

# The Relationship Between Physical Exercise and Aggressive Behavior Among College Students: The Mediating Roles of Life Satisfaction, Meaning in Life, and Depression

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**Purpose:** The deleterious impact of aggressive behavior on college students necessitates urgent mitigation. To explore the influencing factors and underlying mechanisms of aggressive behaviors among college students, this study aims to validate the mediating roles of life satisfaction, meaning in life, and depression by examining the relationship between physical exercise and aggressive behaviors among college students.

**Methods:** The Physical Activity Rating Scale-3 (PARS-3), Satisfaction with Life Scale, Meaning in Life Questionnaire, Chinese Version DASS-21 and 12-item Perception of Aggression Scale (POAS) were tested on 1596 college students from three universities in western China, and SPSS 26.0 and Mplus 8.3 were used for analysis.

**Results:** Physical exercise exhibited a significant negative correlation with both aggressive behaviors and depression among college students ( $r = -0.57, P < 0.001$ ;  $r = -0.36, P < 0.001$ ), as well as a significant positive correlation with life satisfaction and meaning in life ( $r = 0.45, P < 0.001$ ;  $r = 0.27, P < 0.001$ ). Regarding the impact of physical exercise on aggressive behaviors among college students, the mediating effects of life satisfaction, meaning in life, and depression were significant. The respective effect sizes were  $-0.11, -0.08$ , and  $-0.03$ . The chain mediation effect of life satisfaction through depression was also found to be significant, with an effect size of  $-0.02$ .

**Conclusion:** This study elucidates the mechanistic pathways through which physical exercise influences aggressive behavior among college students. The relationship between physical exercise and aggressive behavior is influenced by the individual mediating effects of life satisfaction, meaning in life, and depression, as well as the chain mediation effect of life satisfaction through depression. These findings provide a novel perspective on the prevention and intervention of aggressive behaviors among college students in China and potentially worldwide. This suggests that more attention should be paid to the organic combination of students' physical activity and mental health education.

**Keywords:** physical exercise, life satisfaction, meaning in life, depression, aggressive behavior

## Introduction

College students are currently situated within a critical phase of individual socialization, necessitating the simultaneous management of diverse pressures such as academic and career challenges, interpersonal relationship complexities, personal skills enhancement, and societal development.<sup>1</sup> This confluence of stressors renders them susceptible to the manifestation of aggressive behavior, a characteristic extroverted behavioral issue representative of the college student demographic.<sup>2</sup> Aggressive behavior refers to any intentional conduct directed at causing harm to others, and it encompasses both physical and psychological harm.<sup>3</sup> The existing research has indicated that aggressive behavior not only exerts adverse effects on the holistic development of individual college students, both physically and mentally,<sup>4</sup> but

it also contributes to the introduction of destabilizing elements in the normalization of socioeconomic development at the national level.<sup>5</sup> Therefore, investigating the influencing factors and inherent mechanisms of aggressive behavior among college students holds significant theoretical value and practical relevance for mitigating both the internal and external challenges faced by college students.

Physical exercise represents a primary avenue for college students to maintain both physical and mental well-being, denoting individual engagement in purposeful physical activities of a certain intensity, frequency, and duration for health-related purposes during leisure time.<sup>6</sup> Grounded in embodied cognition theory, it posits that the body's condition directly influences cognitive processes, and the physical processes of the body, as well as its interaction with the external environment, also exert a direct impact on cognitive processes.<sup>7</sup> Consequently, individuals can optimize their physical functions through exercise and engage in positive interactions with the external environment, thereby jointly having a positive impact on cognition.<sup>8</sup> Simultaneously, social cognitive theory posits that judgments and cognitions formed through internal processing of social information by individuals are crucial factors in triggering aggressive behavior.<sup>9</sup> According to this theory, positive changes at the cognitive level can, to some extent, reduce the occurrence of aggressive behavior.<sup>10</sup> In line with previous research findings, physical exercise, serving as a conduit for the body, not only yields beneficial effects on physical function and interpersonal interactions, but it also positively influences cognition. This, in turn, facilitates optimistic judgments and cognitions regarding external social information, effectively stimulating positive social behaviors and inhibiting irrational behaviors such as aggression.<sup>11,12</sup> Therefore, this study posits that physical exercise plays an inhibitory role in individual aggressive behavior. However, the current understanding of whether physical exercise, in the process of reducing aggressive behavior among college students, is influenced by other factors remains unclear and warrants further investigation.

