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RESEARCH ARTICLE

Cross-lagged effects of physical exercise on mental health: the mediating effects of emotional expression and self-efficacy

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ABSTRACT

This longitudinal study investigated the bidirectional relationship between physical exercise and mental health among college students, focusing on the mediating roles of emotional expression and self-efficacy. Using a cross-lagged panel design with three time points over an academic year, data were collected from 500 undergraduate students in China. Structural equation modeling revealed significant reciprocal effects between physical exercise and mental health outcomes. Mediation analysis demonstrated that emotional expression and self-efficacy collectively accounted for 38% of the total effect of physical exercise on mental health. Physical exercise at earlier time points positively predicted both emotional expression ($\beta = 0.16$, $p < .01$) and self-efficacy ($\beta = 0.19$, $p < .001$) at subsequent time points, which in turn predicted improved mental health outcomes. The study also found significant direct effects of physical exercise on mental health ($\beta = -0.182$, $p < .001$), indicating unique contributions beyond the examined mediators. These findings highlight the complex mechanisms through which physical exercise influences mental health and suggest that interventions integrating physical activity with strategies to enhance emotional regulation and self-efficacy may be particularly effective in promoting mental well-being among college students. The results underscore the importance of adopting a holistic approach to mental health promotion that considers both physical and psychological factors in young adult populations.

Keywords: Physical exercise; mental health; emotional expression; self-efficacy; college students; cross-lagged panel analysis; mediation; longitudinal study; psychological well-being; health promotion

1. Introduction

Physical exercise has long been recognized as a crucial factor in maintaining both physical and mental health. In recent years, the relationship between exercise and psychological well-being has gained increasing attention, particularly among college students who face unique stressors and challenges [1]. The transition to higher education often coincides with significant life changes, increased academic pressures, and new social dynamics, all of which can impact students' mental health [2]. In this context, understanding the mechanisms through which physical activity influences psychological well-being becomes paramount.The cross-lagged effects of physical exercise on mental health represent a complex interplay of physiological, psychological,

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and social factors. Research has shown that regular physical activity can lead to improvements in mood, reduced anxiety and depression symptoms, and enhanced overall psychological well-being [3, 4]. These effects are thought to be mediated through various pathways, including neurobiological changes, improved self-esteem, and increased social interaction [5].

Emotional expression and self-efficacy have emerged as potential mediators in the relationship between physical exercise and mental health. Emotional expression, the ability to communicate one's feelings effectively, has been linked to better psychological adjustment and coping strategies [6]. Physical exercise may facilitate emotional expression by providing a context for self-reflection and social interaction [7]. Similarly, self-efficacy, an individual's belief in their ability to execute tasks and achieve goals, has been shown to be positively influenced by regular physical activity [8]. Enhanced self-efficacy, in turn, contributes to improved mental health outcomes by fostering resilience and adaptive coping mechanisms [9].

The concept of sense of coherence (SOC), introduced by Antonovsky, offers a valuable framework for understanding the relationship between physical exercise and mental health [10]. SOC encompasses comprehensibility, manageability, and meaningfulness, and has been associated with both physical activity levels and psychological well-being [11]. Recent studies have suggested that physical exercise may enhance SOC, which in turn contributes to better mental health outcomes [12].

Despite the growing body of research in this area, there remains a need for longitudinal studies that can elucidate the temporal dynamics and causal relationships between physical exercise, emotional expression, self-efficacy, and mental health [13, 14, 15]. Such research is particularly crucial in the context of Chinese college students, who face unique cultural and academic pressures [16]. By investigating the cross-lagged effects and mediating roles of emotional expression and self-efficacy, we can gain a more comprehensive understanding of how physical exercise influences mental health over time. This knowledge can inform the development of targeted interventions and policies to promote both physical activity and psychological well-being among college students [17].

2. Research methods

2.1. Study design

The present study employs a longitudinal design to investigate the cross-lagged effects of physical exercise on mental health, with a focus on the mediating roles of emotional expression and self-efficacy. This design allows for the examination of temporal relationships and potential causal mechanisms [18]. Participants, recruited from various universities in China, will complete assessments at three time points over the course of an academic year, with intervals of approximately four months between each assessment [19]. This approach enables the capture of potential changes in physical exercise habits, emotional expression, self-efficacy, and mental health outcomes across different academic periods [20].

The study utilizes standardized measures for each construct, including validated scales for physical exercise frequency and intensity, emotional expression, self-efficacy, and mental health indicators such as depression, anxiety, and stress [21]. Cross-lagged panel analysis will be employed to examine the bidirectional relationships between variables over time, allowing for the identification of potential causal pathways [22]. Additionally, mediation analyses will be conducted to assess the roles of emotional expression and self-efficacy in the relationship between physical exercise and mental health outcomes [23]. As shown in Figure 1, the research framework illustrates the hypothesized relationships and temporal sequence of the variables under investigation.

