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Physical activity moderated the mediating effect of self-control between bullying victimization and mobile phone addiction among college students

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This study aims to investigate the relationship between bullying victimization and mobile phone addiction (MPA) among college students, taking into consideration the mediating role of self-control and the moderating role of physical activity. A self-report survey was administered to college students from 4 universities in Guangxi, Liaoning, and Hunan provinces in China. Participants were asked to report their experiences of bullying victimization, level of MPA, self-control, and physical activity. Descriptive statistics, correlation analysis, and regression analysis were conducted to analyze the data. Mediation and moderation models were subsequently established to examine the relationships between variables. The results indicated a positive correlation between bullying victimization and MPA among college students. Additionally, bullying victimization was negatively correlated with self-control. Bullying victimization significantly predicted MPA, and self-control partially mediated this relationship. Furthermore, physical activity moderated the association between bullying victimization and self-control among college students. The findings suggest that self-control plays a partial mediating role in the relationship between bullying victimization and MPA among college students. Moreover, physical activity weakens the association between bullying victimization and self-control. Therefore, promoting physical activity to reduce MPA among college students who have experienced bullying victimization is highly recommended.

Keywords Bullying victimization, Mobile phone addiction, Physical activity, Self-control, College students

Due to the convenience and powerful functions of mobile phone, they have become an indispensable part of people's lives in contemporary society^{1,2}. As of March 2020, there were nearly 900 million mobile internet users in China, many of whom were adolescents³. Unfortunately, an increasing number of young people have become "devotees" to their mobile phone⁴. Even worse, excessive use of mobile phone can lead to mobile phone dependence, also known as mobile phone addiction (MPA)⁵. Research has found that MPA has negative impacts on individuals' lives, academics, social interactions, psychology, and behavior^{6–10}. Given the significant impact of MPA on individuals, it is important to explore its underlying mechanisms.

In addition to interacting with family members, adolescents also spend a significant amount of time interacting with peers, such as classmates at school. Therefore, the relationship between adolescents and their peers and its association with MPA have received recent attention in research⁷. Studies have found a significant positive correlation between bullying victimization and MPA among adolescents^{7,11,12}. Bullying victimization refers to repeated aggressive behaviors, including physical, verbal, and relational aggression, between individuals of similar ages with imbalanced power and status¹³. Bullying victimization increases the likelihood of emotional problems and maladaptive behaviors^{12,14,15}. Bullying victimization is a source of stress for victims¹⁶. According to the self-determination theory¹⁷, frequent exposure to bullying victimization deprives adolescents of their basic psychological needs, especially the need for relationships. In line with the general strain theory¹⁸, diverse stressors such as incidents of bullying victimization can trigger negative emotions in individuals, prompting addictive

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behaviors as a coping mechanism to alleviate these emotional strains. Under these multiple influences, mobile phones may become an important tool for bullying victims to escape negative emotions and fulfill their need for relationships. Similar to adverse childhood experiences, research has found a positive correlation between adverse childhood experiences and MPA among college students¹⁹. Therefore, it is necessary to further explore the relationship between bullying victimization and MPA among college students, as well as the underlying psychological mechanisms and preventive measures. Based on the above analysis, this study proposes the first hypothesis that there is a positive correlation between bullying victimization and MPA among college students.

Several psychological factors mediate the relationship between bullying victimization and MPA among college students, and self-control is a widely studied psychological variable. Self-control refers to an individual's conscious ability to resist impulses, act in accordance with norms, and pursue long-term goals²⁰, similar to social cognitive theory²¹. Studies have found abnormal activation of brain regions involved in self-control among bullying victims²², and there is a negative correlation between bullying victimization and self-control as reported by numerous studies^{22–24}. In a longitudinal study, it was found that bullying victimization at the first time point significantly predicted the level of self-control at the second time point in a negative direction²⁵. Bullying victimization, as a source of strain^{16,26}, consumes individuals' cognitive resources and weakens their self-control²⁰, leading them to turn to mobile phone as a means of escaping this stress. According to the explanations of self-control theory²⁷, individuals continuously adjust their thoughts and behaviors to align with the developmental needs of long-term goals rather than short-term impulses. As mentioned earlier, experiences of bullying victimization impair the self-control levels of college students, further diminishing their ability to regulate mobile phone dependency. Numerous studies have extensively explored the negative correlation between self-control and individual MPA^{28–30}. High levels of self-control can inhibit current inappropriate behaviors^{31,32}, including MPA. However, different types of bullying victimization predict negative emotions to varying extents^{33–35}, with relational and physical victimization showing higher predictive power³⁵. Therefore, this study proposes the second hypothesis that self-control mediates the relationship between bullying victimization and MPA among college students, with different dimensions of bullying victimization having varying mediating effects.

