagement, and social interaction are the core variables that influence learning satisfaction. Learning strategies and academic emotions can influence learning satisfaction, and this satisfaction can also be influenced by behavioral engagement

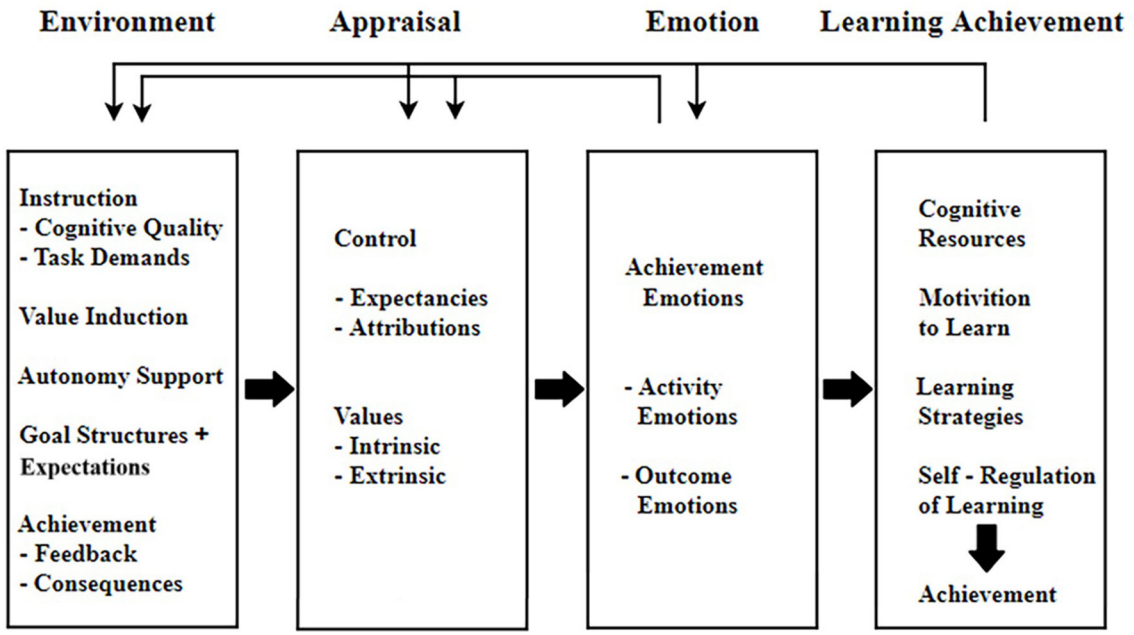

FIGURE 1 | The control-value theory (partial) (Pekrun, 2006).

and social interaction. Moreover, according to the CVT (Pekrun, 2006), learning strategies may influence learning satisfaction by influencing academic emotions. However, few studies have explored the mechanism by which learning strategies indirectly influence learning satisfaction by influence learning emotions. In addition, behavioral engagement and social interaction are used as boundary conditions for learning strategies to influence learning satisfaction. Although insights into the relationships between constructs have been provided, studies do not make causal inferences. Therefore, mediating and moderating models were constructed in the current study. We address the following hypotheses:

H1: Learning strategies positively predict positive emotions and negatively predict negative emotions.

H2: Positive emotions positively predict learning satisfaction, while negative emotions negatively predict learning satisfaction.

H3: Academic emotions have a mediating effect on the relationship between learning strategies and learning satisfaction.

H4: Behavioral engagement and social interaction have a moderating effect on the relationship between learning strategies and learning satisfaction, respectively.

METHOD

Context

During the COVID-19 pandemic, to reduce the spread of the virus and protect the health and safety of teachers and students, educational institutions in various countries canceled all face-to-face learning activities and encouraged teachers and students to conduct online teaching. As a result, tens of millions of students suddenly switched from traditional face-to-face learning to fully online learning. Therefore, in the spring semester of 2020, a university in Chengdu, Sichuan, China, was investigated by class as a unit. Taking the online course "*Computer Science Fundamentals*" as an example, the rain classroom (an intelligent online teaching platform) was adopted for teaching. The relevant empirical study was conducted on learning satisfaction and its influencing factors.

TABLE 1 | The basic information of participants.

Characteristic	Variable	Quantity	Proportion
Gender	Male	128	35.26%
	Female	235	64.74%
Household	Country	69	19.01%
	Town	90	24.79%
	City	204	56.20%
Major	Accountancy	58	15.98%
	Dance	10	2.75%
	Music performance	98	27.00%
	Apparel fashion design	164	45.18%
	Social sports guidance and management	33	9.09%

Participants

In this study, 363 pre-service teachers (M_{age} = 18.95, SD_{age} = 0.88) who participated in online learning were the participants (**Table 1**). They completed an online survey (www.wjx.cn) in ∼15 min voluntarily and anonymously.

Measurements

Learning Strategies

The learning strategy questionnaires developed by Pintrich and De Groot (1990) and Duncan and McKeachie (2005) were used to revise it. The questionnaire was translated into Chinese and developed by Kong and Lu (2012) and Xiong et al. (2012). This study consisted of 22 items with a five-point Likert scale (from 1 = strongly disagree to 5 = strongly agree), which was divided into three dimensions of metacognitive self-regulation (12 items, e.g., "I ask myself questions to make sure I understand the material I have been studying in this class"), elaboration (six items, e.g., "When reading for this class, I try to relate the material to what I already know"), and organization strategies (four items, e.g., "When I study for this course, I go over my class notes and make an outline of important concepts"), to measure the student's use of learning strategies during online learning. The overall internal consistency α coefficient of this Chinese questionnaire was 0.96 (the corresponding α values for the three dimensions were 0.90, 0.96, and 0.95), which indicated the high reliability quality.

Academic Emotions

This questionnaire was adapted from the Achievement Emotion Questionnaire (AEQ) developed by Pekrun et al. (2011). The questionnaire was translated into Chinese and developed by Gong et al. (2016). The survey had three dimensions, and a total of 13 items with a five-point Likert scale (from 1 = strongly disagree to 5 = strongly agree), namely, enjoyment (4 items, e.g., "I am enjoying the online course"), boredom (five items, e.g., "I feel bored while studying the online course"), and frustration (four items, e.g., "I felt very frustrated when studying the online course"), to measure the student's academic emotions during online learning (Artino and Jones, 2012). The overall internal consistency α coefficient was 0.85 (the corresponding α values of the three dimensions were 0.91, 0.96, and 0.96), which indicated the high reliability of this Chinese questionnaire.

Learning Satisfaction

This questionnaire was derived from the Chinese-language Video Course Learning Satisfaction Questionnaire (Yang, 2014). According to the actual needs, some items were appropriately deleted and modified in this study to adapt to the online teaching context, and 10 items (e.g., "Overall, I was satisfied with the teaching of this online course.") were retained at last. A five-point Likert scale (from 1 = strongly disagree to 5 = strongly agree) was used for the questionnaire options. The purpose of this questionnaire was to measure the learning satisfaction of students for online courses. The internal consistency α coefficient was 0.93 in this study, which indicated the high reliability of the questionnaire.