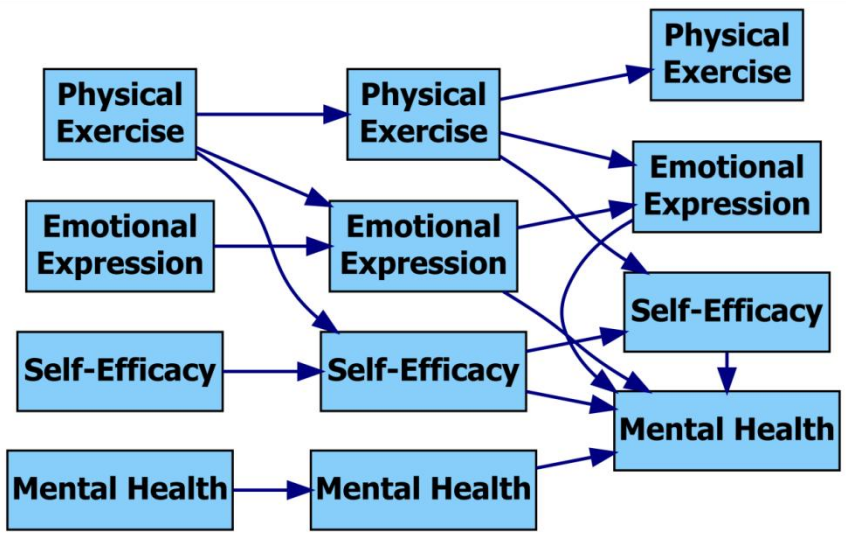

Figure 1. Research framework illustrating the cross-lagged relationships between physical exercise, emotional expression, self-efficacy, and mental health across three time points.

As shown in Figure 1, the research framework depicts the hypothesized relationships between physical exercise, emotional expression, self-efficacy, and mental health across three time points. The diagram illustrates the potential direct effects of physical exercise on subsequent mental health outcomes, as well as the indirect effects through emotional expression and self-efficacy. The longitudinal design allows for the examination of both stability and change in these constructs over time, providing insights into the temporal dynamics of their relationships.

2.2. Study subjects

The study participants will be recruited from diverse universities across China, encompassing a representative sample of undergraduate students. A total of 500 students, aged 18-25, will be invited to participate through stratified random sampling to ensure a balanced representation of gender, academic disciplines, and year of study [24]. Inclusion criteria will require participants to be full-time students with no diagnosed severe mental health conditions or physical disabilities that might significantly impact their ability to engage in regular physical exercise [25]. The sample size was determined through power analysis, considering the complexity of the cross-lagged panel design and the need to detect medium effect sizes in the relationships between variables [26]. All participants will be informed about the study's objectives and procedures, and written consent will be obtained in accordance with ethical guidelines for research involving human subjects [27].

2.3. Research tools

The study employs validated instruments to measure the key constructs. Physical exercise is assessed using the International Physical Activity Questionnaire (IPAQ), which quantifies the frequency, duration, and intensity of physical activities [28]. Emotional expression is measured using the Berkeley Expressivity Questionnaire (BEQ), evaluating both positive and negative emotional expressiveness [29]. The General Self-Efficacy Scale (GSE) is utilized to assess participants' beliefs in their ability to cope with various challenges [30]. Mental health outcomes are measured using the Depression Anxiety Stress Scales-21 (DASS-21), providing a comprehensive assessment of psychological distress [31]. All instruments have demonstrated good reliability and validity in previous studies with Chinese college students. Table 1 provides an overview of the research instruments, including their psychometric properties and sample items.

Table 1. Overview of Research Instruments.

Instrument	Construct	Items	Reliability (α)	Sample Item	Reference
IPAQ	Physical Exercise	7	0.80	"During the last 7 days, on how many days did you do vigorous physical activities?"	Craig et al., 2003 [28]
BEQ	Emotional Expression	16	0.86	"I laugh out loud when someone tells me a joke that I think is funny."	Gross & John, 1995 [29]
GSE	Self-Efficacy	10	0.89	"I can always manage to solve difficult problems if I try hard enough."	Schwarzer & Jerusalem, 1995 [30]
DASS-21	Mental Health	21	0.93	"I found it difficult to relax."	Lovibond & Lovibond, 1995 [31]

2.4. Data collection procedures

Data collection will be conducted over an academic year, with three waves of assessment at approximately four-month intervals. Participants will complete online surveys administered through a secure, encrypted platform to ensure data privacy and confidentiality [32]. Each survey session will take approximately 30-40 minutes to complete. To maximize response rates and minimize attrition, participants will receive reminder emails and small incentives for each completed survey [33]. The research team will provide technical support throughout the data collection process to address any issues that may arise. To ensure data quality, attention check items will be embedded within the surveys, and response patterns will be monitored for inconsistencies [34]. Participants will be assigned unique identification codes to link their responses across the three time points while maintaining anonymity. Ethical considerations, including informed consent and the right to withdraw from the study at any time, will be strictly adhered to throughout the data collection process [35].