However, the negative correlation between past bullying victimization and current levels of self-control is not always consistent. Some positive factors can weaken the predictive effect between the two, and physical activity is one such variable that has been widely studied. Physical activity is generally defined as any bodily movement produced by skeletal muscles that requires energy expenditure³⁶. Research has found that physical activity positively predicts individuals' levels of self-control^{37,38}. Therefore, physical activity may play a role in attenuating the negative predictive effect of bullying victimization on college students' self-control. The final hypothesis of this study is that physical activity moderates the relationship between bullying victimization and self-control among college students.

In summary, this study aims to further elucidate the psychological mechanisms and prevention of the relationship between bullying victimization and MPA among college students. With self-control as a mediating factor and physical activity as a moderating factor, this study seeks to enrich the theoretical foundation of this research field. Therefore, a hypothetical path model is constructed in this study (see Fig. 1).

Methods

Participants

The present study, conducted in April 2023, surveyed university students from 4 institutions located in Hunan, Guangxi, and Liaoning provinces, China. Ethical approval was obtained from the medical ethics committee of the authors' institution prior to the commencement of the study. Before administering the questionnaires, permission was obtained from class teachers, and participants were briefed on the purpose, confidentiality, and use of the data. Informed consent was obtained electronically at the beginning of the survey, where participants confirmed their understanding and willingness to participate. Participation was voluntary, and participants had the right to withdraw at any time. The survey was anonymous and could be completed in approximately 20 min. The study was conducted in accordance with the Declaration of Helsinki.

To ensure efficient responses, a classroom-based approach was adopted, excluding those who voluntarily chose not to participate. During initial data processing, participants with excessively short or patterned response times were excluded. A total of 778 students completed the survey, with 697 datasets deemed valid (179 males, 518 females), averaging 19.22 years of age (SD = 1.00).

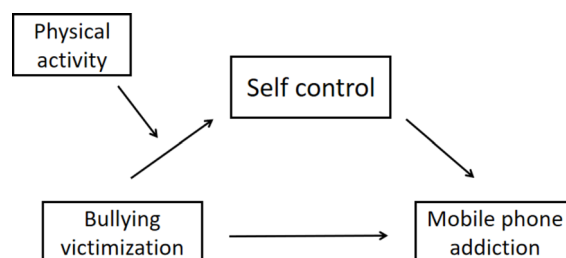


Fig. 1. Hypothesized a moderated and mediation model.

Measures

Physical activity

The Physical Activity Rating Scale-3 (PARS-3) was used to measure the physical activity level of college students³⁹. The scale comprises three items, including physical activity intensity, time, and frequency. Each item has five different levels, with scores ranging from 1 to 5 for intensity and frequency and 0 to 4 for time. The total score of physical activity is the product of the scores of the three items, with higher scores indicating higher levels of physical activity. The current sample's Cronbach's α coefficient is 0.677.

Bullying victimization

The revised Bullying Victimization Scale⁴⁰ was used to measure the degree of physical, relational, and verbal victimization experienced by college students during primary education. The scale comprises 12 items and uses a Likert 5-point scale, ranging from 1 (never) to 5 (every day). Higher scores indicate a higher degree of bullying victimization. As this study discusses participants' memories of their experiences during primary education, the word "once" was added in an appropriate position in each item, such as "I was once deliberately pushed by others." This type of research has been explored in the Chinese context⁴¹. The Cronbach's α coefficients of the bullying victimization scale in the sample were 0.813 ~ 0.822.