Behavioral Engagement

The course teaching in this study was based on the rain classroom. Students read online courseware related to the course content, the number of check-in times in class, and the number of times of reading the bulletin board, which were defined as behavioral engagement. Data were automatically generated and exported through the backstage of this platform. They were divided into low and high behavioral engagement groups according to the median. Behavioral engagement was coded 1 = low group, 2 = high group.

Social Interaction

Social interaction mainly referred to the student's interactive behavior of sending danmakus, specifically referring to the number of danmakus messages sent. Social interaction data were also automatically recorded, generated, and exported backstage of the rain classroom. The data were divided into low and high social interaction groups according to the median. Social interaction was coded 1 = low group, 2 = high group.

Data Collection and Analysis

Data were collected in May 2020. First, the questionnaire was uploaded to WJX (www.wjx.cn). Then, the data were entered and managed using Excel 2019, and SPSS 24.0 was used for descriptive statistical analysis and correlation analysis. Finally, the mediating and moderating effects of the model were analyzed in Mplus 8.3 by SEM analysis. The deviation-corrected percentile Bootstrapping method was used to test (repeat sampling, 2,000 times).

RESULTS

Descriptive Statistics and Correlation Analysis

In this study, the mean, standard deviation, and Pearson correlation coefficient of the learning strategies (i.e., metacognitive self-regulation, elaboration, and organization strategies), academic emotions (i.e., positive emotions and negative emotions), behavioral engagement, social interaction, and learning satisfaction were analyzed (**Table 2**).

The results showed that learning strategies were positively linked with positive emotions ($r = 0.44$, $p < 0.01$; $r = 0.45$, $p < 0.01$; $r = 0.40$, $p < 0.01$) and learning satisfaction ($r = 0.59$, $p < 0.01$; $r = 0.65$, $p < 0.01$; $r = 0.59$, $p < 0.01$) but negatively linked with negative emotions ($r = -0.40$, $p < 0.01$; $r = -0.35$, $p < 0.01$; $r = -0.34$, $p < 0.01$). Positive emotions were positively linked with learning satisfaction ($r = 0.49$, $p < 0.01$) and were negatively linked with negative emotions ($r = -0.31$, $p < 0.01$). Negative emotions were negatively linked with learning satisfaction ($r = -0.46$, $p < 0.01$). Metacognitive self-regulation strategies were positively linked with behavioral engagement ($r = 0.14$, $p < 0.01$). Organization strategies were negatively linked with social interaction ($r = 0.13$, $p < 0.05$). The behavioral engagement was positively linked with social interaction ($r = 0.23$, $p < 0.01$), gender ($r = 0.25$, $p < 0.01$), and learning satisfaction ($r = 0.14$, $p < 0.01$).

Analysis of the Mediating Effect of Academic Emotions

In this study, learning strategies were considered as the independent variables, academic emotions were the mediating variables, and learning satisfaction was the dependent variable to build a mediating model (**Figure 2**). This model used the χ^2 value by the degrees of freedom (χ^2/df), root mean square error

TABLE 2 | Descriptive statistics and correlation analysis of each variable.

Variable	M	SD	1	2	3	4	5	6	7	8
1. Metacognitive self-regulation strategies	3.68	0.62	—							
2. Elaboration strategies	3.94	0.74	0.70**	—						
3. Organization strategies	3.74	0.79	0.80**	0.71**	—					
4. Positive emotions	3.80	0.89	0.44**	0.45**	0.40**	—				
5. Negative emotions	2.01	0.95	−0.40**	−0.35**	−0.34**	−0.31**	—			
6. Behavioral engagement	13.79	3.68	0.14**	0.08	0.02	0.06	−0.17**	—		
7. Social influence	22.51	31.63	−0.04	−0.09	−0.13*	−0.02	−0.02	0.23**	—	
8. Gender	1.65	0.48	0.10	−0.05	−0.04	0.01	−0.10	0.25**	−0.02	—
9. Learning Satisfaction	4,30	0.60	0.59**	0.65**	0.59**	0.49**	−0.46**	0.14**	−0.02	0.05