Since aggression is a behavior generated by individuals to ameliorate their current maladaptive state, the underlying mechanism may stem from the buffering effect of physical exercise on individual maladaptation, which is closely associated with life satisfaction and meaning in life. Life satisfaction is the comprehensive cognitive evaluation of life events experienced by individuals.<sup>13</sup> Studies have found a positive correlation between physical exercise and life satisfaction.<sup>14</sup> Physical exercise not only influences individuals' social cognitive abilities through its unique group environment, but it also enhances cognition by improving physiological functions and mood states, thereby increasing individual life satisfaction.<sup>15</sup> Meaning in life refers to individuals' perception and awareness of the nature of themselves and their existence, including the recognition and perception of things they deem important,<sup>16</sup> encompassing two dimensions: having meaning and seeking meaning.<sup>17</sup> Regarding the relationship between meaning in life and physical exercise, a positive correlation has been observed.<sup>18</sup> Physical exercise can stimulate individuals' pursuit of life goals, enhance their awareness of life quality, and optimize their meaning in life.<sup>19</sup> Nevertheless, previous research has shown that life satisfaction has a protective effect on adolescents' criminal and aggressive behaviors,<sup>20</sup> and meaning in life has a positive role in reducing aggressive behavior among college students.<sup>21</sup> In other words, both life satisfaction and meaning in life may play a role in reducing aggressive behavior among college students. Therefore, this study posited that both life satisfaction and meaning in life may act as mediators in the relationship between physical exercise and aggressive behavior among college students.

In addition, a close association exists between physical exercise and depression.<sup>22</sup> Depression is a complex negative emotion characterized by feelings of helplessness in coping with external pressures, and it encompasses a combination of low mood, indifference, pessimism, and despair.<sup>23</sup> The existing research has indicated that physical exercise has a moderate to strong anti-depressive effect, and even minimal physical exercise activities can have a preventive effect on depression.<sup>24</sup> The beneficial impact of physical exercise on improving depressive emotions is significant for clinical patients,<sup>25</sup> non-clinical individuals,<sup>26</sup> and diverse populations, including college students.<sup>27</sup> However, studies by Chinese scholars have confirmed that Chinese college students with higher levels of depressive emotions exhibit stronger aggression.<sup>28</sup> International scholars have also indicated depression as one of the crucial factors triggering individual aggressive behavior.<sup>29</sup> The emotion-cognition integration model of social information processing further suggests that emotional processes influence the processing of social information by individuals in social contexts.<sup>30</sup> Based on this model, this study posits that depression, as a typical negative emotional experience, may interfere with the information processing of college students in social situations. This interference could lead to exaggerated reactions to social

information, making college students more prone to irrational, aggressive behaviors. Therefore, depression plays a role in the relationship between physical exercise and aggressive behavior among college students.

It is crucial to note the close interconnection between life satisfaction, meaning in life, and depression.<sup>31,32</sup> The Qualities of Depression-Stress Theory posits that depression arises from stressors that activate latent tendencies and transform the potential for depression into reality.<sup>33</sup> When life satisfaction is high, individuals tend to rate life events positively. Such positive and optimistic evaluations buffer the negative impact of stressors, helping individuals disrupt the generative chain of depression at its source and reduce the likelihood of depressive emotions.<sup>34</sup> Moreover, according to the Self-discrepancy Theory, individuals are more prone to depressive emotions when the actual-ideal self-discrepancy is significant, indicating that their ideal self is not realized and that the outcomes deviate greatly from self-expectations.<sup>35</sup> However, individuals with a higher meaning in life possess a deeper understanding of life's significance and clearer life goals, and they experience more meaning, fulfillment, and inner satisfaction. This enables them to bridge the gap between expectations and reality, reducing negative factors that contribute to depressive emotions in adolescents, such as perceived failure.<sup>36</sup> In summary, both life satisfaction and meaning in life have inhibitory effects on depression. In general, college students can enhance their life satisfaction through physical exercise.<sup>37</sup> College students with higher levels of life satisfaction are likely to have fewer experiences of depression, ultimately preventing aggressive behavior. Additionally, college students who engage in more substantial physical exercise often have higher overall levels of life meaning,<sup>38</sup> indicating a lower likelihood of depression and, consequently, a reduced risk of aggressive behavior.