Self-control

The revised Self-Control Scale⁴² was used to measure the self-control level of college students. The scale comprises 13 items and uses a Likert 5-point scale, ranging from 1 (completely disagree) to 5 (completely agree). Higher scores indicate higher levels of self-control. The Cronbach's α coefficient of the current sample is 0.754.

Mobile phone addiction (MPA)

The Mobile Phone Dependence Questionnaire⁴³ was used to measure the level of MPA among college students. The scale comprises 13 items and uses a Likert 5-point scale, ranging from 1 (never) to 5 (always). Higher scores indicate a higher degree of MPA. The Cronbach's α coefficient of the current sample is 0.895.

Covariates

Considering the influence of demographic variables on the analysis results, such as gender and age^{11,12}, we controlled for these variables in the analysis.

Statistical analysis

All statistical analyses were performed using SPSS 26.0 software. First, we tested for method bias to check for potential biases caused by the use of self-report questionnaires. Second, we performed descriptive statistics and correlation analyses on demographic variables and main analysis variables. Third, we standardized the data of the main variables before testing. Finally, to verify our hypotheses, we used the PROCESS macro plugin (Model 7) in SPSS to analyze the relationships between variables⁴⁴. The PROCESS macro plugin was based on 5000 bootstrap resampling evaluations of model testing and 95% confidence interval (95% CI) estimates, with a relationship considered significant when the 95% CI did not include 0. Gender and age were controlled as covariates in the analysis. The significance level was set at $\alpha = 0.05$.

Results

Harman's Single-factor test

The Harman's single-factor test was used to examine common method bias. The results of the analysis showed that only two factors met the criterion of having eigenvalues greater than 1. Without conducting a principal component factor rotation, the first factor accounted for 32.17% of the variance, which is below the recommended threshold of 40%⁴⁵. Therefore, based on the analysis results, there was no significant evidence of common method bias in this study.

Descriptive data and Correlational analyses

Table 1 presents the Pearson correlation coefficients between the variables of interest. Bullying victimization and its dimensions were significantly positively correlated with MPA among college students ($r = 0.440 \sim 0.484$, $p < 0.001$), and significantly negatively correlated with self-control ($r = -0.169 \sim -0.245$, $p < 0.001$). Physical activity was significantly positively correlated with self-control ($r = 0.233$, $p < 0.001$). Self-control was significantly negatively correlated with MPA among college students ($r = -0.550$, $p < 0.001$).

Moderated and mediation analysis

After controlling for covariates, the results of the moderated and mediation analyses indicated that bullying victimization and its dimensions still significantly predicted MPA among college students ($\beta = 0.33 \sim 0.37$, $p < 0.001$). Additionally, self-control partially mediated the relationship between bullying victimization and MPA ($\beta = -0.17 \sim -0.23$, $p < 0.001$). Physical activity exhibited a similar moderating effect in the relationship between bullying victimization and self-control among college students (Bullying victimization: $\beta = -0.10$, $p < 0.01$; Physical victimization: $\beta = -0.09$, $p < 0.05$; Verbal victimization: $\beta = -0.10$, $p < 0.01$; Relational victimization: $\beta = -0.10$, $p < 0.01$). Please refer to Table 2, Figs. 2, and 3 for details.

Furthermore, this study analyzes the moderating effects of different levels of physical activity (low, medium and high) and finds that at low levels, physical activity has no significant moderating effect on the relationship between verbal victimization and self-control. Please refer to Table 3 and Fig. 3 for details.

	1	2	3	4	5	6	7	8	9
1 Gender	–								
2 Age	– 0.096*	–							
3 Physical activity	– 0.198***	0.059	–						
4 Self-control	– 0.045	0.077*	0.233***	–					
5 Mobile phone addiction	– 0.052	0.005	– 0.152***	– 0.550***	–				
6 Physical victimization	– 0.112**	– 0.012	– 0.054	– 0.245***	0.466***	–			
7 Verbal victimization	– 0.256***	– 0.024	0.011	– 0.169***	0.440***	0.767***	–		
8 Relational victimization	– 0.057	– 0.031	– 0.060	– 0.234***	0.442***	0.854***	0.768***	–	
9 Bullying victimization	– 0.150	– 0.024	– 0.038	– 0.233***	0.484***	0.943***	0.905***	0.940***	–
Mean	–	19.22	17.07	36.78	27.64	7.67	6.31	7.25	21.23
SD	–	1.00	17.00	6.42	8.61	2.92	2.65	2.75	7.75