*M, mean; SD, standard deviation; *p < 0.05, **p < 0.01.*

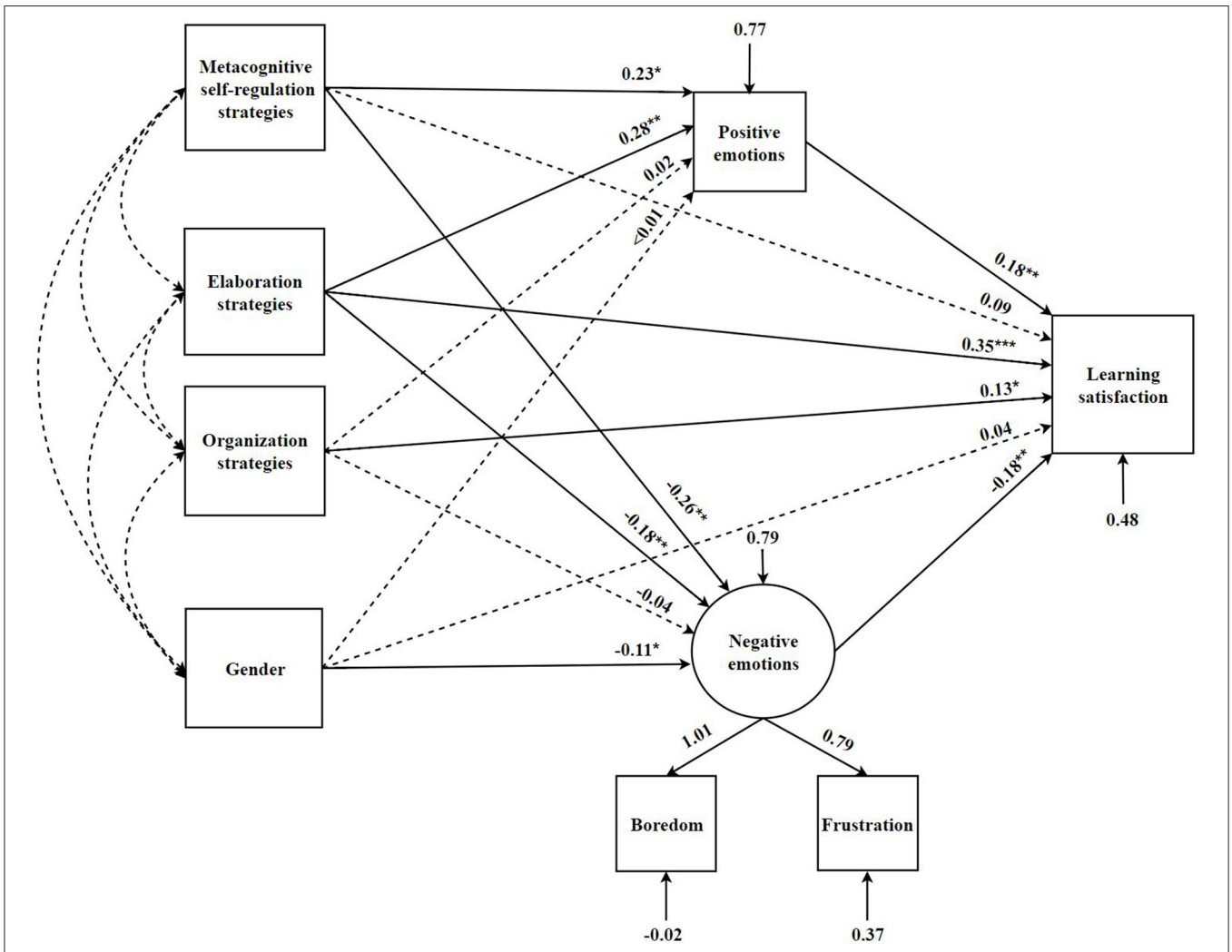

FIGURE 2 | The influence of learning strategies on learning satisfaction: a mediating model of academic emotions. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

of approximation (*RMSEA*), comparative fit index (*CFI*), and Tucker-Lewis index (*TLI*) to evaluate the fit index in the current study. The results showed that the model fit well ($\chi^2 = 16.37$, $df = 6$, $\chi^2/df = 2.73$, $p < 0.05$; $RMSEA = 0.07$, $CFI = 0.99$, $TLI = 0.95$). The significance of the mediating effect was analyzed by the bias correction Bootstrapping method (**Table 3**). If the 95%

TABLE 3 | Path coefficients of the initial structural model.

Variable		*β*	*se*	*t*	*p*
Metacognitive self-regulation strategies	Positive emotions	0.23*	0.09	2.45	<0.05
	Negative emotions	−0.26**	0.09	−2.94	<0.01
	Learning satisfaction	0.09	0.07	1.34	>0.05
Elaboration strategies	Positive emotions	0.28**	0.08	3.45	<0.01
	Negative emotions	−0.18**	0.07	−2.77	<0.01
	Learning satisfaction	0.35***	0.06	6.09	<0.001
Organization strategies	Positive emotions	0.02	0.08	0.24	>0.05
	Negative emotions	−0.04	0.08	−0.51	>0.05
	Learning satisfaction	0.13*	0.06	2.12	<0.05
Gender	Positive emotions	<0.01	0.05	0.07	>0.05
	Negative emotions	−0.11*	0.05	−2.11	<0.05
	Learning satisfaction	0.04	0.04	1.00	>0.05
Positive emotions	Learning satisfaction	0.18**	0.05	3.38	<0.01
Negative emotions		−0.18**	0.05	−3.33	<0.01

*β, standardized path coefficient; se, standard error; t, t-statistic; *p < 0.05, **p < 0.01, ***p < 0.001.*

confidence interval of the average estimate of the mediating effect of a path in the model did not contain 0, the mediating effect corresponding to the path was significant (Shrout and Bolger, 2002).

Table 3 demonstrated the hypotheses testing results for direct path coefficients of initial structural model. In the condition of gender being controlled, the results showed that metacognitive self-regulation self-regulation strategies had significant influence on positive emotions ($\beta = 0.23$, $t = 2.45$, $p < 0.05$) and negative emotions ($\beta = -0.26$, $t = -2.94$, $p < 0.01$), whereas its predictive effect on learning satisfaction was not significant. Additionally, positive emotions ($\beta = 0.28$, $t = 3.45$, $p < 0.01$), negative emotions ($\beta = -0.18$, $t = -2.77$, $p < 0.01$), and learning satisfaction ($\beta = 0.35$, $t = 6.09$, $p < 0.001$) were significantly predicted by elaboration strategies. As for organization strategies, we only found a significant direct effect between organization strategies and learning satisfaction ($\beta = 0.13$, $t = 2.12$, $p < 0.05$). Furthermore, learning satisfaction was significantly predicted by positive emotions ($\beta = 0.18$, $t = 3.38$, $p < 0.01$), and negative emotions ($\beta = -0.18$, $t = -3.33$, $p < 0.01$). Finally, regarding gender, we did not find any effect of gender on positive emotions or learning satisfaction, but gender significantly predicted negative emotions ($\beta = -0.11$, $t = -2.11$, $p < 0.05$).

The direct and mediating effects of learning strategies on learning satisfaction were examined using the Bootstrapping method (**Table 4**). First, elaboration strategies ($g = 0.35$, $p < 0.001$) and organization strategies ($g = 0.13$, $p < 0.05$) had direct influence on learning satisfaction, while metacognitive self-regulation strategies had no direct influence on learning satisfaction. Second, positive emotions ($g = 0.04$, $p < 0.05$) and negative emotions ($g = 0.05$, $p < 0.05$) had fully mediating effects on the relationship between metacognitive self-regulation strategies and learning satisfaction, respectively. Positive emotions ($g = 0.05$, $p < 0.05$) and negative emotions ($g = 0.03$, $p < 0.05$) partially mediated the relationship between elaboration strategies and learning satisfaction. Finally, positive emotions did not show a mediating effect on the relationship between organization strategies and learning satisfaction, nor did negative emotions.

The results showed that the student's metacognitive self-regulation strategies indirectly influenced learning satisfaction by influencing their academic emotions. Elaboration strategies not only directly influenced learning satisfaction but also indirectly influenced learning satisfaction by influencing academic emotions. Although we found that organization strategies directly inflence learning satisfaction. However, organization strategies did not indirectly influence learning satisfaction through academic emotions. Specifically, if students often used metacognitive self-regulation and elaboration strategies, they experienced more positive emotions and less negative emotions during the learning process and thus had higher learning satisfaction. In addition, male students reported more negative emotions than female students.

Analysis of Moderating Effect of Behavioral Engagement and Social Interaction

In this study, learning strategies were used as the independent variables, learning satisfaction as the dependent variable, and behavioral engagement and social interaction were the moderating variables to build the moderating model (**Figures 3**, **4**).

From the moderating models that we constructed, behavioral engagement had a moderating effect on the relationship between learning strategies and learning satisfaction, while social interaction had no moderating effect. From the simple slope figure of moderating effect (**Figure 5**), under low-level learning strategies, a high level of behavioral engagement increased learning satisfaction, and low-level behavioral engagement reduced the learning satisfaction. By contrast, under the high-level learning strategy, the scenario was the opposite.

TABLE 4 | Bootstrapping analysis of the mediating effect test.

