



OPEN Physical and emotional abuse with internet addiction and anxiety as a mediator and physical activity as a moderator

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This study aimed to explore the relationship between physical and emotional abuse (physical-emotional abuse) and Internet addiction in university students, as well as the mediating role of anxiety and the moderating role of physical activity. The data of physical-emotional abuse, anxiety and Internet addiction, and physical activity were measured by subjective questionnaire with convenience sampling in March 2024. A total of 1591 participants (806 males and 692 females) from Shanxi, Henan, Hunan and Hubei provinces in China were investigated. Subsequently, the relationships among the variables were explored using Pearson correlation analysis. Finally, mediation and moderation models were assessed using the SPSS PROCESS macro plugin. After controlling for participants' gender, grade level, and place of residence, only-child status, the study findings revealed that physical-emotional abuse significantly and positively predicted internet addiction and anxiety among university students ($\beta = 0.157$, $\beta = 0.271$, $p < 0.001$). However, upon the inclusion of anxiety as a variable, the predictive effect of physical-emotional abuse on internet addiction among university students became non-significant ($\beta = 0.035$, $p > 0.05$). Anxiety was found to have a significant complete mediating effect between physical-emotional abuse and internet addiction among university students. Additionally, physical activity significantly and negatively predicted anxiety ($\beta = -0.062$, $p < 0.05$), and the interaction term between physical-emotional abuse and physical activity also significantly and negatively predicted anxiety ($\beta = -0.053$, $p < 0.05$). Physical activity moderated the first half of the mediation pathway from "physical-emotional abuse to anxiety to internet addiction." Anxiety may be the internal mechanism of physical-emotional abuse affecting university students' Internet addiction, and physical activity plays a moderator role in the relationship between physical-emotional abuse and university students' Internet addiction. The study will provide new perspectives and strategies for the public health field to address physical-emotional abuse and Internet addiction among university students. It is also critical that future studies validate these findings on a large, multi-country basis.

Keywords Physical-emotional abuse, Internet addiction, Anxiety, Physical activity, University student

Background

Physical abuse refers to the intentional use of force that results in harm to a child's health, survival, development, or dignity¹, while emotional abuse entails actions that damage a child's self-worth or emotional well-being, characterized by verbal hostility, ridicule, belittlement, and rejection². Initially, World Health Organization survey data indicate that three-quarters of adolescents have experienced abuse during childhood³. Subsequently, a Chinese survey report reveals that the incidence of physical and emotional abuse (physical-emotional abuse) among Chinese university students during childhood is as high as 64.7%⁴. Lastly, a global assessment of children's exposure to violent behaviors, encompassing moderate to severe physical abuse, reveals that at least 64% of children aged 2 to 17 in Asia have suffered violent injuries, compared to 56% in North America, 50% in Africa, and 34% in Latin America⁵. Furthermore, stress and coping theories suggest that physical-emotional abuse may lead to chronic stress responses, prompting individuals to overuse the internet as a means

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of chronic stress and arousal, thereby triggering a series of negative emotional regulation outcomes⁶. Another study finds that individuals who experienced physical-emotional abuse in childhood may exhibit higher levels of aggression and self-harm behavior during college^{7–9}. Additionally, psychological abuse can have detrimental effects on adolescents' cognitive development, emotional regulation capabilities¹⁰, and social adaptation skills¹¹. Further research reveals the intergenerational transmission of psychological abuse: adolescents who suffered psychological abuse in childhood are more likely to psychologically abuse their own children in adulthood compared to those who grew up in healthy environments¹². Beyond this, the impact of experiencing physical-emotional abuse during childhood can extend into adolescence, leading to reduced self-esteem and self-efficacy, increased shame, and heightened sensitivity to interpersonal rejection¹³. As the types of abuse and neglect increase, so too do the negative mental health behaviors in adolescents¹⁶. Therefore, this study conducts an epidemiological survey to comprehensively understand the internal impacts and regulatory mechanisms of physical-emotional abuse among Chinese university students, providing foundational data for the prevention of adolescent mental and physical health issues.

Internet addiction, also referred to as pathological internet use, is characterized by impulsive and uncontrolled behaviors or psychological states associated with excessive internet use in the absence of addictive substances¹⁴. With the advancement of information technology, the number of internet users continues to grow. According to a 2021 survey on internet usage among minors in China, individuals aged 20 to 29 accounted for 27.9% of the total internet user population, while college students constituted a significant 24.8%¹⁸. Research has identified a history of physical-emotional abuse as a significant negative factor contributing to internet addiction among university students¹⁵. Experiences of such abuse can adversely affect adolescents' emotional well-being, and studies have shown a significant positive correlation between childhood psychological abuse and internet addiction in university students^{16,17}. The compensatory internet use model posits that individuals may seek to fulfill unmet needs in the online world that are not satisfied in their real lives¹⁸. Furthermore, childhood trauma can impair the development of emotional regulation skills¹⁸. When individuals are unable to effectively express their negative emotions in real life, they may resort to internet use as an escape or coping strategy to alleviate the impact of these emotions, potentially leading to internet addiction over time¹⁹.