Table 1. Pearson correlation matrix between relevant variables. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Discussion

This study explores the relationship between bullying victimization, MPA, self-control, and physical activity among college students. It also examines the mediating role of self-control in the relationship between bullying victimization and its dimensions and MPA among college students, as well as the moderating role of physical activity in the relationship between bullying victimization and self-control. The findings of this study reveal a negative correlation between bullying victimization and self-control, and a positive correlation between bullying victimization and MPA. Additionally, there is a positive correlation between physical activity and self-control, and a negative correlation between self-control and MPA among college students. Controlling for demographic variables, self-control serves as a mediator between bullying victimization and its dimensions and MPA among college students, while physical activity moderates the relationship between bullying victimization and self-control. These results validate our initial hypotheses.

Our study found that bullying victimization positively predicts MPA among college students, which aligns with similar previous research conducted^{12,46,47}. This finding supports the self-determination theory¹⁷ and social compensation theory⁴⁸, suggesting that individuals resort to alternative means to cope with unmet relational needs. Moreover, bullying victimization leads to significant negative emotions in individuals^{49,50}, and victims may engage in substance use as a way to escape these negative emotions⁵¹. These factors combined make mobile phones an irreplaceable medium. The relationship between bullying victimization and MPA has been previously reported^{14,52,53}. Therefore, the findings of this study confirm our initial hypothesis that bullying victimization is positively related to MPA among college students.

Furthermore, this study reveals that self-control plays a mediating role in the relationship between bullying victimization and MPA, which is consistent with similar results found in previous cross-sectional and longitudinal studies conducted^{24,25}. For adolescents, positive peer relationships are crucial as they provide a healthy social norm and contribute to the development of higher levels of self-control⁵⁴. Conversely, negative peer relationships, such as the bullying victimization examined in our study, increase negative emotions in victims^{33–35}, thereby impairing self-control^{55–57}, leading to the occurrence of behaviors such as MPA. Additionally, our study finds that self-control plays different mediating roles in various forms of bullying victimization and MPA. Self-control exhibits the strongest mediating role in relational victimization and MPA, which is consistent with previous research^{14,34}. The results obtained in this study may be attributed to the different forms of bullying victimization. For instance, physical and verbal victimization are more overt, and the perpetrators may cease their actions once they achieve their desired outcomes^{58,59}. In contrast, relational victimization is often more covert and has greater potential for harm⁶⁰. Therefore, compared to physical and verbal victimization, relational victimization may inflict greater harm on the victims. Hence, our study observed a higher level of mediation by self-control in the relationship between relational victimization and MPA.

Moreover, this study finds that physical activity negatively moderates the relationship between bullying victimization (regardless of the form) and self-control, which aligns with our final hypothesis. Previous research has shown that physical activity predicts levels of self-control^{61–63}. Experimental studies have found that the self-control levels of the exercise intervention group are higher than those of the control group^{64,65}, possibly due to the promotion of metabolic and developmental levels in brain regions associated with self-control as a result of physical activity^{66–68}. Our study also finds that physical activity positively predicts self-control among college students and negatively predicts the relationship between different forms of bullying victimization and self-control.

Based on the results obtained, this study provides insights for future research in this area. Firstly, it further investigates the relationship between bullying victimization and college students’ MPA. Additionally, it considers the role of self-control between these variables. Moreover, the study explores the impact of physical activity on alleviating the effect of bullying victimization on college students’ self-control, aiming to mitigate the risk of lower MPA among those who have experienced bullying victimization. One strength of this study is its differentiation between dimensions of bullying victimization and varying levels of physical activity, revealing different effects on the relationship between bullying victimization types and college students’ self-control. Specifically, the relationship between verbal victimization and college students’ self-control may not significantly moderate