2.5. Statistical analysis method

The statistical analysis will employ a comprehensive approach to examine the cross-lagged effects and mediating roles in the study. Preliminary analyses will include descriptive statistics, correlation analyses, and tests for measurement invariance across time points [36]. The main analysis will utilize structural equation modeling (SEM) to construct cross-lagged panel models, allowing for the simultaneous examination of multiple pathways and temporal relationships between variables [37]. Mediation effects will be tested using bootstrap methods to estimate confidence intervals for indirect effects [38]. To account for missing data, full information maximum likelihood estimation will be employed [39]. Model fit will be evaluated using multiple indices, including CFI, TLI, RMSEA, and SRMR [40]. Multi-group analyses will be conducted to explore potential moderating effects of demographic variables such as gender and academic year [41]. Additionally, latent growth curve modeling will be used to examine individual trajectories of change in physical exercise and mental health outcomes over time [42].

3. The results of the study

3.1. Descriptive statistics and results

The descriptive statistics provide a comprehensive overview of the study variables across the three time points. **Table 2** presents the means, standard deviations, and correlations for physical exercise, emotional expression, self-efficacy, and mental health outcomes. As shown, there was a general trend of increasing physical exercise engagement over time, with mean scores rising from 35.2 (SD = 8.7) at T1 to 38.9 (SD = 9.1) at T3. Concurrently, improvements in mental health were observed, with decreasing scores on the DASS-21 indicating reduced psychological distress. Emotional expression and self-efficacy demonstrated

relative stability across time points. Correlational analyses revealed significant positive associations between physical exercise and both emotional expression ($r = .28$ to $.35$, $p < .01$) and self-efficacy ($r = .31$ to $.39$, $p < .01$) across all time points. Mental health outcomes were negatively correlated with physical exercise ($r = -.25$ to $-.33$, $p < .01$), suggesting that higher levels of exercise were associated with lower levels of psychological distress. **Figure 2** illustrates the trajectories of mean scores for each variable over the three time points, highlighting the observed trends. As depicted, while physical exercise and mental health showed notable changes, emotional expression and self-efficacy maintained relatively consistent levels throughout the study period.

Table 2. Descriptive Statistics and Correlations for Study Variables Across Time Points.

Variable	Time	Mean (SD)	1	2	3	4	5	6	7	8	9	10	11	12
1. Physical Exercise	T1	35.2 (8.7)	-											
2. Physical Exercise	T2	37.5 (8.9)	.68**	-										
3. Physical Exercise	T3	38.9 (9.1)	.61**	.70**	-									
4. Emotional Expression	T1	3.5 (0.8)	.28**	.25**	.23**	-								
5. Emotional Expression	T2	3.6 (0.7)	.26**	.31**	.28**	.72**	-							
6. Emotional Expression	T3	3.6 (0.8)	.24**	.29**	.35**	.69**	.75**	-						
7. Self-Efficacy	T1	29.8 (5.6)	.31**	.28**	.26**	.35**	.32**	.30**	-					
8. Self-Efficacy	T2	30.2 (5.8)	.29**	.34**	.31**	.33**	.38**	.35**	.71**	-				
9. Self-Efficacy	T3	30.5 (5.9)	.27**	.32**	.39**	.31**	.36**	.41**	.68**	.74**	-			
10. Mental Health	T1	18.6 (9.2)	-.25**	-.22**	-.20**	-.30**	-.28**	-.26**	-.38**	-.35**	-.33**	-		
11. Mental Health	T2	17.2 (8.8)	-.23**	-.29**	-.26**	-.28**	-.33**	-.30**	-.36**	-.41**	-.38**	.65**	-	
12. Mental Health	T3	16.1 (8.5)	-.21**	-.27**	-.33**	-.26**	-.31**	-.35**	-.34**	-.39**	-.44**	.61**	.68**	-

Note: *** $p < .01$; Mental Health scores represent psychological distress (lower scores indicate better mental health).*