Given the strong evidence linking physical-emotional abuse to internet addiction, as well as the detrimental effects of internet addiction on individuals' mental and physical health, it is crucial to explore the psychological and behavioral mechanisms underlying the relationship between abuse and internet addiction among university students. Based on this context, this study posits the following hypothesis: There is a significant positive correlation between physical-emotional abuse and internet addiction among university students (H 1).

Anxiety refers to a spectrum of subjective, unpleasant feelings that individuals experience when confronted with stressful events or continuous stimuli¹². An epidemiological survey conducted in 2023 revealed that the prevalence of anxiety among Chinese students is 13.97%¹⁴. According to the Shattered Assumptions Theory proposed by psychologist Ronnie Janoff-Bulman, individuals undergo psychological changes following traumatic events. Prior to such events, individuals generally hold a set of fundamental positive assumptions about the world and their self-worth; however, when these traumatic events occur, these basic assumptions are shattered, leading to alterations in worldview, values, and self-perception, which in turn trigger negative emotional and behavioral responses²⁰. Research indicates that adolescents who suffer abuse and neglect in childhood are more likely to develop mental health issues such as anxiety in adulthood and middle age²¹. Studies examining multiple variables have found that childhood abuse can predict anxiety, with abuse and neglect during childhood affecting adolescent mental health, and individuals with a history of abuse being more prone to anxiety symptoms²². Longitudinal research has closely linked childhood abuse (emotional, sexual, and physical neglect) to anxiety symptoms²³, with all three factors being independent risk factors for anxiety symptoms in adolescents. Additionally, a survey in the Czech Republic supports the notion that adverse childhood experiences are risk factors for anxiety²⁴. A meta-analysis of childhood abuse in China found that physical and emotional abuse are the most common forms of abuse experienced during childhood²⁵, and adolescents who experience physical and emotional abuse are at a significantly higher risk of anxiety than those who experience other forms of abuse. Furthermore, childhood abuse can predict anxiety symptoms at a one-year follow-up²⁶, and results suggest that anxiety is not only related to adverse early experiences¹² but also to physical-emotional abuse. Moreover, anxiety is associated with adolescent internet addiction, with levels of anxiety increasing as internet addiction severity rises²⁷, and there are gender differences, with females generally having higher levels than males^{28,29}. The results of a longitudinal study indicate that anxiety is a significant predictor of adolescent internet addiction²⁹. Based on these findings, the following research hypothesis is proposed: Anxiety mediates the relationship between physical-emotional abuse and internet addiction among university students (H 2).

Physical activity, defined as engagement in bodily movement of a certain frequency, intensity, and duration, has been consistently shown in literature and empirical studies to play a positive role in promoting both physical and mental health³⁰. According to self-regulation theory³¹, physical activity can enhance an individual's self-regulatory capabilities, including emotional regulation and behavioral control, thereby reducing the likelihood of internet addiction. Studies have indicated that university students who have experienced adverse experiences, such as physical-emotional abuse, are more prone to negative emotions²⁸. Firstly, physical activity has been proven to effectively alleviate negative emotions and enhance psychological well-being²⁹. Secondly, regular engagement in physical activity helps to improve an individual's capacity to experience positive emotions³². The benefits of physical activity in preventing or treating anxiety disorders are well-documented, and activity is emerging as a cost-effective new therapeutic pathway for various anxiety disorders^{33,34}. Furthermore, physical activity can alleviate anxiety symptoms in adolescents²¹. A cross-sectional study found a negative correlation between activity frequency and anxiety, and participation in sports and interventions that strengthen the self-system can help reduce anxiety among university students^{35,36}. Additionally, research has found that the more severe the abuse experienced by adolescents, the shorter their adherence to physical activity, and emotional

abuse is a significant factor affecting adolescents' physical activity³⁷. Similarly, physical activity can improve emotional abilities and is significantly positively correlated with adolescents' emotional capabilities, alleviating the relationship between physical-emotional abuse and anxiety³⁰. In light of the increasing severity of physical-emotional abuse and internet addiction among adolescents, this study explores the intrinsic factors affecting university students' experiences of physical-emotional abuse and internet addiction. Based on the above, Hypothesis 3 is proposed: Physical activity exerts a moderating effect in the relationship between physical-emotional abuse and anxiety among university students (H 3).

In summary, this study constructs a moderated mediation model to explore the influence path and mechanism of anxiety and physical activity on the relationship between physical-emotional abuse and Internet addiction, so as to provide more support and care for university students who have suffered physical and mental abuse, reduce their anxiety symptoms and increase the number of physical activity, alleviate or reduce the mental health problems of university students, and provide a reference for carrying out mental health intervention and improving the social psychological construction of university students. See Fig. 1.

