

Physical exercise and depression among college students: The chain mediating effect of regulatory emotional self-efficacy and mobile phone addiction

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Abstract: This study explored the relationship between physical exercise (PE) and depression among college students, focusing on the independent and sequential mediating roles of regulatory emotional self-efficacy (RESE) and mobile phone addiction (MPA). A total of 2021 college students (36.86% male; mean age = 19.02 years, SD = 1.38 years) completed self-report questionnaires assessing PE, depression, RESE, and MPA. The mediation analysis indicated a significant negative association between PE and depression. RESE and MPA each presented significant indirect effects in the separate mediation pathways. The sequential indirect pathway through RESE and MPA was also statistically significant. These results suggest that university mental health support may benefit from promoting exercise participation, strengthening students' confidence in emotion regulation, and fostering healthier mobile phone use behaviours.

Keywords: Physical exercise; regulatory emotional self-efficacy; college students; depression; mobile phone addiction

Introduction

Depression in college students remains a major issue for university mental health. College students often experience academic, social, and career-related pressures, which may increase their vulnerability to depressive symptoms (Zhang et al., 2022a; Seppälä et al., 2020). Recent evidence indicates that depressive symptoms are relatively common among Chinese college students (Lin et al., 2025; Dong et al., 2024). Physical exercise (PE) is widely regarded as a low-cost and accessible health behaviour that may be associated with better mental health in young adults. Previous studies have shown a negative association between PE and depressive symptoms among college students, with higher levels of PE generally related to fewer depressive symptoms (Zhang et al., 2022b; Liu et al., 2024). However, the pathways through which PE is related to depression remain less well understood. In particular, less is known about whether psychological and behavioural factors may operate together in this relationship.

Physical exercise and depression

PE involves bodily movement through skeletal muscle activity and energy expenditure (Plaza-Díaz et al., 2022). Existing research suggests a negative association between PE and depressive symptoms. Several physiological and psychological perspectives may help explain this association. From a physiological perspective, regular PE may improve cerebral blood flow, stimulate the release of brain-derived neurotrophic factor and endorphins, and regulate neurotransmitter activity, all of which may support emotional functioning (Hossain et al., 2024; Pahlavani, 2024). At the psychological level, PE may promote self-confidence, reduce stress, and help individuals redirect

attention away from negative thinking and rumination (Tikac et al., 2021; Liu et al., 2023). Empirical evidence further suggests that college students with greater physical activity levels generally report fewer depressive symptoms than their less active peers (Ji et al., 2022; Zhang et al., 2025). Although a growing body of research has reported an association between PE and depressive symptoms, less is known about the psychological and behavioural processes that may explain this relationship. The present study therefore focused on regulatory emotional self-efficacy (RESE) and mobile phone addiction (MPA) as potential mediating factors.

RESE and MPA as mediators

RESE is defined as individuals' confidence in managing and expressing positive and negative emotions effectively (Bandura, 1997; Bandura et al., 2003). As a form of self-efficacy related to emotion, RESE can be viewed as an important psychological resource that may help individuals cope with stress and regulate their emotions more effectively. College students with higher RESE may be more capable of dealing with distress, maintaining emotional stability, and reducing the disruptive influence of negative emotions in daily life (Wan et al., 2023; Lu et al., 2025). Previous studies have similarly suggested that college students with stronger RESE tend to report fewer depressive symptoms (Zhang et al., 2024). According to Bandura's self-efficacy theory, efficacy beliefs may develop through mastery and vicarious experiences (Bandura, 1990, 1997). In the context of PE, repeated participation, goal attainment, and observing peers' success may help strengthen confidence in emotion regulation. Prior evidence also indicates that RESE may serve as one

explanatory pathway linking PE with negative emotional outcomes in college students (Tang et al., 2022). Thus, RESE may be one psychological pathway through which PE is related to depression.

MPA refers to a behaviour in which individuals are addicted to mobile phone use, develop strong cravings and dependence, and thereby cause physical and mental dysfunction (Gao et al., 2018). Among college students, MPA is a relatively prevalent behavioural problem and is associated with multiple adverse outcomes, including lower sleep quality, academic impairment, and poorer psychological well-being (Zhu et al., 2024; Shang et al., 2024; Zhao et al., 2025c). Previous evidence indicates that students with more pronounced MPA generally show higher levels of depressive symptoms (Li et al., 2025; Hashemi et al., 2022). In contrast, greater PE may correspond to lower MPA. One possible explanation is that exercise offers offline opportunities for social interaction, enjoyment, and emotional release, which may reduce reliance on mobile phones. This interpretation is broadly consistent with the uses and gratifications approach, which suggests that media use is often motivated by users' attempts to satisfy various needs, including companionship, entertainment, escape, and information seeking (Joo & Sang, 2013). Empirical findings further suggest that higher exercise participation among college students may be linked to lower levels of MPA (Yang et al., 2021; Liu et al., 2022). Therefore, MPA may represent one explanatory pathway linking PE with depression.