Dependent variable	Independent variable	Mediating variable	Direct effect	Mediating effect	LLCI	ULCI
Learning satisfaction	Metacognitive self-regulation strategies	Positive emotions	0.09	0.04*	0.01	0.09
		Negative emotions	0.09	0.05*	0.01	0.10
	Elaboration strategies	Positive emotions	0.35***	0.05*	0.02	0.11
		Negative emotions	0.35***	0.03*	0.01	0.07
	Organization strategies	Positive emotions	0.13*	—	−0.02	0.04
		Negative emotions	0.13*	—	−0.02	0.04

*LLCI, lower level of confidence interval; ULCI, upper level of confidence interval; *$p < 0.05$, ***$p < 0.001$.*

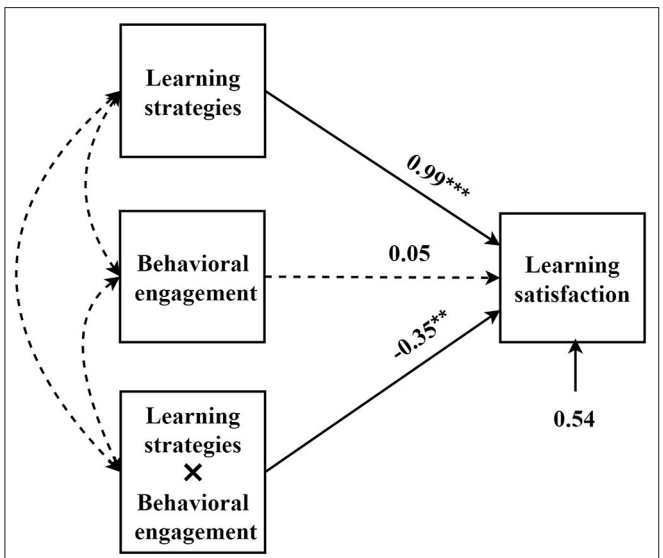

FIGURE 3 | The influence of learning strategies on learning satisfaction: a moderating model of behavioral engagement. **$p < 0.01$, ***$p < 0.001$.

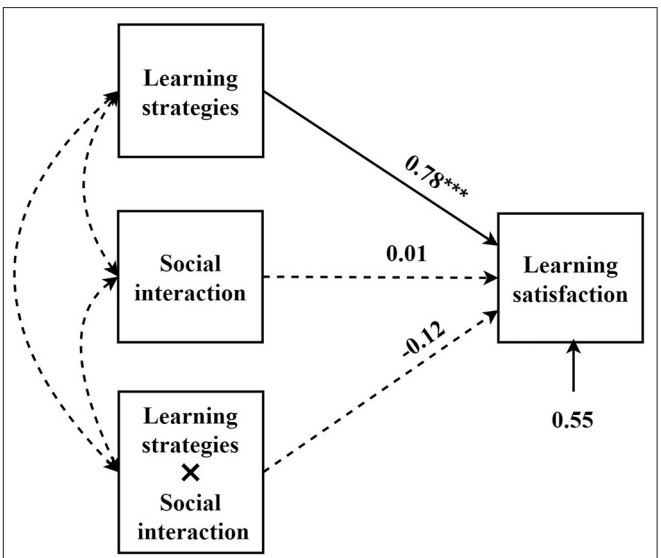

FIGURE 4 | The influence of learning strategies on learning satisfaction: a moderating model of social interaction. ***$p < 0.001$.

The results showed that the student's behavioral engagement had a moderating effect on the relationship between learning strategies and satisfaction. With the increase in the student's use of learning strategies, excessive behavioral engagement would negatively reduce learning satisfaction. Nonetheless, the moderating effect of social interaction on the relationship between learning strategies and satisfaction was not significant.

Figure 6 shows that during online learning, the student's social interaction presented a polarization trend. Most students did not send danmakus or rarely sent them. Only a minority of students liked to send a large number of danmakus.

DISCUSSION

Due to the COVID-19 pandemic, the vast majority of college students around the world rely on online learning platforms to continue their studies. This massive online learning activity will facilitate the sustainable development of blended learning in the post-pandemic era. Some studies have suggested that learning satisfaction is correlated with a stronger intention to participate in online learning (Salam and Farooq, 2020), lower dropout rates (Hew et al., 2020), and better learning performance (Al-Fraihat et al., 2020). Therefore, measuring the learning satisfaction of students on online learning platforms is urgent. Hence, the purpose of the current study is to respond to this need by examining how learning strategies predict academic emotions and how do these variables predict learning satisfaction. In addition, the manner by which the interaction of learning strategies with behavioral engagement and social interaction may predict learning satisfaction was also explored. This study is conducted in a real learning context. Although experimental research is the only way to draw a definite causal conclusion, investigating in a real learning context will help to gain a preliminary understanding of the possible causal processes (Obergriesser and Stoeger, 2020).

Conclusion

The results offered partial support for the models we constructed. The conclusions emerging from the present study are as follows: First, students using different learning strategies could stimulate more positive emotions and less negative emotions. Second, positive emotions positively predicted learning satisfaction, while

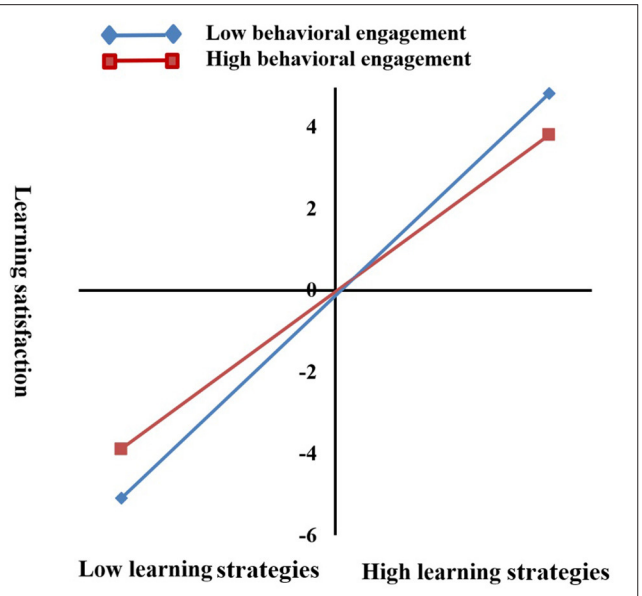

FIGURE 5 | The influence of learning strategies on learning satisfaction: a simple slope figure of the moderating effect.

negative emotions negatively predicted learning satisfaction. Third, learning strategies had indirect effects on learning satisfaction through academic emotions. Lastly, behavioral engagement had a moderating effect on the relationship between learning strategies and satisfaction. The current research combined learning strategies with academic emotions, behavioral engagement, and social interaction to clarify how these variables work together to predict online learning satisfaction, which extends the influence of these variables on student's learning. Our findings suggested that learning strategies, academic emotions, and behavioral engagement are important variables influencing learning satisfaction. Therefore, this study is significant in that it provides empirical information on the importance of learning strategies, academic emotions, and behavioral engagement in online learning satisfaction, particularly by highlighting the mediating role of positive emotions and negative emotions.