Methods

Participants

This study employed a convenience sampling method due to its ease of implementation, cost-effectiveness, and time efficiency, as well as its feasibility for conducting research within educational institutions. In March 2024, a total of 1,591 university students from four provinces in China—Shanxi, Henan, Hunan, and Hubei—were selected to participate in the study, yielding 1,498 valid questionnaires, with 806 males and 692 females. Prior to the commencement of the survey, the target provinces for the study were identified. Subsequently, collaborations with local educational institutions were established to randomly select various types of universities (such as comprehensive, science and engineering, and liberal arts universities). Within each university, students from different grades and majors were randomly selected as research participants. Prior to the start of the survey, participants were informed of the content and purpose of the survey, and all test subjects were informed and signed on a voluntary basis. The study was conducted in accordance with the Declaration of Helsinki. During the investigation, the researchers briefed the participants, including the main purpose of the study, the confidentiality of the data, and the eventual destination. We also informed participants of the voluntary nature of the survey and that there was no risk to the participants. This was followed by an electronic questionnaire for each class. This study was approved by the Medical Ethics Committee of the author's institution prior to initiation (JSDX-2024-0086).

Measuring tools

Physical-emotional abuse

The International Adverse Experiences of Childhood Abuse Short Form (ACE-ASF) was used to measure participants' experiences of physical and psychological abuse^{38,39}. The scale contains 8-item retrospective self-reports that assess physical-emotional abuse and are scored using a binary approach³⁹. The scale is scored on a scale of 0 (no) – 1 (yes) with a total score of 0–4. The specific item within the scale reads: "Have your parents, guardians, or other family members ever slapped, kicked, punched, or beaten you?" Higher scores on this scale indicate a more severe degree of physical-emotional abuse. The Kaiser-Meyer-Olkin (KMO) measure for this scale in our study sample is 0.781, with a $p < 0.001$, suggesting good validity of the scale. Furthermore, the Cronbach's alpha coefficient for this tool in our study sample is 0.817, indicating a high level of internal consistency and reliability.

Anxiety

The Depression Anxiety Stress Scale (DASS-21) Chinese developed by Lovibond et al.⁴⁰ and revised by Gong et al.⁴¹ was used to measure the emotional state of the subjects in the past 1 week. The full scale contains 21 items, and the three sub scales of depression, anxiety and stress contain 7 items each, and the anxiety sub scale is used

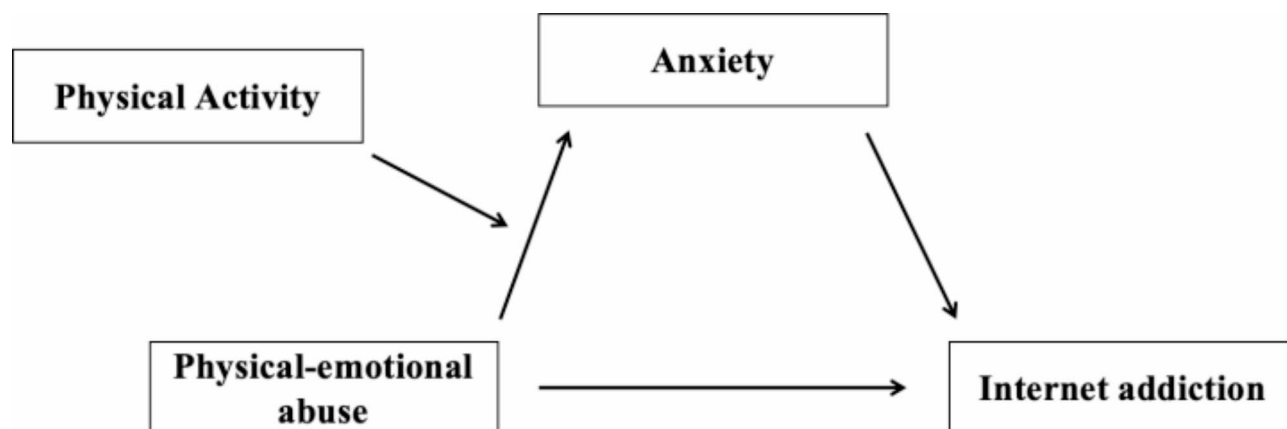


Fig. 1. Moderated mediation model.

in this study. The scale employed a 4-point Likert-type scoring system, with responses ranging from 1 (strongly disagree) to 4 (strongly agree). An illustrative item from the scale is: “Feeling difficulty in calming oneself down.” Higher total scores on this scale correspond to increased levels of anxiety, with a possible range from 7 to 28 points. Prior to the assessment of reliability, we conducted an analysis of construct validity. The KMO value for this scale in our study sample was 0.884, with a $p < 0.001$, indicating that the scale possesses good construct validity. Furthermore, the Cronbach’s alpha coefficient for this instrument in our study sample was 0.862, which demonstrates a high level of internal consistency.

Internet addiction

The data measurement scale utilized in this study is the “Internet Addiction Scale” developed by Wei et al.⁴². This scale comprises 8 items, with responses rated on a 5-point Likert scale ranging from 1 (completely disagree) to 5 (completely agree). A specific item on the scale is: “Use of social networking sites distracts me from focusing on my studies.” Higher scores on this scale indicate a greater severity of internet addiction, with a total score ranging from 8 to 40 points. The Cronbach’s alpha coefficient for this scale in the current study is 0.902, indicating a high level of internal consistency. Prior to the reliability assessment, an analysis of construct validity was conducted, yielding a KMO value of 0.914 with a $p < 0.001$, which suggests that the scale has good construct validity. Furthermore, the Cronbach’s alpha coefficient for this instrument in our study sample is 0.862, reinforcing the scale’s reliability.