	Bullying victimization						Physical victimization						Verbal victimization						Relational victimization					
	Self-control			Mobile phone addiction			Self-control			Mobile phone addiction			Self-control			Mobile phone addiction			Self-control			Mobile phone addiction		
	β	SE	t	β	SE	t	β	SE	t	β	SE	t	β	SE	t	β	SE	t	β	SE	t	β	SE	t
Gen-der	-0.07	0.08	-0.83	-0.03	0.07	-0.42	-0.05	0.08	-0.54	-0.07	0.07	-1.03	-0.10	0.09	-1.15	0.06	0.07	0.81	-0.02	0.08	-0.26	-0.11	0.07	-1.71
Age	0.05	0.04	1.51	0.05	0.03	1.68	0.06	0.04	1.63	0.04	0.03	1.44	0.05	0.04	1.47	0.05	0.03	1.85	0.05	0.04	1.51	0.05	0.03	1.60
A	-0.22	0.04	-6.05***	0.37	0.03	12.60***	-0.23	0.04	-6.37***	0.35	0.03	11.60***	-0.17	0.04	-4.46***	0.36	0.03	12.06***	-0.22	0.04	-6.04***	0.33	0.03	10.94***
B				-0.47	0.03	-15.84***				-0.47	0.03	-15.65***				-0.49	0.03	-16.75***				-0.48	0.03	-15.89
C	0.23	0.04	6.17***				0.22	0.04	6.06***				0.24	0.04	6.43***				0.22	0.04	5.99**			
B×C	-0.10	0.03	-2.92**				-0.09	0.03	-2.48*				-0.10	0.03	-3.13**				-0.10	0.04	-2.80**			
R2	0.12			0.44			0.12			0.42			0.10			0.43			0.12			0.41		
F	18.83***			135.00***			18.94***			126.28***			15.60***			130.20***			18.17***			120.84***		

Table 2. Moderated and mediation analysis. A: Bullying victimization and its dimensions; B: Self-control; C: Physical activity. *p<0.05; **p<0.01; ***p<0.001.

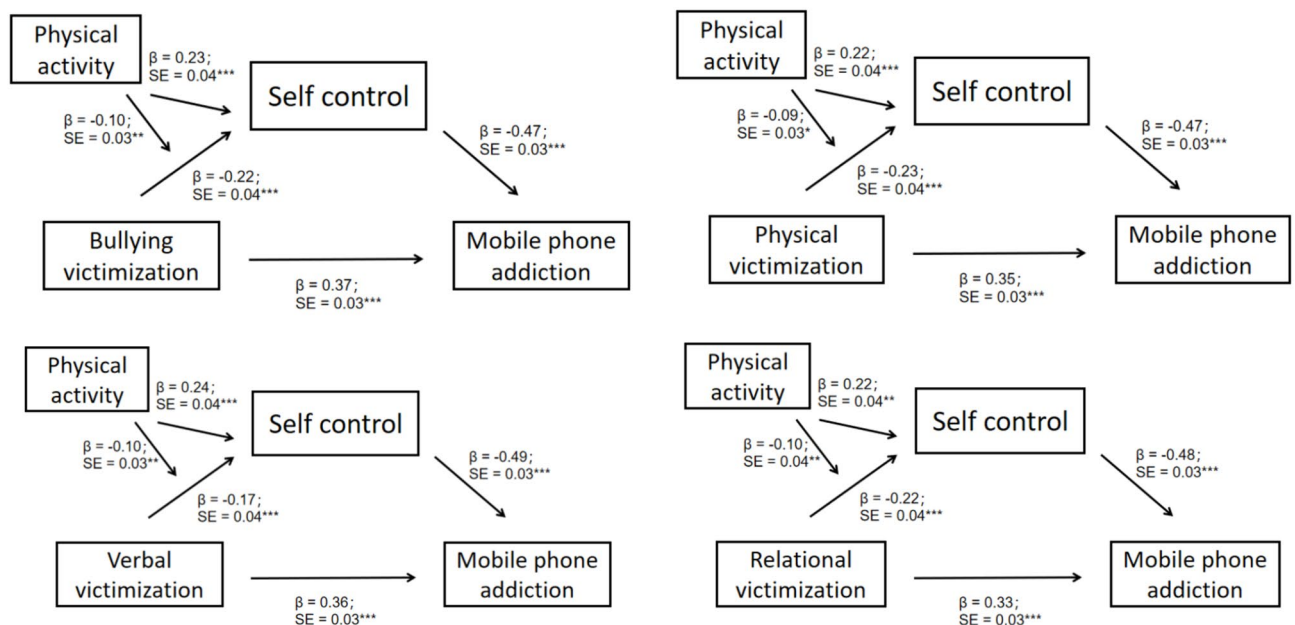


Fig. 2. Hypothesized a moderated and mediation model.