In summary, this study is the first to explore the relationships among physical exercise, life satisfaction, meaning in life, depression, and aggressive behavior in Chinese college students by investigating the internal mechanisms between these five factors (the theoretical model is illustrated in Figure 1). We hypothesize as follows:

H1: Physical exercise negatively predicts aggressive behavior among college students.

H2: Life satisfaction, meaning in life, and depression individually mediate the relationship between physical exercise and aggressive behavior among college students.

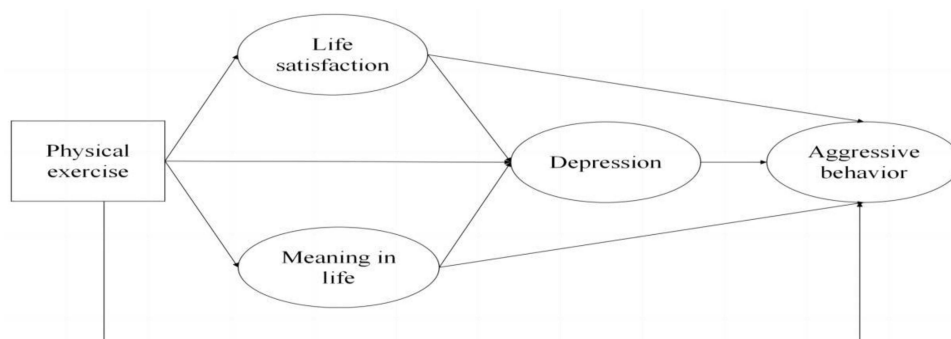
H3: Life satisfaction and depression jointly mediate the relationship between physical exercise and aggressive behavior among college students.

H4: Meaning in life and depression jointly mediate the relationship between physical exercise and aggressive behavior among college students.

## Material and Methods

### Participants and Procedures

This study employed an electronic questionnaire to survey first- to fourth-year students from three universities in the western region of China. Initially, 1770 questionnaires were distributed and 1596 questionnaires were collected, with a validity rate of 90.2%. The survey targeted 643 men (40.29%) and 953 women (59.71%). Regarding the grade variable,



**Figure 1** The Hypothesized Theoretical Model.

the first to fourth years included 430, 412, 394, and 360 participants, respectively. Their age distribution was primarily between 17 and 25 years ( $M = 20.21$ ,  $SD = 1.65$ ).

This study was approved by the Research Ethics Committee of Southwest University in China. Prior to the study, we contacted the administrative personnel of the participating schools and obtained permission for questionnaire testing and informed consent from the students. In this study, participants under the age of 18 received informed consent from their parents/legal guardians. Participation in the survey was voluntary, and the study was conducted following the principles of the Declaration of Helsinki.

## Measures and Instruments

### Physical Exercise

The Physical Activity Rating Scale-3 (PARS-3), developed by Koho Hashimoto and revised by Qingde Liang,<sup>39</sup> assesses physical exercise levels on the basis of three aspects: intensity, frequency, and duration. Each indicator is rated on a 5-point scale (1–5), and the physical exercise score is calculated as follows: Exercise Volume Score = Intensity Score  $\times$  (Duration Score - 1)  $\times$  Frequency Score. A higher score indicates a greater level of physical exercise. The scale has been demonstrated to exhibit high reliability and validity in the Chinese school environment.<sup>40</sup> In the current study, the Cronbach's  $\alpha$  coefficient for this scale was 0.84.

### Life Satisfaction

The Satisfaction with Life Scale, developed by Diener et al, was employed to assess individuals' satisfaction with their overall life status.<sup>41</sup> This scale comprises five items rated on a 7-point Likert scale ( $1 = \text{completely disagree}$  to  $7 = \text{completely agree}$ ). Higher scores indicate a higher level of satisfaction with life. The scale is suitable for adolescents in the Chinese school environment, demonstrating excellent reliability.<sup>42</sup> In the present study, the Cronbach's  $\alpha$  coefficient for this scale was 0.92.