Physical activity

Physical activity was assessed by a single item: “How many times have you exercised or done at least 20 minutes of physical activity in the past 7 days that made you sweat or have trouble breathing?” Options range from 0 to 7 days⁴³. This tool has been used in previous studies^{21,44}.

Covariates

To account for the potential influence of demographic variables on the outcome analysis, such as gender, grade level, only-child status and place of residence, these variables were controlled for during the analysis process.

Data processing

Data entry was conducted using Excel 2021, followed by an examination of methodological biases within the self-administered questionnaires to identify potential sources of bias. The Shapiro-Wilk test was employed to assess the normality of the data. In accordance with Kim’s criteria⁴⁵, data with absolute skewness values below 2 and absolute kurtosis values below 7 were considered to be approximately normally distributed. In this study, the variables of physical-emotional abuse, internet addiction, anxiety, and physical Activity were found to be normally distributed. For variables conforming to a normal distribution, descriptive analysis was performed using mean (*M*) and standard deviation (*SD*). Subsequently, Pearson’s correlation analysis was conducted using SPSS 26.0, and mediation and moderation models were tested with the PROCESS macro. The PROCESS macro program developed by Hayes⁴⁶ was utilized to examine the mediating effect of anxiety between physical-emotional abuse and university students’ internet addiction (Model 4), and to test the moderating role of physical activity in the mediation model between physical-emotional abuse and university students’ anxiety (Model 7). This study employed 5,000 bootstrap resampling iterations to assess model fit and estimate the 95% confidence interval (95% CI), with non-inclusion of zero in the interval indicating significance. Gender, place of residence, and grade level were controlled as covariates in the analysis. The significance level was set at $\alpha = 0.05$.

Result

Common method deviation test

The study employed Harman’s single-factor test⁴⁶ to assess common method bias. The results indicated that the characteristic roots of the six factors were all greater than 1, with the first factor accounting for 27.32% of the total variance, which is below the critical threshold of 40%. This suggests that there is no significant common method bias present in the data of this study.

Correlation analysis

The results of Pearson correlation analysis showed that physical-emotional abuse was positively correlated with anxiety and Internet addiction ($r = 0.253$, $r = 0.136$, $p < 0.001$), which verified hypothesis 1. There was a positive correlation between anxiety and Internet addiction ($r = 0.472$, $p < 0.001$), and physical activity was negatively correlated with anxiety ($r = -0.094$, $p < 0.001$). See Table 1 for details.

A mediating model test for anxiety

This study examines the moderating role of physical activity in the relationship between physical-emotional abuse and anxiety, while controlling for gender, grade, and place of residence, Only-child status. The results, as depicted in Fig. 3, are discussed below. The results are shown in Table 2: Physical-emotional abuse had a significant direct predictive effect on Internet addiction ($\beta = 0.271$, $p < 0.001$), but its predictive effect was no longer significant when the mediating variable anxiety was included ($\beta = 0.035$, $p > 0.05$), physical-emotional abuse had a significant predictive effect on anxiety ($\beta = 0.271$, $p < 0.001$), and anxiety was a positive predictor of Internet addiction ($\beta = 0.450$, $p < 0.001$).

The direct effect size of physical-emotional abuse on Internet addiction was 0.035 and the indirect effect size was 0.122, and 95% CI did not include 0, indicating that the indirect effect of anxiety on the relationship between physical-emotional abuse and Internet addiction was significant, and anxiety played a complete mediating role

Variables	1	2	3	4
1. Physical-emotional abuse	1			
2. Anxiety	0.253**	1		
3. Internet addiction	0.136**	0.472**	1	
4. Physical activity	-0.030	-0.094**	-0.064*	1
<i>M</i>	1.080	12.090	19.660	2.590
<i>SD</i>	1.395	4.314	6.674	1.980

Table 1. Results of correlation analysis among variables. * $P < 0.05$, ** $P < 0.001$.

Outcome variables	Predictive variables	R	R ²	F	β	SE	t	Bootstrap 95%CI	
								Lower limit	Upper limit
Anxiety	Physical-emotional abuse	0.275	0.075	24.465	0.271	0.025	10.822***	0.222	0.320
	Gender				0.125	0.051	2.483*	0.026	0.225
	Grade				0.046	0.041	1.107	-0.035	0.128
	Place of residence				0.041	0.051	0.807	-0.059	0.141
	Only-child status				0.062	0.061	1.021	-0.057	0.181
Internet addiction	Physical-emotional abuse	0.247	0.061	19.408	0.157	0.025	6.235***	0.107	0.207
	Gender				0.409	0.051	8.005***	0.308	0.509
	Grade				0.020	0.042	0.473	-0.062	0.102
	Place of residence				0.018	0.051	0.362	-0.082	0.120
	Only-child status				0.049	0.061	0.801	-0.071	0.169
Internet addiction	Physical-emotional abuse	0.498	0.248	82.282	0.035	0.023	1.503	-0.01	0.081
	Anxiety				0.450	19.3	7.803***	0.404	0.496
	Gender				0.352	0.045	7.690***	0.262	0.442
	Grade				-0.001	0.037	-0.023	-0.074	0.073
	Place of residence				0.003	0.046	0.002	-0.091	0.091
	Only-child status				0.021	0.054	0.384	-0.086	0.128

Table 2. Regression analysis of the mediating role of anxiety. * $p < 0.05$, *** $p < 0.001$.

between physical-emotional abuse and Internet addiction, and the mediating model of anxiety was established (See Fig. 2), and H 2 was verified, as shown in Table 3.