Self-regulation failure theory may help explain the sequential relationship between RESE and MPA. When individuals perceive themselves as less able to regulate negative emotions, they may be more likely to rely on external and immediately available coping tools, including mobile phones, to manage distress (Pychyl & Flett, 2012; Wacks & Weinstein, 2021). By contrast, those reporting stronger RESE may be more inclined to adopt adaptive internal emotion-regulation approaches and may rely less on maladaptive behaviours. In college students, who commonly face academic and social stress, mobile phones may become a convenient means of distraction, emotional relief, and social compensation when internal regulatory resources are insufficient (Shi et al.,

2025; Wang et al., 2025). Taken together, students with greater PE participation may show stronger RESE, and this stronger emotion-regulation confidence may be linked to reduced MPA levels and less severe depressive symptoms. This proposed ordering is theoretically plausible because it links a psychological resource to a behavioural risk factor within the same explanatory pathway.

Goal of the Study

PE and depression are important concerns for college students' mental health, while the mediating mechanisms are less well studied. Against this background, this study developed a sequential mediation model that included PE, RESE, MPA, and depression. Within this model, RESE and MPA were treated as possible mediators of the association between PE and depression. Figure 1 presents the theoretical model proposed in this study. The following hypotheses were proposed:

H1: PE is negatively associated with depression.

H2: RESE significantly mediates the association between PE and depression.

H3: MPA significantly mediates the association between PE and depression.

H4: There is a significant chain mediating effect of RESE and MPA in the association between PE and depression.

Methods

Participants and setting

Initially, data were collected from 2120 college students attending 8 universities in Henan Province, China. After data screening and the removal of invalid questionnaires, 2021 valid responses were included in the final analysis. Participants were 19.02 years old on average ($SD = 1.38$), and Table 1 summarises their demographic information.

Measures

Participants completed the Physical Activity Rating Scale-3 (PARS-3) (Liang, 1994), the Regulatory Emotional Self-Efficacy Scale (RES) (Wen et al., 2009), the Mobile Phone Addiction Tendency Scale for College Students (MPATS) (Xiong et al., 2012), and the Center for Epidemiologic Studies Depression Scale (CES-D) (Zhang et al.,

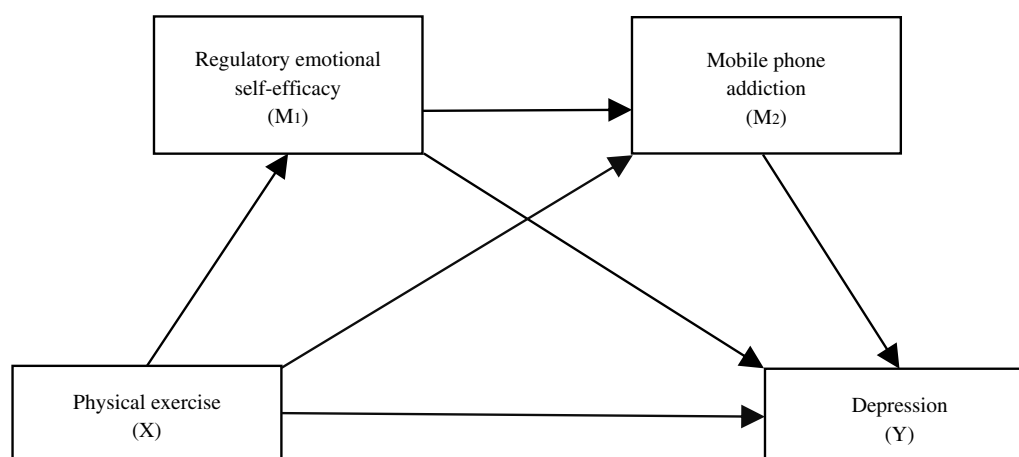


Figure 1. Hypothesised chain mediation model

Table 1. Participant demographic profile (n = 2 021)

Demographic variable	Category	Frequency	Percentage (%)
Gender	Male	745	36.86
	Female	1276	63.14
Grade	Freshman	958	47.40
	Sophomore	774	38.30
	Junior	233	11.53
	Senior	31	1.53
	Postgraduate	25	1.24
Major	Liberal arts	951	47.06
	Science	716	35.43
	Physical education	77	3.81
	Art	277	13.71
Place of origin	Urban	307	15.19
	Rural	1714	84.81
Only-child status	Only child	184	9.10
	Non-only child	1837	90.90

2010). Demographic information was also collected from the participants.