Mediating Effect of Academic Emotions

By constructing a mediating model, we found that metacognitive self-regulation and elaboration strategies had indirect effects on learning satisfaction through academic emotions, but the indirect effects of organization strategies were not significant (partially supporting H3). This finding showed that more metacognitive self-regulation and elaboration strategies were used to promote the positive and high arousal emotions of students to improve their learning satisfaction. However, in this study, the indirect effect of organization strategies on learning satisfaction was not significant. First, we examined that learning strategies can influence academic emotions. Metacognitive self-regulation and elaboration strategies could significantly positively predict positive emotions and negatively predict negative emotions, while organization strategies had no significant predictive effect (partially supporting H1). Theoretically, the influence of academic emotions and learning strategies could go in both directions (Pekrun, 2006; Pekrun and Perry, 2014). Thus, our findings support the CVT from which we drew this hypothesis. However, in direct contradiction to H1, organization strategies were unrelated to academic emotions. The relationship between organizational strategies and academic emotions is controversial. For example, King and Areepattamannil's (2014) findings showed that the use of organization strategies was positively associated with positive emotions but not correlated with negative emotions among secondary school students. Muis et al. (2015b) found in a study that the positive emotions of fifth-grade students were not related to how often they used organization strategies, but negative emotions were strongly correlated with organization strategies. The findings of these previous studies are all based on the influence of academic emotion on learning strategies, and there is still a lack of literature on the influence of learning strategies on academic emotion. One explanation for these findings may be that students are asked to complete tasks that fully demonstrate their learning abilities. However, these tasks are not important or necessary for students to use deep organization strategies to accomplish them (Obergriesser and Stoeger, 2020). Therefore, the organization strategies in this study are not enough to influence their academic emotions. Second, we found that positive emotions significantly positively predicted learning satisfaction, while negative emotions significantly negatively predicted learning satisfaction (supporting H2). This result was consistent with those of previous studies that academic emotions were important predictors of learning satisfaction and academic performance (Artino and Jones, 2012; Lee et al., 2021) and verified that academic emotions influenced learning achievement in the CVT (Pekrun, 2006). Specifically, Lee et al. (2021) indicated that the more positive emotions nursing graduate students had, the higher their learning satisfaction, highlighting the important role of academic emotions in graduate study. Pekrun et al. (2002) also proposed the influence of academic emotions on students' cognitive processes and academic performance, which is related to mental health (e.g., learning satisfaction). Lastly, we also found that elaboration and organization strategies significantly positively predicted learning satisfaction, which was consistent with some study results of Choi (2016) and Kasalak and Dagyar (2020). These conclusions verified that learning strategies had a positive influence on the learning achievement in the CVT (Pekrun, 2006). However, metacognitive self-regulation strategies could not significantly predict learning satisfaction. This phenomenon is possibly due to the fact that metacognitive self-regulation strategies belonged to deep-level learning strategies, and their use imposed higher requirements on the student's metacognitive abilities (Obergriesser and Stoeger, 2020). Thus, the relationship between metacognitive self-regulation strategies and learning satisfaction could be not a simple linear correlation. Although online students have more choices and opportunities to use learning strategies freely, they often report using them frequently but are not able to use them competently (Obergriesser and Stoeger, 2015). This phenomenon indicates that the students may give up their current learning strategies and adopt other more effective learning strategies if

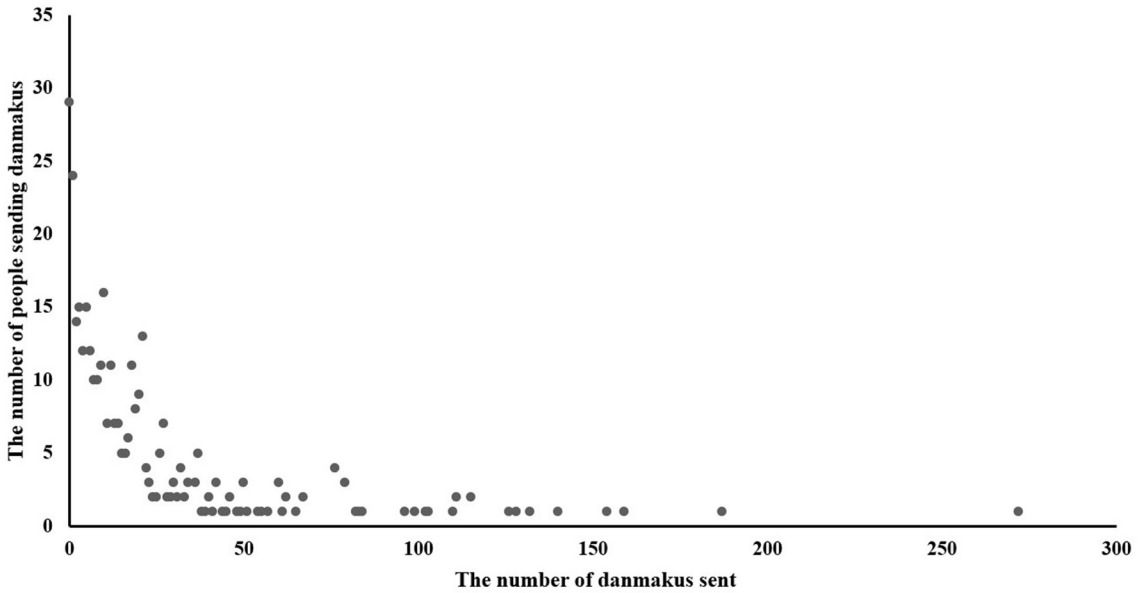

FIGURE 6 | The scatter figure of the number of people sending danmakus and the number of danmakus sent.

they have poor academic performance when using metacognitive self-regulation strategies.

Moderating Effect of Behavioral Engagement and Social Interaction

After constructing two moderating models, we found that behavioral engagement had a significant moderating effect on the relationship between learning strategies and satisfaction, but the moderating effect of social interaction was not significant (partially supporting H4).

For students who use low learning strategies, high behavioral engagement enhanced their learning satisfaction. By contrast, students with high learning strategies, high behavioral engagement weakened their learning satisfaction. This finding shows that although behavioral engagement in online learning could promote learning satisfaction, its promotion effect largely depended on the level of use of learning strategies. When students used fewer learning strategies, their learning initiative was not high, and high behavioral engagement would encourage them to study more actively, thus leading to higher learning satisfaction (Gray and DiLoreto, 2016; Luo et al., 2019). However, when students used more learning strategies, the higher behavioral engagement would reduce learning satisfaction. This phenomenon is probably because the student's learning process involved strong planning and was targeted, and high engagement increased the external cognitive load (Gong et al., 2018). The high external cognitive load would influence the learning process, resulting in low learning satisfaction (Hawlitschek and Joeckel, 2017). However, for social interaction, we did not find a moderating effect. As mentioned in the literature review, danmakus related to learning content may improve learning satisfaction, while unrelated danmakus may reduce learning satisfaction (Zhang et al., 2019). This phenomenon is possibly due to the fact that many students send a lot of danmakus irrelevant to the learning content, which interfered with the learning process. In addition, most students did not send danmakus or rarely send them. Hence, these findings partially supported H4.