Moderated mediating effect

Analyzing the mediating role of physical activity in the relationship between physical-emotional abuse and anxiety, controlling for gender, grade, and place of residence, only-child status. the results, as presented in Table 4, indicate that physical activity significantly and negatively predicts anxiety ($\beta = -0.062$, $p < 0.05$). Additionally, the interaction term between physical-emotional abuse and physical activity also negatively predicts anxiety ($\beta = -0.053$, $p < 0.05$). This suggests that physical activity significantly moderates the first half of the mediation pathway from “physical-emotional abuse to anxiety to internet addiction,” thereby validating H 3.

In order to further explore the moderating effect of physical activity, this study used simple slope plot analysis to calculate the relationship between physical-emotional abuse and university students’ Internet addiction when physical activity was one standard deviation below the mean and 1 standard deviation above the mean. The results showed that there was a significant positive correlation between physical-emotional abuse and Internet addiction in university studentwith low physical activity, and a significant positive relationship between physical-emotional abuse and Internet addiction in university studentwith high physical activity. See Figs. 3 and 4 for details.

Discussion

This study discussed the relationship between physical-emotional abuse and Internet addiction among university students, as well as the mediating role of anxiety and the moderating role of physical activity. Our findings reveal a significant positive association between physical-emotional abuse and internet addiction among university students. Through mediation analysis, it is found that physical-emotional abuse can not only directly affect university students’ Internet addiction, but also affect university students’ Internet addiction by influencing anxiety, and anxiety plays a complete mediating role between physical-emotional abuse and university students’ internet addiction. Through moderation analysis, it was found that physical activity could alleviate the relationship between physical-emotional abuse and anxiety, and then may alleviate the Internet addiction of university students. This study found that there was a significant positive correlation between physical-emotional abuse and university students’ internet addiction when no variables were added, and physical-emotional abuse

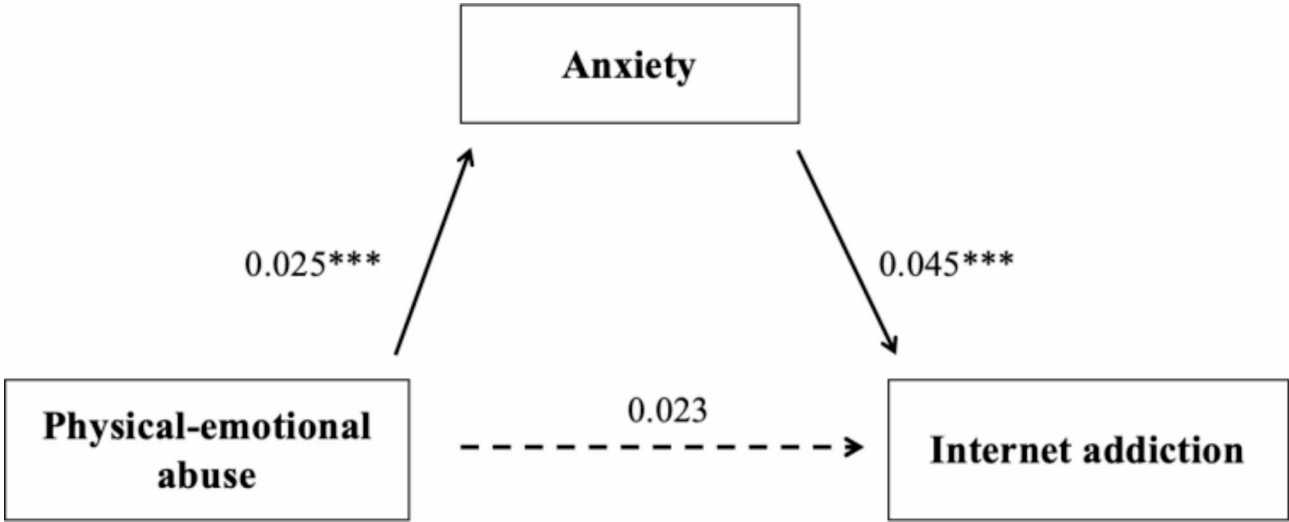


Fig. 2. Mediation model test (***p* < 0.001).

Effect	Effect size	Bootstrap 95%CI	SE	Proportion of mediating effects (%)
Total effect	0.157	0.108,0.207	0.025	
Direct effect	0.035	-0.010,0.081	0.024	22.29
Indirect effect	0.122	0.095, 0.151	0.014	77.71

Table 3. Analysis of the mediating effect of anxiety.