Physical activity rating scale-3 (PARS-3)

PE was measured with the PARS-3. This 3-item instrument records exercise intensity, exercise duration, and exercise frequency during the previous month. Sample items include “What kind of physical exercise do you usually do?” and “When you engage in the above physical activity, how long does it usually last?” Each item was scored using a 5-point scoring method, with scores ranging from 1 to 5. Following previous studies (Jiang et al., 2025), the overall exercise score was obtained using the formula $\text{Intensity} \times (\text{Duration} - 1) \times \text{Frequency}$. Higher values represent greater participation in PE. In the present sample, Cronbach’s α for the PARS-3 was 0.74.

Regulatory emotional self-efficacy scale (RESE)

RESE was evaluated using the 12-item RESE. Sample items include “I get excited about my successes” and “When facing difficulties, I can keep myself from getting discouraged”. Participants respond on a 5-point scale (1 = strongly inconsistent, 5 = strongly consistent). Higher summed scores represent stronger RESE. In the present sample, Cronbach’s α for the RESE was 0.92.

Mobile phone addiction tendency scale for college students (MPATS)

MPA was measured with the 16-item MPATS. Sample items include “I would feel lonely without my mobile phone” and “My classmates or friends frequently state that I am overly dependent on my mobile phone”. Participants respond on a 5-point scale (1 = strongly inconsistent, 5 = strongly consistent). Higher values denote more severe addictive use of mobile phones. In the present sample, Cronbach’s α for the MPATS was 0.93.

Center for epidemiologic studies depression scale (CES-D)

Depressive symptoms were evaluated with the 20-item CES-D. Sample items include “I could not concentrate on what I was doing” and “I felt sad”. Participants respond on a 4-point scale, ranging from 0 (less than 1 day) to 3 (5–7 days). Higher scores represent more severe depressive symptoms. In the present sample, Cronbach’s α for the CES-D was 0.89.

Procedure

The study was carried out in line with the Declaration of Helsinki and was approved by the Institutional Ethics Committee of China University of Geosciences (Wuhan). Data were gathered through an online questionnaire. Before the survey began, participants were required to read an electronic informed consent form to understand the purpose of the study. The informed consent form clearly stated that participation was completely voluntary and that all data would be collected anonymously and kept strictly confidential. Participants were also told that they could leave the survey before final submission without any penalty.

Statistical analyses

All statistical analyses in this study were conducted with SPSS 27.0. First, we assessed common method bias using Harman’s single-factor test. Next, descriptive statistics and Pearson correlation coefficients were computed for the primary study variables. Finally, mediation analyses were performed using Hayes’s PROCESS macro version 4.2 for SPSS (Hayes, 2013), applying Model 6 to test the sequential indirect effects of RESE and MPA. The significance of each indirect path was evaluated via 95% bootstrap confidence intervals, with a path deemed statistically significant if its 95% CI did not contain zero (Hayes & Rockwood, 2017).

Table 2. Descriptive statistics and bivariate correlations

Variable	<i>M</i>	<i>SD</i>	1	2	3	4
1. PE	13.01	17.39	—			
2. CES-D	12.05	8.87	−0.188**	—		
3. RESE	41.82	7.54	0.166**	−0.352**	—	
4. MPA	40.81	11.17	−0.179**	0.430**	−0.193**	—

Note. PE = physical exercise; CES-D = depression; RESE = regulatory emotional self-efficacy; MPA = mobile phone addiction; *M* = mean; *SD* = standard deviation. ** $p < 0.01$.