Educational Implications

First, monitoring their learning process and making effective learning decisions are difficult for students, resulting in great differences in autonomous learning efficiency among individuals (Dunlosky and Rawson, 2012). Therefore, from the perspective of online instructional design, teachers should pay attention to guiding and helping students to use more effective and deep learning strategies, such as metacognitive self-regulation and elaboration strategies. Students need to use these strategies accurately to monitor and regulate learning behavior to optimize the learning process and results. The students use metacognitive self-regulation strategies (i.e., planning, monitoring, and regulation) to control their cognition and behavior, while they use elaboration strategies to connect new knowledge with existing knowledge in their brain (Obergriesser and Stoeger, 2020). This behavior was more likely to achieve better academic performance. Before a class, teachers can design relevant questionnaires to analyze the characteristics of students and their learning to help the students choose appropriate learning strategies based on their situation and previous experience. In addition, the course of "strategic learning" can be formulated to make the students clearly understand the advantages and disadvantages of their learning strategies use. This activity may promote the students to better manage the learning process and increase their positive emotions.

Second, from the perspective of online learning platform development, learning analysis technology based on artificial intelligence and big data can be introduced. For example, an online teaching feedback mechanism can be introduced to monitor and feedback the student's use of learning strategies and actively give adjustment suggestions to the students. Especially at the beginning of learning, the students will have positive emotions, such as curiosity and enjoyment, due to the freshness of online learning. However, the intensity and frequency of these positive emotions gradually decrease as the learning progresses. Previous studies have shown that positive emotions can promote students to seek actively learning opportunities and resources and participate more actively in learning activities (Zhen et al., 2017). Therefore, teachers should especially pay attention to guiding and helping students to conduct emotional self-regulation to improve effectively the learning satisfaction and results. Online learning platforms can also introduce technologies, such as affective computing, to develop affective teaching agents to acquire, evaluate, and give feedback on emotions and provide effective support to encourage students to produce positive emotions.

Finally, behavioral engagement, as a core variable to improve the quality of online learning, can help teachers clarify the online learning activity design from the perspective of online instructional design. Enhancing the quality of online courses by intervening and optimizing the design of the online teaching activities to promote student's learning satisfaction (Caskurlu et al., 2021). From the perspective of online learning platform development, user portrait and visualization technology can be introduced to guide and help students who use different levels of learning strategies to make appropriate behavioral engagement. In addition, relevant data collection tools, such as functional magnetic resonance imaging (fMRI) and electroencephalogram (EEG), can be developed to obtain the student's behavioral data and provide teachers and students feedback (Abreu et al., 2018). Students that use low learning strategies should be encouraged to reflect on learning and guided to make more behavioral engagement, such as the introduction of excellent online learning resources, the construction of active learning activities, and atmosphere (Shi et al., 2021). Students who use high learning strategies should be guided and helped to reduce unnecessary behavioral engagement.

LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

Several limitations should be acknowledged in this study that can profitably be addressed to stimulate future research. First, the sample size of participants is limited. In future research, data can be collected from more participants from different schools and different age levels. Second, we only evaluated three academic emotions (i.e., enjoyment, boredom, and frustration). These three emotions are the strongest and most frequently experienced emotions in school. However, many other emotions are also related to learning (e.g., confusion, curiosity, and pride, etc.) that need further research. Third, in this study, we first verify whether learning strategies can influence academic emotions. In future research, we will do a six-month follow-up study, using T1 (learning strategies), T2 (academic emotions), and T3 (learning strategies) as three-time points, and conduct a cross-lagged regression to further disentangle possible causal effects. Forth, in this study, students' academic emotions were derived from their self-report. In the future, EEG, fMRI, eye-tracking technologies, and other facial expression analysis tools combined with a face reader technology can be considered to conduct an in-depth study on academic emotions and cognitive neural mechanisms based on a single academic emotion (e.g., anxiety when asking questions) or a single academic emotion function (e.g., learning interest). Therefore, in the future, more advanced technologies and tools combined with educational neuroscience, starting from the specific application of the online student's learning strategies and changes in academic emotions at each stage, should be used.

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. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

CW contributed to the study conception and design. Material preparation and data collection were performed by CW and JL. Data analysis was performed by BJ. The first draft of the manuscript was written by BJ and CW and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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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.2021.717683/full#supplementary-material

REFERENCES

Abreu, R., Leal, A., and Figueiredo, P. (2018). EEG-informed fMRI: a review of data analysis methods. *Front. Hum. Neurosci.* 29:29. doi: 10.3389/fnhum.2018.00029

Ahmed, W., Greetje, V. D. W., Kuyper, H., and Minnaert, A. (2013). Emotions, self-regulated learning, and achievement in mathematics: a growth curve analysis. *J. Educ. Psychol.* 105, 150–161. doi: 10.1037/a0030160

Alexander, P. A., Graham, S., and Harris, K. R. (1998). A perspective on strategy research: progress and prospects. *Educ. Psychol. Rev.* 10, 129–154. doi: 10.1023/A:1022185502996

Al-Fraihat, D., Joy, M., and Sinclair, J. (2020). Evaluating E-learning systems success: an empirical study. *Comput. Human Behav.* 102, 67–86. doi: 10.1016/j.chb.2019.08.004

Artino Jr, A. R., and Jones II. K. D. (2012). Exploring the complex relations between achievement emotions and self-regulated learning behaviors in online learning. *Internet High. Educ.* 15, 170–175. doi: 10.1016/j.iheduc.2012.01.006

Baber, H. (2020). Determinants of students' perceived learning outcome and satisfaction in online learning during the pandemic of COVID-19. *J. Educ. E-Learn. Res.* 7, 285–292. doi: 10.20448/journal.509.2020.73.285.292

Caskurlu, S., Richardson, J. C., Alamri, H. A., Chartier, K., Farmer, T., Janakiraman, S., et al. (2021). Cognitive load and online course quality: insights from instructional designers in a higher education context. *Br. J. Educ. Technol.* 52, 584–605. doi: 10.1111/bjet.13043

Chao, C.-M. (2019). Factors determining the behavioral intention to use mobile learning: an application and extension of the UTAUT model. *Front. Psychol.* 10:1652. doi: 10.3389/fpsyg.2019.01652

Choi, B. (2016). How people learn in an asynchronous online learning environment: the relationships between graduate students' learning strategies and learning satisfaction. *Can. J. Learn. Technol.* 42, 1–15. doi: 10.21432/T24K7R