### Meaning in Life

The Meaning in Life Questionnaire, developed by Steger et al and revised by Xinqiang Wang, consists of 10 items divided into two subscales: Presence of Meaning and Search for Meaning.<sup>43</sup> This questionnaire is suitable for adolescents in the Chinese school environment and exhibits excellent reliability overall.<sup>44</sup> The scale employs a 7-point Likert scoring system ( $1 = \text{completely disagree}$  to  $7 = \text{completely agree}$ ), with higher scores indicating a stronger sense of meaning in life. In the present study, the Cronbach's  $\alpha$  coefficients for the two dimensions of the scale were 0.91 and 0.91, and the overall scale had a Cronbach's  $\alpha$  coefficient of 0.95.

### Depression

This study utilized the Depression dimension of the Chinese Version of DASS-21, developed by Lovibond et al and revised by Xu Gong et al, as a measure of the participants' depression levels.<sup>45</sup> The scale has been demonstrated to possess high reliability and validity in the Chinese school environment.<sup>45</sup> The Depression dimension consists of seven items rated on a 4-point Likert scale ( $1 = \text{almost never}$  to  $7 = \text{always}$ ), with higher scores indicating higher levels of perceived depression. In the present study, the Cronbach's  $\alpha$  coefficient for the Depression dimension of this scale was 0.88.

### Aggressive Behavior

The 12-item Perception of Aggression Scale (POAS),<sup>46</sup> developed by Bryant and Smith, was employed for measurement in this study. This scale has demonstrated good reliability and validity within the context of Chinese culture.<sup>47</sup> The questionnaire consists of 12 items organized into four dimensions: physical aggression, verbal aggression, anger, and hostility. Responses are rated on a 5-point Likert scale ( $1 = \text{strongly disagree}$  to  $7 = \text{strongly agree}$ ), with higher scores indicating more prominent aggressive behavior. In the present study, the Cronbach's  $\alpha$  coefficients for each dimension of the questionnaire were 0.87, 0.87, 0.87, and 0.87, and the overall Cronbach's  $\alpha$  coefficient was 0.97.

## Analytic Strategy

The core variables and demographic information were subjected to descriptive statistics using SPSS 26.0, and the mean values, standard deviations, and correlations between the variables were reported. Frequency analysis was employed to analyze the population's composition and characteristics. Subsequently, Mplus 8.3 was utilized to construct a structural equation model to validate the hypotheses in this study. To test the significance of the mediating effects, the Bootstrap method was applied with 5000 resampling iterations to obtain bias-corrected percentile confidence intervals for the mediating effects. If the confidence interval does not include 0, it indicates the presence of a significant mediating effect.<sup>48</sup>

To examine the potential presence of common method bias effects, this study employed Harman's single-factor test, and all items in the study were subjected to an exploratory factor analysis without rotation. The results revealed a total of seven eigenvalues greater than 1 for the common factors. The first common factor accounted for 20.92% of the variance, falling below the critical standard of 40%.<sup>49</sup> This suggests no apparent common method bias in the present study.

## Results

### Descriptive Statistics Among the Variables

Descriptive statistics were performed on the core variables in this study, presenting the means and standard deviations. Table 1 reports the interrelationships between the variables. The results indicate a significant positive correlation between physical exercise and life satisfaction ( $r = 0.45, P < 0.001$ ;  $r = 0.27, P < 0.001$ ), as well as meaning in life. Moreover, a significant negative correlation was observed between physical exercise and both depression and aggressive behavior ( $r = -0.36, P < 0.001$ ;  $r = -0.57, P < 0.001$ ). Life satisfaction and meaning in life exhibited significant negative correlations with depression and aggressive behavior ( $r = -0.42, P < 0.001$ ;  $r = -0.23, P < 0.001$ ;  $r = -0.48, P < 0.001$ ;  $r = -0.41, P < 0.001$ ). Furthermore, a significant positive correlation was found between depression and aggressive behavior ( $r = 0.38, P < 0.001$ ).