Table 3. Regression results for the chain mediation model

Outcome variable	Predictor variable	β	<i>t</i>
CES-D	PE (before mediators)	−0.224	−9.488***
RESE	PE	0.161	6.771***
MPA	PE	−0.130	−5.536***
MPA	RESE	−0.161	−7.435***
CES-D	PE (after mediators)	−0.122	−5.858***
CES-D	RESE	−0.267	−13.737***
CES-D	MPA	0.374	18.950***

Note. PE = physical exercise; CES-D = depression; RESE = regulatory emotional self-efficacy; MPA = mobile phone addiction; β = standardised regression coefficient. Gender, age, grade, major, place of origin, and only-child status were controlled in all regression models, but their coefficients are not shown for brevity. *** $p < 0.001$.

Results

Common method bias

Harman's single-factor test was applied to evaluate common method variance. The analysis yielded eight factors with eigenvalues > 1 , with the first factor explaining only 25.34% of the variance, which was below the 40% threshold (Zhou & Long, 2004). Thus, the dataset did not indicate substantial common method bias.

Descriptive statistics and bivariate correlations

Table 2 reports the means, standard deviations, and bivariate correlations for PE, depression, RESE, and MPA. The correlation coefficients showed that PE was inversely correlated with depression ($r = -0.188, p < 0.01$) and MPA ($r = -0.179, p < 0.01$), but positively correlated with RESE ($r = 0.166, p < 0.01$). Depression was negatively related to RESE ($r = -0.352, p < 0.01$) and positively related to MPA ($r = 0.430, p < 0.01$). Finally, RESE was inversely correlated with MPA ($r = -0.193, p < 0.01$).

Association between physical exercise and depression

H1 examined the association between PE and depression. Demographic variables were entered as control variables. Table 3 shows that, before the mediators were added, PE was significantly related to depression ($\beta = -0.224, t = -9.488, p < 0.001$). This result suggests that students reporting greater PE tended to have lower depression scores. Hypothesis 1 was therefore supported.

RESE mediation

H2 examined whether RESE served as a mediator in the association between PE and depression. As presented in Table 3, PE was related to stronger RESE ($\beta = 0.161, t = 6.771, p < 0.001$), whereas RESE was inversely related to depression ($\beta = -0.267, t = -13.737, p < 0.001$).

The indirect pathway from PE to depression via RESE was statistically significant ($\beta = -0.043, 95\% \text{ CI } [-0.061, -0.026]$), as reported in Table 4. This suggests that students reporting higher levels of PE tended to report stronger RESE, which was further related to fewer depressive symptoms. Hypothesis 2 was therefore supported.

MPA mediation

H3 examined whether MPA served as a mediator in the association between PE and depression. As presented in Table 3, PE was inversely related to MPA ($\beta = -0.130, t = -5.536, p < 0.001$), whereas MPA was positively related to depression ($\beta = 0.374, t = 18.950, p < 0.001$). The indirect pathway from PE to depression via MPA was statistically significant ($\beta = -0.049, 95\% \text{ CI } [-0.070, -0.028]$), as reported in Table 4. This pattern suggests that students reporting higher levels of PE tended to report lower MPA, which was further linked to fewer depressive symptoms. Hypothesis 3 was therefore supported.

RESE and MPA chain mediation

H4 assessed whether RESE and MPA jointly formed a chain mediating pathway in the association between PE and depression. In this model (Figure 2), PE (X) was specified as the predictor variable, while RESE (M1) and MPA (M2) were specified as mediators, and depression (Y) was specified as the outcome variable. As presented in Table 3, RESE was inversely related to MPA ($\beta = -0.161, t = -7.435, p < 0.001$). The sequential indirect pathway from PE to depression via RESE and MPA reached statistical significance ($\beta = -0.010, 95\% \text{ CI } [-0.016, -0.005]$), as reported in Table 4, suggesting evidence of chain mediation. Hypothesis 4 was therefore supported.

Table 4. The direct and indirect effects in the chain mediation model

Mediation pathways	β	Boot SE	Bootstrap 95% CI	
			LLCI	ULCI
Total effect	−0.224	0.024	−0.270	−0.178
Direct effect	−0.122	0.021	−0.163	−0.081
PE → RESE → CES-D	−0.043	0.009	−0.061	−0.026
PE → MPA → CES-D	−0.049	0.011	−0.070	−0.028
PE → RESE → MPA → CES-D	−0.010	0.003	−0.016	−0.005
Total indirect effect	−0.102	0.014	−0.129	−0.075

Note. PE = physical exercise; CES-D = depression; RESE = regulatory emotional self-efficacy; MPA = mobile phone addiction; β = standardised regression coefficient; SE = standard error; CI = confidence interval.