Outcome variables	Predictive variables	R	R ²	F	β	SE	t	Butstrap 95%CI	
								Lower limit	Upper limit
Anxiety	Physical-emotional abuse	0.288	0.082	19.249	0.266***	0.025	10.652	0.217	0.315
	Physical activity				-0.062*	0.025	-2.459	-0.111	-0.013
	Gender				0.119*	0.05	2.246	0.02	0.218
	Grade				0.035	0.041	0.827	-0.047	0.116
	Place of residence				0.054	0.05	0.92	-0.043	0.153
	Only-child status				0.050	0.061	0.826	-0.068	0.169
	Physical-emotional abuse × Physical activity				-0.053*	0.023	-2.200	-0.098	-0.006
Internet addiction	Physical-emotional abuse	0.498	0.248	82.282	0.035	0.023	1.503	-0.011	0.081
	Anxiety				0.450***	0.023	19.300	0.404	0.496
	Gender				0.352***	0.045	7.690	0.262	0.442
	Grade				-0.001	0.038	-0.023	-0.075	0.073
	Place of residence				0.001	0.046	0.002	-0.09	0.09
	Only-child status				0.021	0.054	0.384	-0.086	0.128

Table 4. The relationship between physical-emotional abuse and internet addiction has a moderated mediating effect test. **p* < 0.05, ****p* < 0.001.

could significantly predict university students’ internet addiction. Based on the above findings, this study further explains the mechanism of the internal psychological impact of physical-emotional abuse and university students’ Internet addiction.

In this study, we found that physical-emotional abuse has a significant direct predictive effect on internet addiction among university students, which is consistent with previous research findings¹⁴. According to the person-affect-cognition-execution interaction model, various factors such as personal characteristics, individual emotions and cognition, and executive functions play a crucial role in the formation of internet addiction^{47,48}. Childhood trauma may lead to the development of maladaptive cognitive patterns (e.g., excessive positivity towards the online world and inappropriate expectations) and result in a higher prevalence of negative emotions in real life^{49,50}. Consequently, individuals who have suffered from childhood trauma are more likely to seek

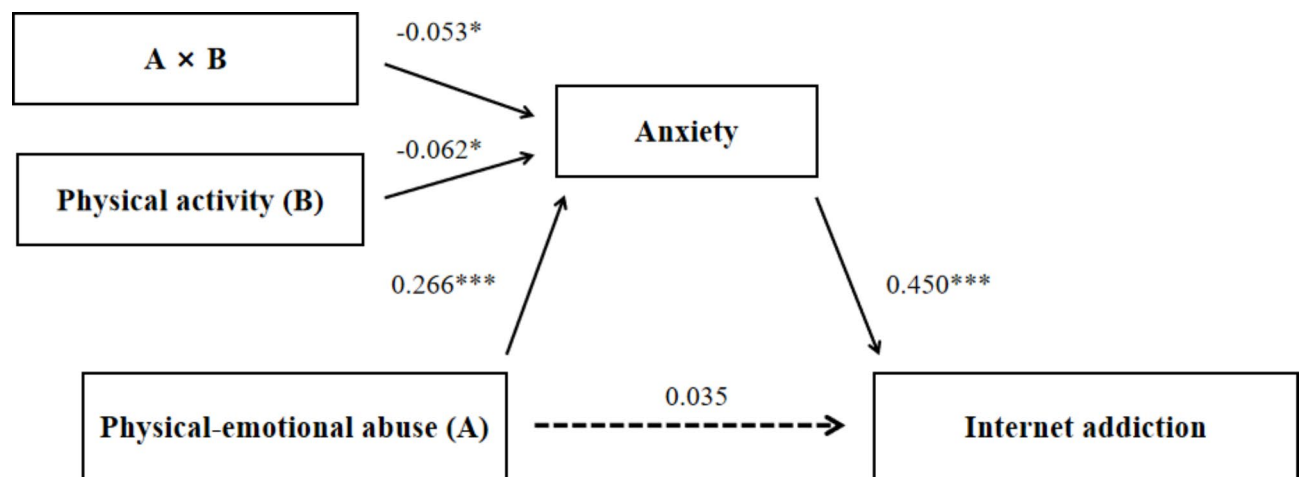


Fig. 3. Moderated mediation model test (* $p < 0.05$, *** $p < 0.001$).