at low levels of physical activity. However, at moderate levels of physical activity, significant moderation effects are observed in the relationship between bullying victimization and its different dimensions and college students' self-control. Furthermore, the moderation effect is even stronger at high levels of physical activity. Drawing on the strength model of self-control²⁰, which posits that self-control is akin to a muscle that can be strengthened through physical activity⁶⁹, and guided by the general strain theory¹⁸, which suggests that negative emotions resulting from bullying victimization may lead individuals to seek relief through social media and other means, thus impairing their self-control^{70,71}, thereby exacerbating MPA. In summary, interventions aimed at guiding college students who have experienced bullying victimization should focus on promoting moderate levels of physical activity, which can enhance self-control across all forms of bullying victimization. Additionally, given the social nature of physical activity, high levels of participation may foster the accumulation of social capital⁷², strengthen interpersonal connections^{73,74}, facilitate the alleviation of negative emotions^{75,76}, and ultimately prevent MPA^{77,78}.

However, this study has limitations. Firstly, it is based on cross-sectional surveys, which impose significant constraints when interpreting causal relationships. Secondly, our assessment of college students' experiences of bullying victimization relies on retrospective surveys, introducing uncertainties compared to real-time assessments of this variable. Future research could employ longitudinal tracking and multi-dimensional data collection methods to further challenge some conclusions of this study. Lastly, the sample size and scope of this survey are limited, thereby constraining the generalizability of findings across different cultural backgrounds.

Conclusion

This study explores the relationship between bullying victimization, mobile phone addiction, self-control, and physical activity among college students. The findings reveal the mediating role of self-control in the relationship between bullying victimization and mobile phone addiction, as well as the moderating role of physical activity in the relationship between bullying victimization and self-control. Furthermore, we find that self-control exhibits varying levels of mediation in the relationship between different forms of bullying victimization and mobile phone addiction among college students. Schools should promptly identify bullying victims, especially those experiencing relational victimization, as it may become a significant hidden risk for adverse psychological and behavioral outcomes in their future lives, and they should be encouraged and supported to engage actively in physical activity.