### Intermediate Effect Test Based on Structural Equation Model

To examine the potential significant mediating roles of life satisfaction, meaning in life, and depression in the relationship between physical exercise and aggressive behavior, this study employed the coefficient product method and Bootstrap estimation to test the significance of the mediating effects. When subjected to 5000 bootstrap resampling iterations, if the confidence interval of the obtained mediating effect does not include zero, it indicates the presence of a significant mediating effect.

First, the model's goodness of fit was assessed, with the following results:  $\chi^2/df = 3.79$ , CFI = 0.94, TLI = 0.96, RMSEA = 0.02, and SRMR = 0.06. These findings suggest a good fit for the model, justifying further analysis of the pathway results. Figure 2 shows the specific results of the pathway analysis.

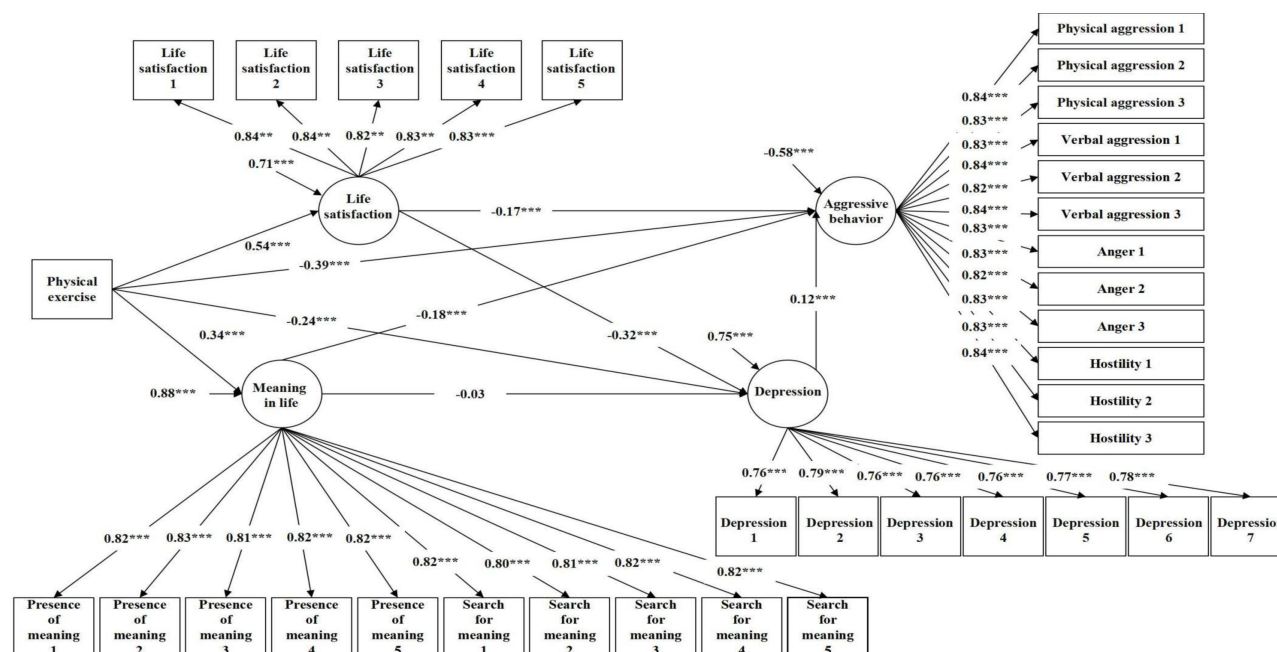
The figure reveals that physical exercise significantly predicts life satisfaction ( $\beta = 0.54, p < 0.001$ ), meaning in life ( $\beta = 0.34, p < 0.001$ ), and depression ( $\beta = -0.24, p < 0.001$ ). Life satisfaction exhibits a significant negative predictive effect on depression ( $\beta = -0.32, p < 0.001$ ), whereas the prediction of depression by meaning in life does not reach a significant level ( $\beta = -0.03, p = 0.297$ ). Moreover, life satisfaction ( $\beta = -0.17, p < 0.05$ ), meaning in life ( $\beta = -0.19, p < 0.001$ ), and depression ( $\beta = 0.12, p < 0.001$ ) equally demonstrate significant predictive effects on aggressive behavior. Additionally, the direct predictive effect of physical exercise on aggressive behavior remains significant ( $\beta = -0.39, p < 0.001$ ).