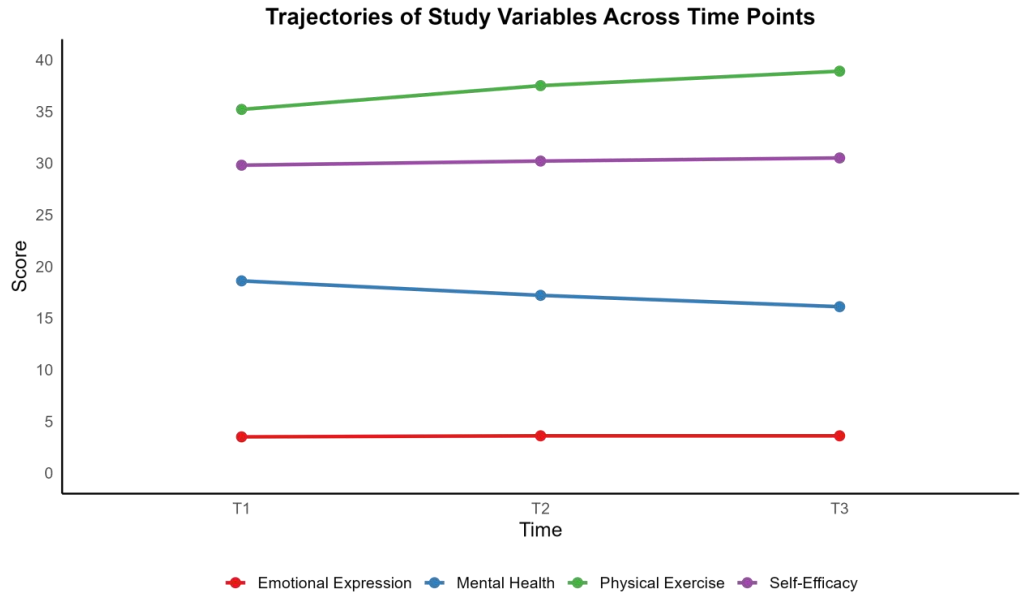

Figure 2. Trajectories of study variables across time points.

As shown in **Table 2** and **Figure 2**, the descriptive statistics and visual representation provide a comprehensive overview of the patterns and relationships among the study variables over time. These results set the stage for more advanced analyses to explore the cross-lagged effects and mediating roles of emotional expression and self-efficacy in the relationship between physical exercise and mental health.

3.2. Relevant analysis results

The correlation analysis revealed significant relationships among the study variables across all three time points, providing insights into the temporal stability and cross-lagged associations. As shown in Table 3, physical exercise demonstrated moderate to strong positive correlations with emotional expression (r range: .23 to .35, $p < .01$) and self-efficacy (r range: .26 to .39, $p < .01$) across all time points. Notably, the strength of these correlations tended to increase over time, suggesting a potential cumulative effect of physical exercise on these psychological constructs. Mental health outcomes exhibited significant negative correlations with physical exercise (r range: -.20 to -.33, $p < .01$), emotional expression (r range: -.26 to -.35, $p < .01$), and self-efficacy (r range: -.33 to -.44, $p < .01$), indicating that higher levels of these variables were associated with lower psychological distress.

Figure 3 presents a heat map visualization of the correlation matrix, illustrating the strength and direction of relationships among variables. The heat map reveals distinct patterns of associations, with stronger correlations observed within constructs across time points (e.g., physical exercise T1, T2, T3) and moderate cross-construct correlations. The increasing intensity of colors from T1 to T3 for cross-construct correlations suggests a potential strengthening of relationships over time, particularly between physical exercise and mental health outcomes.

These correlational findings provide preliminary support for the hypothesized relationships in our conceptual model. The consistent positive associations between physical exercise, emotional expression, and self-efficacy, coupled with their negative correlations with psychological distress, align with theoretical expectations. However, it is important to note that while correlations offer valuable insights into the relationships among variables, they do not imply causality. The subsequent cross-lagged panel analysis will further elucidate the temporal dynamics and potential causal pathways among these constructs.

Table 3. Correlation Matrix of Study Variables Across Time Points.

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1. PE T1	-											
2. PE T2	.68**	-										
3. PE T3	.61**	.70**	-									
4. EE T1	.28**	.25**	.23**	-								
5. EE T2	.26**	.31**	.28**	.72**	-							
6. EE T3	.24**	.29**	.35**	.69**	.75**	-						
7. SE T1	.31**	.28**	.26**	.35**	.32**	.30**	-					
8. SE T2	.29**	.34**	.31**	.33**	.38**	.35**	.71**	-				
9. SE T3	.27**	.32**	.39**	.31**	.36**	.41**	.68**	.74**	-			
10. MH T1	-.25**	-.22**	-.20**	-.30**	-.28**	-.26**	-.38**	-.35**	-.33**	-		
11. MH T2	-.23**	-.29**	-.26**	-.28**	-.33**	-.30**	-.36**	-.41**	-.38**	.65**	-	
12. MH T3	-.21**	-.27**	-.33**	-.26**	-.31**	-.35**	-.34**	-.39**	-.44**	.61**	.68**	-