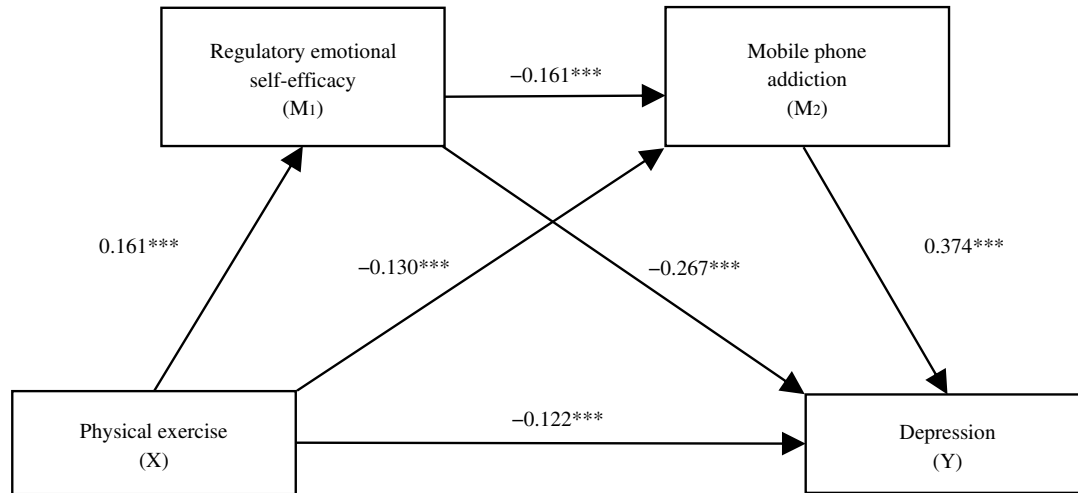


Figure 2. A chain mediation model for physical exercise, regulatory emotional self-efficacy, mobile phone addiction, and depression. Note. *** $p < 0.001$.

Discussion

Using cross-sectional self-report questionnaire data from students at 8 universities in Henan Province, China, this study examined a mediation model involving PE, RESE, MPA, and depression. The findings indicated that students reporting greater participation in PE tended to show fewer depressive symptoms. This result is consistent with earlier studies, suggesting an inverse relationship between PE and depressive symptoms in college students. That is, higher levels of PE are generally linked to fewer depressive symptoms (Zhang et al., 2022b; Zhang et al., 2025; Zhao et al., 2025a). This may be because exercise provides opportunities for social interaction, enjoyment, and temporary distraction from academic and employment-related pressures (Zhu et al., 2023).

The results supported an indirect pathway from PE to depression through RESE. This finding is in line with prior evidence that PE is associated with stronger RESE, and that stronger RESE is related to fewer negative emotional outcomes (Tang et al., 2022). According to Bandura's self-efficacy theory, efficacy beliefs may be strengthened through mastery experiences and vicarious experiences (Bandura, 1997). Experimental findings have shown that, in the context of PE, sport and exercise interventions are associated with stronger emotion regulation abilities among college students (Li, 2025). In turn, stronger RESE

may be associated with more adaptive coping with academic and social stress, and therefore with lower levels of depression (Zhang et al., 2024). The present finding is also consistent with a previous study which indicated that PE was associated with better emotion regulation and student mental health (Hu & Liu, 2025). These findings suggest that RESE may help explain the association between PE and fewer depressive symptoms. Accordingly, programs designed to promote exercise participation among college students may also include components that strengthen students' confidence in regulating negative emotions.

MPA was identified as a significant mediator linking PE with depression. This pattern accords with previous studies showing that PE is related to lower levels of MPA (Shi et al., 2025; Ye et al., 2025) and that MPA is related to more depressive symptoms (Ding et al., 2024). This finding is further supported by recent evidence from Chinese college students showing that MPA acted as a mediator between PE and negative emotions (Li et al., 2026). Additional research has reported that excessive mobile phone use among college students is related to fewer face-to-face interactions, academic difficulties, and attention problems (Lu et al., 2022; Zhao et al., 2025b). In this study, greater PE corresponded to lower MPA. This may be because exercise creates offline contexts in which college students can interact with others, experience enjoyment, and release emotions, which may lessen their

dependence on mobile phones. From this perspective, lower MPA may partly account for the association between PE and fewer depressive symptoms. Therefore, universities could encourage healthier mobile phone use behaviours alongside PE promotion, especially for students who rely on mobile phones when coping with stress.