**Table 1** Presents the Descriptive Statistics and Correlation Analysis of the Variables in This Study

Variable	M	SD	1.	2.	3.	4.
1. Physical Exercise	33.19	26.78	—			
2. Life Satisfaction	4.42	1.68	0.45***	—		
3. Meaning in Life	4.36	1.64	0.27***	0.44***	—	
4. Depression	2.27	0.77	-0.36***	-0.42***	-0.23***	—
5. Aggressive Behavior	2.83	1.06	-0.57***	-0.48***	-0.41***	0.38***

Note: \*\*\* $p < 0.001$ .





**Figure 2** Shows a structural diagram of the mediating model for the relationship between physical exercise and aggressive behavior.

To further understand the mediating roles of life satisfaction, meaning in life, and depression in the relationship between physical exercise and aggressive behavior, this study employed the Bootstrap method with bias correction to examine the significance of the mediating effects, as presented in Table 2.

The table shows the following results: (1) life satisfaction plays a significant and individual mediating role between physical exercise and aggressive behavior, with an effect size of  $-0.11$  and a 95% confidence interval of  $[-0.16, -0.07]$ ; (2) meaning in life exerts a significant and individual mediating effect between physical exercise and aggressive behavior, with an effect size of  $-0.08$  and a 95% confidence interval of  $[-0.11, -0.06]$ ; (3) depression serves as a significant and individual mediator between physical exercise and aggressive behavior, with an effect size of  $-0.03$  and a 95% confidence interval of  $[-0.06, -0.02]$ ; (4) physical exercise also predicts aggressive behavior through a chained mediation involving life satisfaction and depression, with an effect size of  $-0.02$  and a 95% confidence interval of  $[-0.04, -0.01]$ ; (5) physical exercise does not predict aggressive behavior through a chained mediation involving meaning in life and depression, with an effect size of  $-0.001$  and a 95% confidence interval of  $[-0.005, 0.001]$ . In this case, the confidence interval of the mediation effect includes 0, indicating non-significance. By comparing path coefficients, this study found that among the four mediation paths, the path with life satisfaction as the sole mediator has

**Table 2** Summary of the Mediating Effects of Physical Exercise and Aggressive Behavior (N=1596)

Path	Effect size	Effective dose	p-value	95% Confidence Interval	
				Lower Limit	Upper Limit
Physical Exercise → Life Satisfaction → Aggressive Behavior	$-0.11$	44.40%	$<0.001$	$-0.16$	$-0.07$
Physical Exercise → Meaning in Life → Aggressive Behavior	$-0.08$	32.00%	$<0.001$	$-0.11$	$-0.06$
Physical Exercise → Depression → Aggressive Behavior	$-0.03$	13.60%	$<0.001$	$-0.06$	$-0.02$
Physical Exercise → Life Satisfaction → Depression → Aggressive Behavior	$-0.02$	9.60%	$<0.001$	$-0.04$	$-0.01$
Physical Exercise → Meaning in Life → Depression → Aggressive Behavior	$-0.001$	0.40%	0.349	$-0.01$	0.01
Total mediating effect	$-0.25$	100.00%	$<0.001$	$-0.30$	$-0.21$

the strongest effect ( $b = -0.11, p < 0.001$ ), while the chained mediation path “life satisfaction-depression” ( $b = -0.02, p < 0.001$ ), and the paths with meaning in life ( $b = -0.08, p < 0.001$ ) and depression ( $b = -0.03, p < 0.001$ ) as sole mediators exhibit weaker effects.