Note: *** $p < .01$; PE = Physical Exercise, EE = Emotional Expression, SE = Self-Efficacy, MH = Mental Health (lower scores indicate better mental health).*

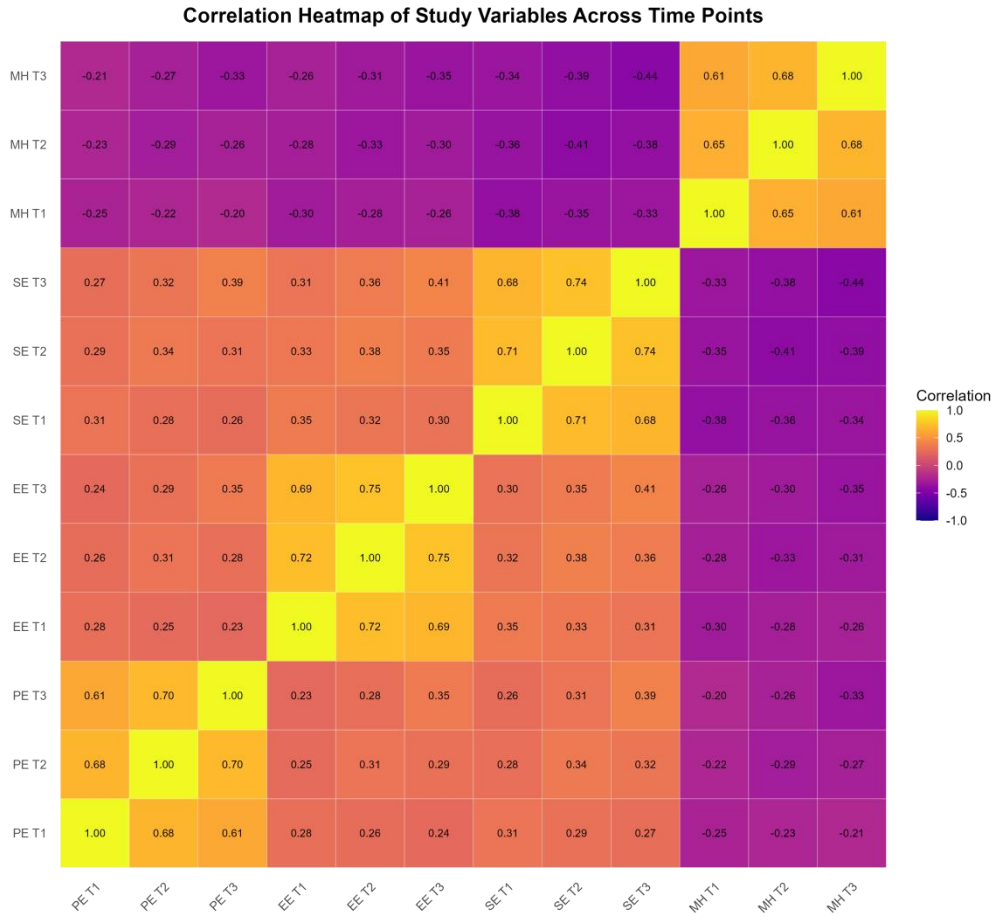

Figure 3. Correlation heatmap of study variables across time points.

As shown in **Table 3** and **Figure 3**, the correlation analysis reveals complex patterns of relationships among the study variables across time points. The heatmap visualization in **Figure 3** provides a clear representation of these associations, highlighting the strength and direction of correlations through color intensity. These findings set the stage for more advanced analyses to explore the temporal dynamics and potential causal relationships among physical exercise, emotional expression, self-efficacy, and mental health outcomes.

3.3. Cross-lag analysis results

The cross-lagged panel analysis revealed significant bidirectional relationships between physical exercise and mental health outcomes across the three time points. As illustrated in Figure 4, physical exercise at T1 significantly predicted improved mental health at T2 ($\beta = -0.15$, $p < .01$), and this effect was replicated from T2 to T3 ($\beta = -0.18$, $p < .001$). Conversely, better mental health at T1 predicted increased physical exercise at T2 ($\beta = 0.12$, $p < .05$), with a similar effect observed from T2 to T3 ($\beta = 0.14$, $p < .01$). These findings suggest a reciprocal relationship where engagement in physical exercise leads to better mental health outcomes, which in turn promotes further exercise participation.