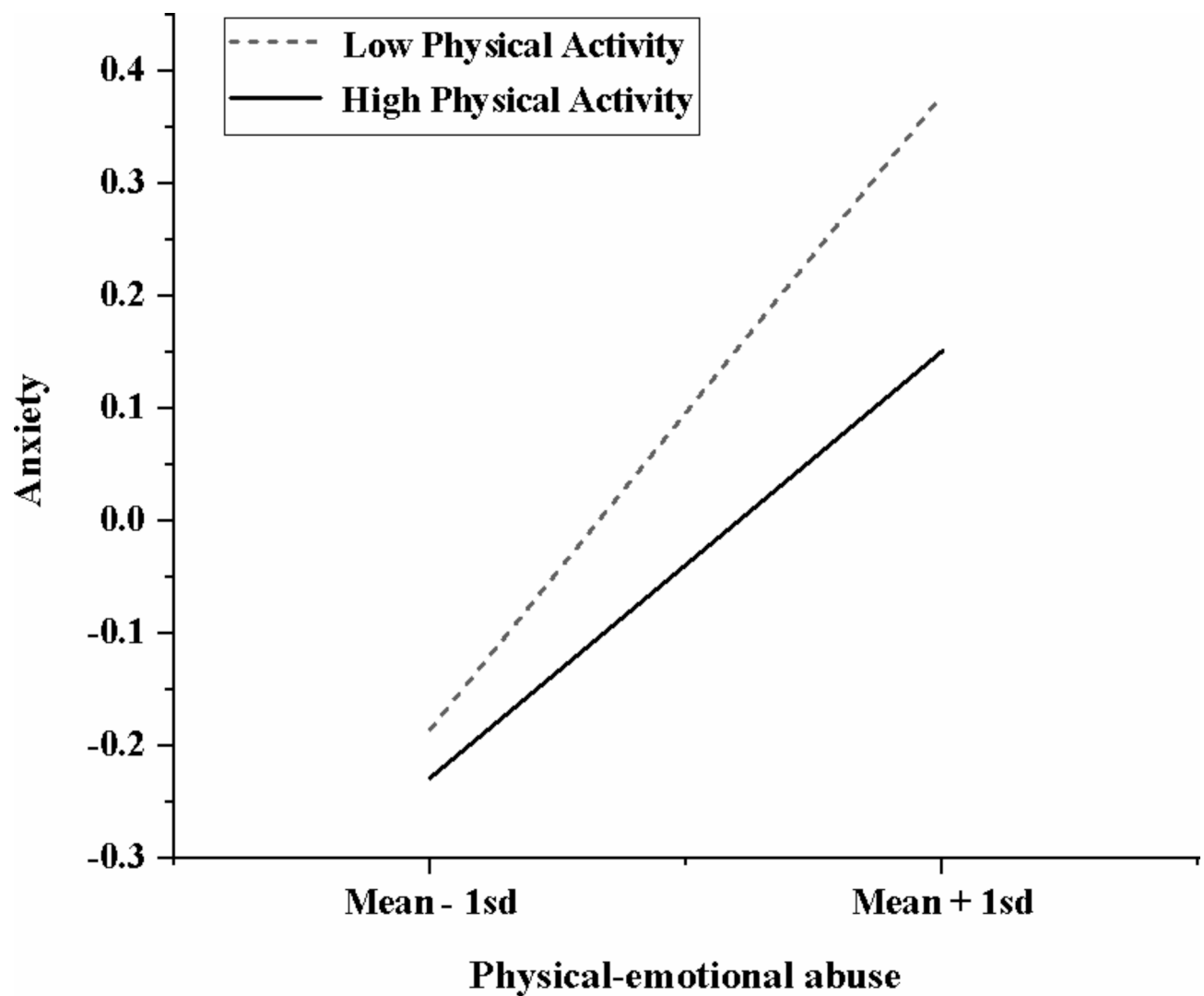


Fig. 4. Simple slope plot.

instant gratification through the internet to mitigate the impact of negative emotions. Previous studies have identified emotional abuse and physical neglect as independent risk factors for internet addiction², and students with childhood trauma are at a higher risk of internet addiction⁵¹. University students with a higher prevalence of internet addiction are more likely to have experienced physical abuse/neglect, emotional abuse, and sexual abuse⁵².

In this study, we observed that the relationship between physical-emotional abuse and internet addiction among university students was no longer significant after introducing anxiety as a mediating variable. This finding suggests that the link between physical-emotional abuse and internet addiction in university students may be influenced by other variables. On one hand, the quality of the living environment provided by parents during childhood has a significant impact on the physical and mental health of adolescents, and those who have suffered physical-emotional abuse tend to have shorter sleep durations, which may further contribute to internet addiction⁵³. On the other hand, psychological factors such as malicious envy may also affect the experience of physical-emotional abuse in adolescents to varying degrees⁵⁴. Furthermore, adolescents with different personality traits exhibit varying levels of anxiety following abuse in childhood. Research indicates that individuals with higher levels of extraversion, openness, agreeableness, and conscientiousness tend to have relatively lower levels of anxiety⁵⁵. These findings underscore the importance of considering individual differences and environmental factors when examining the relationship between physical-emotional abuse and internet addiction.

The Shattered Assumptions Theory posits that individuals experience negative emotions following trauma²⁰, which supports the findings of this study that physical-emotional abuse is a significant predictor of anxiety among university students, and this anxiety has a direct link to internet addiction behavior. Consequently, anxiety is considered a key predictive factor bridging physical-emotional abuse with the propensity for internet addiction among university students. Physical-emotional abuse has been identified as a significant predictor of anxiety in university students^{56,57}, and increased levels of anxiety resulting from abuse experiences can lead to a range of comorbid mental health issues⁵⁸. Abuse significantly predicts anxiety^{23,59}. In summary, the results of this study establish that anxiety mediates the relationship between physical-emotional abuse and internet addiction among university students.