Dai, H. M., Teo, T., Rappa, N. A., and Huang, F. (2020). Explaining Chinese university students' continuance learning intention in the MOOC setting: a modified expectation confirmation model perspective. *Comput. Educ.* 150:103850. doi: 10.1016/j.compedu.2020.103850

de la Fuente, J., Peralta-Sánchez, F. J., Martínez-Vicente, J. M., Santos, F. H., Fadda, S., and Gaeta-González, M. L. (2020). Do learning approaches set the stage for emotional well-being in college students? *Sustainability* 12:6984. doi: 10.3390/su12176984

D'Mello, S., and Graesser, A. (2012). Dynamics of affective states during complex learning. *Learn. Instruct.* 22, 145–157. doi: 10.1016/j.learninstruc.2011.10.001

Duncan, T. G., and McKeachie, W. J. (2005). The making of the motivated strategies for learning questionnaire. *Educ. Psychol.* 40, 117–128. doi: 10.1207/s15326985ep4002_6

Dunlosky, J., and Rawson, K. A. (2012). Overconfidence produces underachievement: inaccurate self evaluations undermine students' learning and retention. *Learn. Instruct.* 22, 271–280. doi: 10.1016/j.learninstruc.2011.08.003

Fredricks, J. A., Blumenfeld, P. C., and Paris, A. H. (2004). School engagement: potential of the concept, state of the evidence. *Rev. Educ. Res.* 74, 59–109. doi: 10.3102/00346543074001059

Gong, C., Li, Q., and Gong, Y. (2018). Issues on learning engagement in smart learning environment. *e-Educ. Res.* 39, 83–89. doi: 10.13811/j.cnki.eer.2018.06.014

Gong, S., Han, Y., Wang, L., Gao, L., and Xiong, J. (2016). The relationships among task value, academic emotions and online learning satisfaction. *e-Educ. Res.* 37, 72–77. doi: 10.13811/j.cnki.eer.2016.03.010

Gray, J. A., and DiLoreto, M. (2016). The effects of student engagement, student satisfaction, and perceived learning in online learning environments. *Int. J. Educ. Leadersh. Prep.* 11. Retrieved from: https://eric.ed.gov/?id=EJ1103654 (Accessed May, 2016).

Guo, X., Wu, F., and Zheng, X. (2019). "What motives learner to learn in MOOC? An investigation of Chinese University MOOC," in *Paper Presented at the 2019 International Joint Conference on Information, Media and Engineering (IJCIME)* (Osaka).

Hawlitschek, A., and Joeckel, S. (2017). Increasing the effectiveness of digital educational games: the effects of a learning instruction on students' learning, motivation and cognitive load. *Comput. Hum. Behav.* 72, 79–86. doi: 10.1016/j.chb.2017.01.040

Hew, K. F., Hu, X., Qiao, C., and Tang, Y. (2020). What predicts student satisfaction with MOOCs: a gradient boosting trees supervised machine learning and sentiment analysis approach. *Comput. Educ.* 145:103724. doi: 10.1016/j.compedu.2019.103724

Hodges, C., Moore, S., and Lockee, B. (2020). The difference between emergency remote teaching and online learning. *Educ. Rev.* 27, 1–12. Retrieved from: https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning (accessed June 15, 2020).

Jiang, H., Islam, A. A., Gu, X., and Spector, J. M. (2021). Online learning satisfaction in higher education during the COVID-19 pandemic: a regional comparison between Eastern and Western Chinese universities. *Educ. Inform. Technol.* doi: 10.1007/s10639-021-10519-x. [Epub ahead of print].

Jung, I., Choi, S., Lim, C., and Leem, J. (2002). Effects of different types of interaction on learning achievement, satisfaction and participation in web-based instruction. *Innov. Educ. Teach. Int.* 39, 153–162. doi: 10.1080/14703290252934603

Karakaya, K. (2021). Design considerations in emergency remote teaching during the COVID-19 pandemic: a human-centered approach. *Educ. Technol. Res. Dev.* 69, 295–299. doi: 10.1007/s11423-020-09884-0

Kasalak, G., and Dagyar, M. (2020). University student satisfaction, resource management and metacognitive learning strategies. *Teach. Curric.* 20, 73–85. doi: 10.15663/tandc.v20i1.343

Ke, F., and Kwak, D. (2013). Constructs of student-centered online learning on learning satisfaction of a diverse online student body: a structural equation modeling approach. *J. Educ. Comput. Res.* 48, 97–122. doi: 10.2190/EC.48.1.e

King, R. B., and Areepattamannil, S. (2014). What students feel in school influences the strategies they use for learning: academic emotions and cognitive/meta-cognitive strategies. *J. Pac. Rim Psychol.* 8, 18–27. doi: 10.1017/prp.2014.3

Kong, B., and Lu, H. (2012). Compilation of questionnaire on self-regulated learning strategies for middle school students. *J. Sichuan Norm. Univ.* 39, 129–134. doi: 10.13734/j.cnki.1000-5315.2012.05.027

Lee, M., Na, H. M., Kim, B., Kim, S. Y., Park, J., and Choi, J. Y. (2021). Mediating effects of achievement emotions between peer support and learning satisfaction in graduate nursing students. *Nurse Educ. Pract.* 52:103003. doi: 10.1016/j.nepr.2021.103003

Leng, J., Zhu, J., Wang, X., and Gu, X. (2016). "Identifying the potential of Danmaku video from Eye Gaze Data," in *Paper Presented at the 2016 IEEE 16th International Conference on Advanced Learning Technologies (ICALT)* (Austin, TX).

Luo, Y., Xie, M., and Lian, Z. (2019). Emotional engagement and student satisfaction: a study of Chinese college students based on a nationally representative sample. *Asia Pac. Educ. Res.* 28, 283–292. doi: 10.1007/s40299-019-00437-5

Mariza, C., Irini, D., Anastasia, E., and Aggeliki, L. (2015). Motivational and affective determinants of self-regulatory strategy use in elementary school mathematics. *Educ. Psychol.* 35, 835–850. doi: 10.1080/01443410.2013.822960

Méndez-Aguado, C., Aguilar-Parra, J. M., Álvarez, J. F., Trigueros, R., and Fernández-Archilla, J. A. (2020). The influence of emotions, motivation and habits in the academic performance of primary education students in French as a foreign language. *Sustainability* 12:2531. doi: 10.3390/su12062531

Moore, J. C. (2005). *The Sloan Consortium Quality Framework and the Five Pillars. The Sloan Consortium* (Newburyport, MA).