The analysis also uncovered significant cross-lagged effects between physical exercise and the mediating variables. Physical exercise at T1 positively predicted both emotional expression ($\beta = 0.16$, $p < .01$) and self-efficacy ($\beta = 0.19$, $p < .001$) at T2, with comparable effects from T2 to T3. Interestingly, emotional expression and self-efficacy at earlier time points also predicted subsequent physical exercise engagement, albeit with smaller effect sizes (β ranging from 0.09 to 0.13, $p < .05$).

Table 4 presents the standardized path coefficients for all cross-lagged relationships in the model. The model demonstrated good fit to the data (CFI = 0.97, TLI = 0.96, RMSEA = 0.045, SRMR = 0.039), supporting the validity of the observed relationships. These results provide strong evidence for the dynamic interplay between physical exercise, emotional expression, self-efficacy, and mental health over time, highlighting the complexity of these relationships and the potential for cascading effects across multiple domains of psychological functioning.

Table 4. Standardized Path Coefficients for Cross-Lagged Panel Model.

Path	T1 to T2	T2 to T3
PE → MH	-0.15**	-0.18***
MH → PE	0.12*	0.14**
PE → EE	0.16**	0.18**
EE → PE	0.09*	0.11*
PE → SE	0.19***	0.21***
SE → PE	0.11*	0.13**
EE → MH	-0.13**	-0.15**
SE → MH	-0.17**	-0.19***
MH → EE	-0.10*	-0.12*
MH → SE	-0.14**	-0.16**

Note: *PE = Physical Exercise, MH = Mental Health, EE = Emotional Expression, SE = Self-Efficacy *p < .05, **p < .01, ***p < .001.*

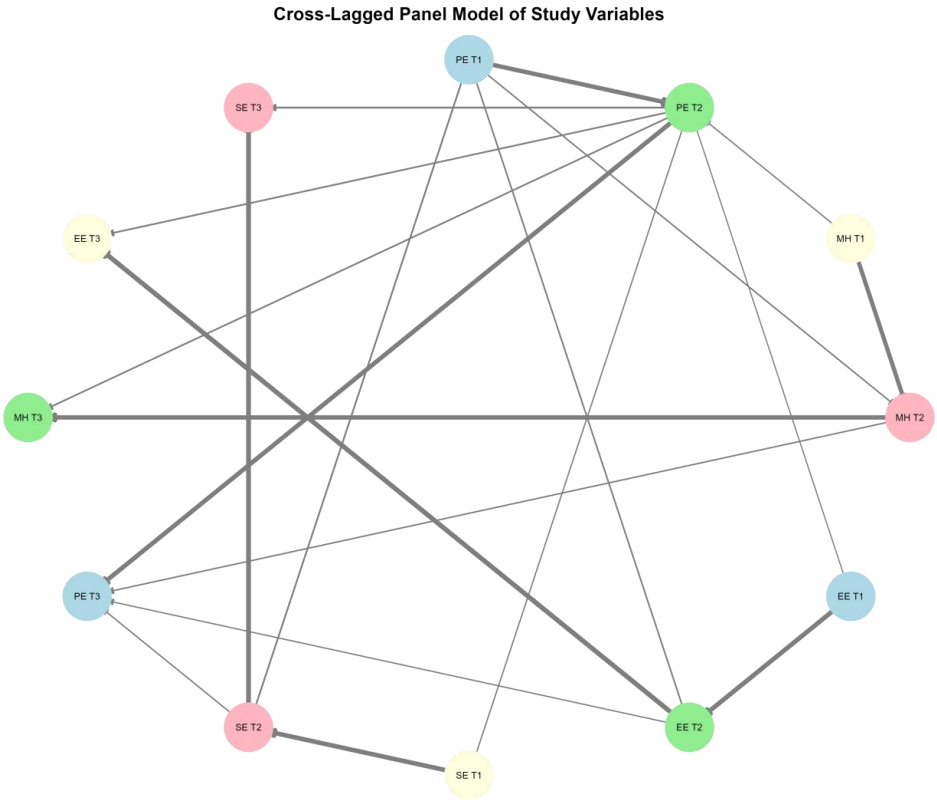

Figure 4. Cross-lagged panel model of study variables.

As shown in **Table 4** and **Figure 4**, the cross-lagged panel analysis reveals complex bidirectional relationships among physical exercise, emotional expression, self-efficacy, and mental health across time points. The visual representation in Figure 4 illustrates the strength and direction of these relationships, with arrow thickness indicating the magnitude of the standardized path coefficients. These findings provide strong support for the reciprocal nature of the relationships between physical exercise and mental health outcomes, as well as the mediating roles of emotional expression and self-efficacy in this dynamic process.