## Discussion

This study investigated the mechanistic role of physical exercise in predicting aggressive behavior among university students, using life satisfaction, meaning in life, and depression as mediating factors to construct an intermediate model. First, the research findings indicate that physical exercise can directly and negatively predict aggressive behavior among university students. Engaging in physical exercise helps alleviate their aggressive behavior; this finding aligns with previous research results<sup>50</sup> and supports the perspectives of embodied cognition and social cognitive theories. Embodied cognition theory posits a close association between the body and cognition,<sup>51</sup> while social cognitive theory suggests that positive cognitions and judgments are conducive to the reduction of individual aggressive behavior.<sup>52</sup> Consequently, it can be inferred that physical exercise, while altering university students’ physical and mental states, also regulates cognitive processes. This assists them in adopting more rational perceptions and judgments of external social environmental information, thereby reducing the occurrence of irrational behaviors such as aggression.

Furthermore, this study identified the independent mediating roles of life satisfaction and meaning in life in the relationship between physical exercise and aggressive behavior. The results indicate that university students’ physical exercise behavior can help reduce aggressive behavior by enhancing life satisfaction and meaning in life. Compared with meaning in life, physical exercise has a greater impact on predicting university students’ aggressive behavior through its influence on life satisfaction. This finding is not surprising; a recent study suggested that physical exercise can improve cognitive levels by enhancing plasticity in the hippocampus and reducing inflammation in the brain.<sup>53</sup> Life satisfaction is not only influenced by cognitive levels but also highly correlated with hippocampal volume. Previous research has confirmed that life satisfaction is positively correlated with gray matter volume in the right hippocampal-adjacent gyrus,<sup>54</sup> which confirms the positive physiological impact of physical exercise on life satisfaction. Thus, university students can enhance life satisfaction in a stable manner through increased physical exercise. The positive changes in cognitive function due to coordinated physical exercise contribute to the joint inhibition of aggressive behavior;<sup>55,56</sup> however, a strong sense of meaning in life provides university students with a broader perspective, helping them transcend the narrow view of the present and accurately position themselves in the social structure.<sup>57</sup> This enables them to focus more on the realization of social common interests, reducing the impact of events triggering aggressive behavior on their energy and attention. To a certain extent, this helps prevent the potential occurrence of aggressive behavior among university students. Additionally, when university students have a clear understanding of their life goals and meaning, they are more likely to pursue them in a relatively positive manner, further reducing the likelihood of adopting aggressive behavior as a negative pursuit of goals.

Moreover, this study corroborated the independent mediating role of depression in the relationship between physical exercise and aggressive behavior. In contrast to life satisfaction and meaning in life, the findings reveal that depression serves as a facilitating factor for aggressive behavior, with an increase in depression exacerbating university students’ aggressive tendencies. This may be attributed to depression as a complex negative emotion involving sadness and gloom, leading individuals to interpret and attribute events negatively.<sup>58</sup> This, in turn, drives individuals to make negative behavioral choices, culminating in aggressive actions with intentional harm toward others. Consistent with the outcomes of this study, previous research has indicated that university students with high levels of depression tend to evaluate and perceive conflict events in their life situations negatively, which contributes to internal imbalance and an increased likelihood of engaging in aggressive behavior.<sup>59</sup> However, regular physical exercise enables university students to focus their attention on present bodily sensations and specific exercise scenarios, assisting them in effectively diverting from negative thoughts and emotions; this diminishes sustained concentration on depressive feelings. As evidenced by longitudinal research, physical exercise is an effective means for university students to reduce depressive emotions.<sup>60</sup> Therefore, university students engaged in regular physical exercise experience lower levels of depressive emotions and reduced interference of negative emotions with rational cognition and judgment, and they are inclined to offer more reasonable interpretations and attributions to life events, thereby minimizing the elicitation of aggressive behavior.