Moore, M. G. (1989). Three types of interaction. *Am. J. Distance Educ.* 3, 1–6. doi: 10.1080/08923648909526659

Muilenburg, L. Y., and Berge, Z. L. (2005). Student barriers to online learning: a factor analytic study. *Dist. Educ.* 26, 29–48. doi: 10.1080/01587910500081269

Muis, K. R., Pekrun, R., Sinatra, G. M., Azevedo, R., Trevors, G., Meier, E., et al. (2015a). The curious case of climate change: testing a theoretical model of epistemic beliefs, epistemic emotions, and complex learning. *Learn. Instruct.* 39, 168–183. doi: 10.1016/j.learninstruc.2015.06.003

Muis, K. R., Psaradellis, C., Lajoie, S. P., Di Leo, I., and Chevrier, M. (2015b). The role of epistemic emotions in mathematics problem solving. *Contemp. Educ. Psychol.* 42, 172–185. doi: 10.1016/j.cedpsych.2015.06.003

Murayama, K., Pekrun, R., Lichtenfeld, S., and Vom Hofe, R. (2013). Predicting long-term growth in students' mathematics achievement: the unique contributions of motivation and cognitive strategies. *Child Dev.* 84, 1475–1490. doi: 10.1111/cdev.12036

Nagy, J. T. (2018). Evaluation of online video usage and learning satisfaction: an extension of the technology acceptance model. *Int. Rev. Res. Open Distrib. Learn.* 19, 159–185. doi: 10.19173/irrodl.v19i1.2886

Noteborn, G., Carbonell, K. B., Dailey-Hebert, A., and Gijselaers, W. (2012). The role of emotions and task significance in virtual education. *Internet High. Educ.* 15, 176–183. doi: 10.1016/j.iheduc.2012.03.002

Obergriesser, S., and Stoeger, H. (2015). The role of emotions, motivation, and learning behavior in underachievement and results of an intervention. *High Abil. Stud.* 26, 167–190. doi: 10.1080/13598139.2015.1043003

Obergriesser, S., and Stoeger, H. (2020). Students' emotions of enjoyment and boredom and their use of cognitive learning strategies–How do they affect one another? *Learn. Instruct.* 66:101285. doi: 10.1016/j.learninstruc.2019.101285

Pekrun, R. (2006). The control-value theory of achievement emotions: assumptions, corollaries, and implications for educational research and practice. *Educ. Psychol. Rev.* 18, 315–341. doi: 10.1007/s10648-006-9029-9

Pekrun, R., Elliot, A. J., and Maier, M. A. (2009). Achievement goals and achievement emotions: testing a model of their joint relations with academic performance. *J. Educ. Psychol.* 101, 115–135. doi: 10.1037/a0013383

Pekrun, R., Goetz, T., Frenzel, A. C., Barchfeld, P., and Perry, R. P. (2011). Measuring emotions in students' learning and performance: the Achievement Emotions Questionnaire (AEQ). *Contemp. Educ. Psychol.* 36, 36–48. doi: 10.1016/j.cedpsych.2010.10.002

Pekrun, R., Goetz, T., Titz, W., and Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: a program of qualitative and quantitative research. *Educ. Psychol.* 37, 91–105. doi: 10.1207/S15326985EP3702_4

Pekrun, R., and Perry, R. P. (2014). "Control-value theory of achievement emotions," in *International Handbook of Emotions in Education*, eds R. Pekrun and L. Linnenbrink-Garcia (https://www.google.com/search?sxsrf=AOaemvK2Som0JMRwYfBFZ2jbBL1tz8ry7g:1630601351743&q=London&stick=H4sIAAAAAAAAAOPgE-LUz9U3ME4xzStW4gAxTbIKcrRUs5Ot9 London: Routledge), 130–151.

Pintrich, P. R., and De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *J. Educ. Psychol.* 82, 33–40. doi: 10.1037/0022-0663.82.1.33

Rabin, E., Kalman, Y. M., and Kalz, M. (2019). An empirical investigation of the antecedents of learner-centered outcome measures in MOOCs. *Int. J. Educ. Technol. High. Educ.* 16, 1–20. doi: 10.1186/s41239-019-0144-3

Salam, M., and Farooq, M. S. (2020). Does sociability quality of web-based collaborative learning information system influence students' satisfaction and system usage? *Int. J. Educ. Technol. High. Educ.* 17, 1–39. doi: 10.1186/s41239-020-00189-z

Sewart, D. (1993). Student support systems in distance education. *Open Learn. J. Open Distance e-Learn.* 8, 3–12. doi: 10.1080/0268051930080302

Shi, Y., Tong, M., and Long, T. (2021). Investigating relationships among blended synchronous learning environments, students' motivation, and cognitive engagement: a mixed methods study. *Comput. Educ.* 168:104193. doi: 10.1016/j.compedu.2021.104193

Shrout, P. E., and Bolger, N. (2002). Mediation in experimental and nonexperimental studies: new procedures and recommendations. *Psychol. Methods* 7, 422–445. doi: 10.1037/1082-989X.7.4.422

Wolters, C. A., Pintrich, P. R., and Karabenick, S. A. (2005). "Assessing academic self-regulated learning," in *What Do Children Need to Flourish?* eds K. A. Moore and L. H. Lippman (https://www.google.com/search?sxsrf=AOaemvIkZGt6zItpTa1tvvKrmPqgIk4IA:1630601612724&q=Berlin&stick=H4sIAAAAAAAAAOPgE-LUz9U3MImvKjFQ4gAxDU3NC Berlin: Springer), 251–270.

Wu, Q., Sang, Y., and Huang, Y. (2019). Danmaku: a new paradigm of social interaction via online videos. *ACM Trans. Soc. Comput.* 2, 1–24. doi: 10.1145/3329485

Xiong, J., Gong, S., and Frenzel, A. C. (2012). The relationship between mathematics academic emotions, learning strategies and mathematics achievements. *Educ. Res. Exp.* 38, 89–92.

Yang, J. (2014). *The effect of the instructor on learning process and effectiveness in online video courses* (doctoral thesis). Central China Normal University, Wuhan, China. Available online at: https://kns.cnki.net/KCMS/detail/detail.aspx?dbname=CDFDLAST2015andfilename=1015520788.nh

Yang, J., Wu, C., Pi, Z., and Xie, H. (2019). Facilitating learning or interfering learning: a meta-analysis of impact of danmaku on learning. *e-Educ. Res.* 40, 84–90. doi: 10.13811/j.cnki.eer.2019.06.011

Zhang, Y., Qian, A., Pi, Z., and Yang, J. (2019). Danmaku related to video content facilitates learning. *J. Educ. Technol. Syst.* 47, 359–372. doi: 10.1177/0047239518811933

Zhen, R., Liu, R.-D., Ding, Y., Wang, J., Liu, Y., and Xu, L. (2017). The mediating roles of academic self-efficacy and academic emotions in the relation between basic psychological needs satisfaction and learning engagement among Chinese adolescent students. *Learn. Individ. Differ.* 54, 210–216. doi: 10.1016/j.lindif.2017.01.017

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