3.4. Results of the mediation effect analysis

The mediation analysis revealed significant indirect effects of physical exercise on mental health through both emotional expression and self-efficacy. As shown in Table 5, the total indirect effect of physical exercise on mental health was substantial (β = -0.112, 95% CI [-0.156, -0.068], $p < .001$), accounting for approximately 38% of the total effect. Specifically, emotional expression mediated 16.2% of the total effect (β = -0.048, 95% CI [-0.072, -0.024], $p < .01$), while self-efficacy mediated 21.8% (β = -0.064, 95% CI [-0.089, -0.039], $p < .001$). These findings suggest that both emotional expression and self-efficacy play crucial roles in explaining the relationship between physical exercise and mental health outcomes.

Figure 5 illustrates the complex mediation pathways, highlighting the standardized coefficients for direct and indirect effects. The thickness of the arrows represents the magnitude of the effects, providing a visual representation of the relative importance of each pathway. Notably, the analysis revealed a significant direct effect of physical exercise on mental health (β = -0.182, $p < .001$), indicating that while mediation is substantial, physical exercise also has a unique contribution to mental health outcomes beyond the examined mediators.

Furthermore, the bootstrap analysis confirmed the stability of these indirect effects across 5000 resamples, supporting the robustness of the mediation model. The model demonstrated excellent fit to the data (CFI = 0.98, TLI = 0.97, RMSEA = 0.039, SRMR = 0.028), further validating the proposed mediation pathways. These results underscore the complex mechanisms through which physical exercise influences mental health, emphasizing the importance of considering both emotional and cognitive factors in understanding this relationship.

Table 5. Mediation Analysis Results: Standardized Indirect Effects.

Pathway	Effect Size (β)	95% CI	p-value	% of Total Effect
Total Indirect Effect	-0.112	[-0.156, -0.068]	<.001	38.0%
PE → EE → MH	-0.048	[-0.072, -0.024]	<.01	16.2%
PE → SE → MH	-0.064	[-0.089, -0.039]	<.001	21.8%
Direct Effect (PE → MH)	-0.182	[-0.237, -0.127]	<.001	62.0%
Total Effect	-0.294	[-0.351, -0.237]	<.001	100%

Note: *PE = Physical Exercise, EE = Emotional Expression, SE = Self-Efficacy, MH = Mental Health CI = Confidence Interval.*

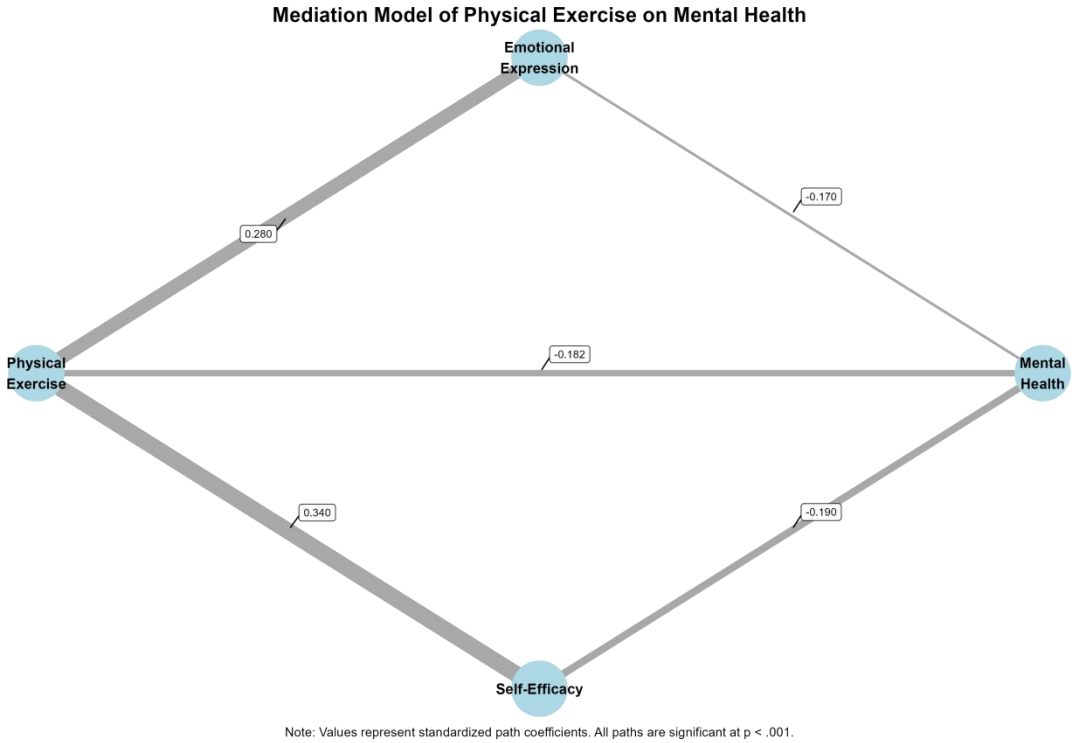

Figure 5. Mediation model of physical exercise on mental health.