Physical activity, renowned for its salutary effects on both physical-emotional abuse health, has been shown to augment positive emotions and diminish negative ones among individuals³⁵. In accordance with the core principles of the exercise-performance integration model⁶⁰, physical activity is a significant predictor of anxiety levels and has been demonstrated to reduce anxiety³³, depression³⁴, and to enhance well-being among university students³⁵. Moreover, physical activity moderates the relationship between emotional abuse and anxiety⁶¹, with moderate to vigorous exercise intensities exhibiting pronounced effects in mitigating anxiety symptoms⁶². There is a substantial negative correlation between levels of physical activity and anxiety²¹, and physical activity can also ameliorate the negative emotions associated with adverse childhood experiences⁶³, thereby supporting the findings of this study. Furthermore, physical activity has been found to alleviate internet addiction; specifically, university students with internet addiction seldom engage in physical activity and tend to have weaker athletic abilities, often participating in physical activities in a passive and negative manner⁶⁴. Physical activity can reduce internet addiction by regulating both the autonomic and central nervous systems⁶⁵. Numerous randomized controlled trials have targeted internet addiction with physical activity interventions, and the results consistently indicate that such interventions significantly decrease the level of internet dependence among adolescents. These interventions not only promote physical health but also have positive effects on participants' self-esteem, willpower, and resistance to internet temptations^{60–62,64–66}. While both the internet and physical activities can provide social interaction and entertainment, they are fundamentally different: internet use tends to immerse users in a virtual environment, whereas physical activity allows participants to experience the real world more deeply through the promotion of mental and physical health. The theoretical basis for physical activity interventions lies in their dual role of reducing internet usage time and unconsciously bringing about positive physiological and psychological effects for participants. Consequently, adolescents who regularly engage in physical activities often exhibit superior mental and physical health and more rational internet usage habits^{67,68}. On the other hand, internet addiction can lead to an increase in negative emotions such as anxiety in adolescents²⁸, but physical activity can moderate this relationship and reduce the incidence of mental health problems in adolescents⁶⁹. It is evident that the regulation of mental health by physical activity is multifaceted. In conclusion, physical activity significantly moderates the predictive relationship between physical-emotional abuse and anxiety in university students.

Limitations

This study investigates the relationships between various behaviors and psychological factors, such as anxiety, and elucidates the intrinsic links between physical-emotional abuse and internet addiction among university students. Additionally, the study examines the moderating effects of external factors. Furthermore, the research employs path analysis, a novel method for assessing the potential role of anxiety in the relationship between physical-emotional abuse and internet addiction among university students. However, the study has several limitations that warrant acknowledgment. Firstly, the study is based on cross-sectional data, which may limit the ability to infer causal relationships between physical-emotional abuse and Internet addiction among university students. Future longitudinal cohort studies are needed to further substantiate these relationships. The potential influencing factors of various variables are numerous, including parent-child relationships and school environments. Physical-emotional abuse, internet addiction, and anxiety are significantly influenced by personality disorders, gender, sleep, and dietary behaviors, as well as regional, familial economic conditions, gender, and cultural differences. This study only explores a subset of these factors, particularly neglecting the role of economic conditions, which may impact the relationship between physical-emotional abuse and internet addiction. The absence of this demographic characteristic in our study limits the comprehensiveness and depth

of our control variables. Future research will delve into these factors from multiple perspectives. Secondly, due to the limitations of our sampling method, the generalizability of our findings to the entire population of Chinese university students may be limited. Our sample is confined to university students from four provinces in China. Future studies should aim to include a more diverse international student population. Thirdly, the reliance on self-reported data collection methods may introduce recall bias, posing certain limitations to the objectivity of our data. Future studies will adopt more effective methods, such as interviews, third-party assessments, or internet usage data. Lastly, the categorization of the severity and frequency of physical-emotional abuse into binary categories (“yes” or “no”) may have an impact on our study. Future research should employ more nuanced measurement standards, such as Likert scales. Due to the original survey design, our study only controlled for the respondents’ grade, gender, place of residence, and only-child status, which may limit the comprehensiveness of our findings. Future studies will aim to conduct a more holistic discussion of the research. In conclusion, while this study provides valuable insights into the relationship between physical-emotional abuse and internet addiction among university students, it is imperative to address these limitations in future research to enhance the understanding of these complex dynamics.

Conclusion

This study further revealed the relationship between physical-emotional abuse and university students’ Internet addiction, and considered the mediating role of anxiety between the two, as well as the moderating role of physical activity in the relationship between physical-emotional abuse and university students’ Internet addiction. The study found that anxiety played a complete mediating role between physical-emotional abuse and university students’ Internet addiction, and physical activity alleviated the relationship between physical-emotional abuse and university students’ anxiety. This research will provide new perspectives and strategies for the public health field to address physical-emotional abuse and internet addiction among university students. It is also critical that future studies validate these findings on a multi-domain, large-sample basis.

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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Author contributions

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Declarations

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). Prior to the commencement of the investigation, all subjects voluntarily participated with informed consent and signed a written informed consent form.

Competing interests

The authors declare no competing interests.

Additional information

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