Finally, this study identified the chain-mediating role of life satisfaction and depression in the relationship between physical exercise and aggressive behavior. Physical exercise has been demonstrated to have a promoting effect on positive emotions.<sup>61</sup> Individual extraction and processing of information are influenced by the current emotional state, and when individuals are in a positive emotional state, they tend to make optimistic judgments and choices.<sup>62</sup> Therefore, the increase in positive emotions associated with physical exercise helps individuals perceive and judge current life events more positively and optimistically, thereby enhancing life satisfaction. This explains the positive predictive effect of physical exercise on life satisfaction observed in this study. Furthermore, individuals with higher life satisfaction often have a relatively positive attitude toward the life events they experience. They also evaluate their overall quality of life from a more optimistic perspective, contributing to attaining happiness and reducing experiences of depressive emotions.<sup>63</sup> Similar conclusions were drawn in an empirical study conducted on university students.<sup>64</sup> The reduction of depressive emotions typically aids university students in undertaking a more rational examination of their self-awareness and judgment of life events. This equips them with stronger emotional regulation and rational thinking abilities when facing conflict situations, making it easier to avoid the occurrence of aggressive behavior. In summary, this study confirms that strengthening physical exercise is beneficial for university students in terms of enhancing life satisfaction, reducing depressive emotions, stabilizing emotional states in conflict situations, and ultimately decreasing aggressive behavior.

Additionally, this study did not find a chain-mediating role of meaning in life and depression in the relationship between physical exercise and aggressive behavior. Meaning in life and depression individually exhibit significant mediating effects on the relationship between physical exercise and aggressive behavior, whereas the relationship between meaning in life and depression is not significant. In the two-dimensional structure of meaning in life, although “presence of meaning” often effectively predicts individuals’ mental health and subjective well-being, the relationship between “search for meaning” and indicators of mental health outcomes is relatively unstable.<sup>65</sup> Research has suggested that the lack of a direct relationship between the effort to seek meaning and mental health may be due to not differentiating the ways in which individuals seek meaning.<sup>66</sup> Therefore, the nonsignificant impact of meaning in life on depression may be attributed to the failure to distinguish the ways in which university students seek meaning. Some students engage in meaning-seeking through proactive and visionary approaches, which leads to an enhancement of the sense of meaning and a reduction in depressive emotions. However, another group of students may pursue meaning in a ruminative manner, potentially resulting in more negative experiences and an increase in depressive emotions.<sup>67,68</sup> This difference may have impacted the significance of the relationship between meaning in life and depression in this study.

In summary, this study employed a mediation model to investigate the mechanism by which physical exercise predicts aggressive behavior in university students by considering the mediating roles of life satisfaction, meaning in life, and depression. The findings offer valuable insights for the prevention and intervention of aggressive behavior among college students. Physical exercise can enhance rational judgment, elevate overall cognitive levels, and alleviate negative emotions by improving life satisfaction, fostering meaning, and reducing depressive feelings; thus, this reduction in aggressive behavior occurrence reveals the internal mechanisms by which physical exercise predicts aggressive behavior among university students. Second, as a modifiable behavioral variable, engaging in brief and easily accessible physical activities daily can help students derive psychological benefits from physical exercise. This provides educators with effective and practical approaches for intervening and preventing aggressive behavior among college students. Finally, educational institutions should emphasize the quality of public physical education classes, cultivate a culture of physical exercise within the school, encourage students to engage in scientifically effective physical exercise to maximize its psychological benefits. Simultaneously, schools should intensify training in mental health education for students, focusing on nurturing life satisfaction and meaning in life, and guiding students to develop self-regulation strategies for negative emotions such as depression. Through this mind-body integrated approach, schools can contribute to reducing aggressive behavior among university students.

## Limitations and Future Directions

This study had several limitations. First, a cross-sectional design was used to prevent the establishment of causal relationships. Future research could employ longitudinal tracking methods to further explore the causal connection



between physical exercise and aggressive behavior among university students. Second, the study focused on a population of university students receiving higher education. Although it may offer insights for preventing and alleviating aggressive behavior in other adolescent groups, further empirical research is required to validate these findings. Finally, different types of exercise may have varying effects on university students' mental and physical well-being. Therefore, future research should meticulously examine the various modes of exercise among university students to gain a more nuanced understanding of the relationship between physical exercise and aggressive behavior in this demographic group.

## Conclusions

In summary, this study investigated the relationship between physical exercise and aggressive behavior among university students. Specifically, it revealed a significant positive prediction of aggressive behavior by physical exercise and verified the mediating roles of life satisfaction, meaning in life, and depression in this association. The findings also confirmed the presence of a serial mediation effect between physical exercise, life satisfaction, depression, and aggressive behavior.

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## Disclosure

The authors report no conflicts of interest in this work.

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