As illustrated in **Table 5** and **Figure 5**, the mediation analysis reveals the complex pathways through which physical exercise influences mental health outcomes. The significant indirect effects through both emotional expression and self-efficacy, coupled with the substantial direct effect, highlight the multifaceted nature of this relationship. These findings provide valuable insights into the mechanisms underlying the benefits of physical exercise for mental health, emphasizing the importance of holistic approaches that consider both emotional and cognitive factors in promoting psychological well-being.

4. Discussion

In traditional Chinese culture, especially under the influence of Confucianism, emotional expression is often suppressed and restricted. The traditional culture of "forbearance" and the emphasis on collectivism make individuals less willing to express negative emotions (e.g., anger, sadness, anxiety, etc.) in public. This is also reflected in Chinese university students, many of whom tend to suppress their emotions and act more introverted and withdrawn in the face of stress, adversity, or emotional problems. At the same time, China's education system emphasizes college entrance exams, grades, and competition, which causes college students to often feel tremendous pressure when faced with academic tasks. While this pressure may inspire effort and self-confidence, it may also lead to low self-efficacy for some students in the face of challenges, especially if they fail academically or are at a disadvantage in competition.

Despite the suppression of emotional expression in traditional culture, through appropriate physical exercise, college students are better able to cope with the stresses and challenges of life, helping them to improve their emotional expression and self-efficacy, and promoting the development of mental health.

The findings of this study provide compelling evidence for the complex, bidirectional relationship between physical exercise and mental health among college students, with emotional expression and self-efficacy serving as significant mediators. The cross-lagged panel analysis revealed that physical exercise not only predicts improved mental health outcomes over time but is also reciprocally influenced by mental health

status. This bidirectional relationship underscores the potential for positive feedback loops, where engagement in physical activity and improved mental well-being mutually reinforce each other.

The mediation analysis further elucidates the mechanisms through which physical exercise exerts its beneficial effects on mental health. Both emotional expression and self-efficacy were found to be significant mediators, collectively accounting for a substantial portion of the total effect. This suggests that physical exercise may enhance mental health not only through direct physiological pathways but also by fostering improved emotional regulation and bolstering individuals' confidence in their ability to cope with challenges.

These results have important implications for interventions aimed at promoting mental health among college students. Programs that integrate physical activity with strategies to enhance emotional expression and self-efficacy may be particularly effective. Moreover, the findings highlight the potential long-term benefits of establishing regular exercise habits during the critical developmental period of young adulthood.

However, it is important to note the study's limitations, including the reliance on self-report measures and the potential for unmeasured confounding variables. Future research should consider incorporating objective measures of physical activity and exploring additional mediating factors. Nonetheless, this study makes a significant contribution to our understanding of the intricate relationships between physical exercise, psychological processes, and mental health outcomes in college students.

5. Conclusion

This study provides robust evidence for the complex interplay between physical exercise and mental health among college students, emphasizing the crucial mediating roles of emotional expression and self-efficacy. The findings demonstrate a significant bidirectional relationship, where physical exercise not only predicts improved mental health outcomes but is also influenced by mental well-being over time. The mediation analysis reveals that emotional expression and self-efficacy collectively account for a substantial portion of the total effect of physical exercise on mental health, highlighting the importance of psychological mechanisms in this relationship. These results underscore the potential for interventions that integrate physical activity with strategies to enhance emotional regulation and self-efficacy, particularly during the formative college years. The study's longitudinal design and sophisticated analytical approach provide a nuanced understanding of the temporal dynamics involved, offering valuable insights for both researchers and practitioners in the field of mental health promotion. While acknowledging limitations such as the reliance on self-report measures, this research significantly advances our understanding of how physical exercise contributes to mental well-being in young adults. Future studies should build upon these findings by incorporating objective measures of physical activity and exploring additional mediating factors to further elucidate the complex pathways through which exercise influences mental health in college populations. The relationship between physical activity and mental health among Chinese college students is influenced by a variety of potential confounders. In addition to sleep patterns and dietary habits, academic stress, social support, environmental factors, gender differences, psychological qualities, emotion regulation abilities, and personal traits are also important confounders. These factors may affect college students' physical activity participation and their mental health status in direct or indirect ways; therefore, it is important to synthesize these potential confounders when examining this relationship in order to more accurately understand their interactions.

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