The analysis further supported a sequential mediating pathway from PE to depression through RESE and MPA. This finding aligns with prior evidence linking PE to stronger RESE (Tang et al., 2022), as well as evidence that stronger RESE is related to less problematic mobile phone use (Xiao & Huang, 2022). Similarly, college students with greater MPA tend to report more depressive symptoms (Ding et al., 2024; Hashemi et al., 2022). These findings suggest a possible pathway in which greater PE corresponds to stronger RESE, and stronger RESE is further linked to lower MPA and fewer depressive symptoms. In this pathway, RESE can be viewed as an internal psychological resource, whereas MPA represents an external maladaptive coping behaviour. Accordingly, the association between PE and depression may be reflected not only in the direct association but also in the sequential indirect pathway involving RESE and MPA. Together, the uses and gratifications perspective and self-regulation failure theory provide a complementary explanation for this pattern: media use may reflect attempts to satisfy users' needs, while stronger internal regulatory resources may reduce reliance on external and potentially maladaptive coping behaviours. However, because this chain mediation pathway involves two mediating links, the indirect effect may be relatively small; at the same time, depressive symptoms themselves are shaped by multiple biological, psychological, and social factors. Therefore, this chain mediation pathway is better understood as a supplementary rather than dominant explanatory pathway. The results suggest that, for college students in Henan Province and for student populations with similar characteristics, PE promotion, emotion regulation support, and healthier mobile phone use behaviours may all be relevant to mental health support.

Practical Implications

These findings may offer practical guidance for universities serving student populations with similar demographic characteristics or comparable regional and cultural contexts. First, universities could consider physical exercise not only as part of physical health education, but also as one way of supporting students' mental health. In practice, campus health programmes could encourage regular participation in group-based exercise, include emotion-related content in physical education courses, and provide guidance on healthier mobile phone use behaviours through student support services. In addition, previous evidence suggests that exercise intensity may be more strongly related to improvements in anxiety and depressive symptoms than exercise frequency (Ji et al., 2022). Therefore, universities may consider guiding students not only to exercise regularly, but also to engage in physical activities at an appropriate intensity according to their physical condition. Second, exercise-based mental health support could also attend to students' confidence in emotion

regulation and their everyday mobile phone use habits. For example, physical activity could be integrated with emotion regulation training in structured interventions to help students identify and understand negative emotions, strengthen RESE, and use exercise as an active and healthy strategy for coping with stress. In addition, universities could guide students towards healthier daily routines and support the replacement of some recreational screen use with exercise or other offline activities. Overall, the results suggest that PE promotion, emotion regulation support, and healthier mobile phone use behaviours may all be relevant to university mental health support.

Limitations and Future Recommendations

This study has several limitations. First, because the study used cross-sectional data, it was not possible to determine causal or temporal relationships among the variables. Future longitudinal or experimental studies would help clarify the order of these associations over time. Second, given that the sample was drawn via convenience sampling from universities in Henan Province, China, the generalisability of the current findings to a wider population of college students may be limited. Future work should include students from different regions and types of institutions. Third, because all study variables were assessed through self-report questionnaires, the findings may be influenced by recall bias and common method bias. Future research could supplement self-report data with objective indicators or information from additional sources. Finally, the PARS-3 may provide only a limited assessment of the complexity and long-term patterns of physical activity. Future studies could use more detailed measures or wearable devices to assess physical activity.

Conclusion

This study showed that PE was associated with lower levels of depression among college students in Henan Province, China. RESE and MPA also had independent and chain mediating effects in this relationship. The findings suggest that promoting physical exercise, supporting students' confidence in emotion regulation, and encouraging healthier mobile phone use behaviours may be useful for university mental health support in similar contexts.

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supervision, Hyun-Chul Jeong; project administration, Hyun-Chul Jeong. All authors reviewed and approved the final version of the manuscript.

Availability of Data and Materials: The data that support the findings of this study are available from the Corresponding Author, Hyun-Chul Jeong, upon reasonable request.

Ethics Approval: The study was carried out in line with the Declaration of Helsinki and was approved by the Institutional Ethics Committee of China University of Geosciences (Wuhan). All participants provided informed consent before completing the survey. Participation was voluntary, responses were anonymous and confidential, and participants could stop before final submission without penalty.

Conflicts of Interest: The authors declare no conflicts of interest.

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