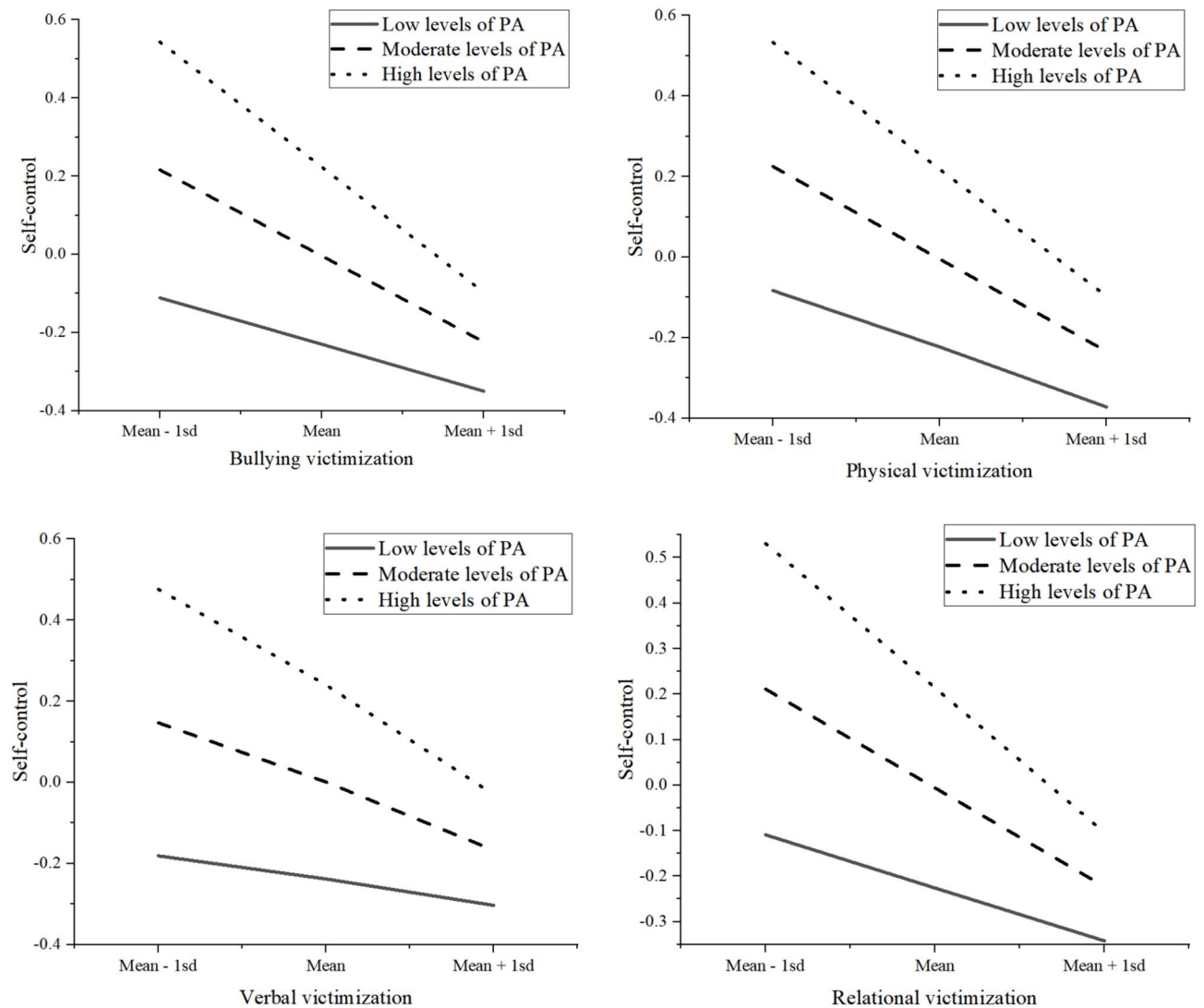


Fig. 3. The moderating effect of physical activity (PA) on bullying victimization and its dimensions and self-control in college students.

	PA levels	Effect size	SE	t	Lower limit 95%CI	Upper limit 95%CI
Bullying victimization	Low	-0.12	0.05	-2.31*	-0.22	-0.02
	Medium	-0.22	0.04	-6.05***	-0.29	-0.15
	High	-0.32	0.05	-6.68***	-0.41	-0.26
Physical victimization	Low	-0.14	0.05	-2.82**	-0.25	-0.04
	Medium	-0.23	0.04	-6.37***	-0.30	-0.16
	High	-0.31	0.05	-6.53***	-0.41	-0.22
Verbal victimization	Low	-0.07	0.05	-1.25	-0.17	0.04
	Medium	-0.17	0.04	-4.46***	-0.24	-0.09
	High	-0.27	0.05	-5.73***	-0.36	-0.18
Relational victimization	Low	-0.12	0.05	-2.27*	-0.22	-0.02
	Medium	-0.22	0.04	-6.04***	-0.29	-0.15
	High	-0.32	0.05	-6.33***	-0.42	-0.22

Table 3. The different physical activity level of bullying victimization and the moderation of relationships between different dimensions and self control. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Data availability

The datasets generated and/or analysed during the current study are not publicly available due [our experimental team's policy] but are available from the corresponding author on reasonable request.

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Competing interests

The authors declare no competing interests.

Ethics approval and consent to participate

The study was approved by the Biomedicine Ethics Committee of Jishou University before the initiation of the project (Grant number: JSDX-2024-0086). And informed consent was obtained from the participants and their guardians before starting the program. We confirm that all the experiment is in accordance with the relevant guidelines and regulations such as the declaration of Helsinki.

Additional information

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