

**ORIGINAL ARTICLE**



# **The Relationship between Family Cohesion and Adolescent Internet Addiction: The Chain Mediation Effects of Physical Activity and Prosocial Behavior**

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## **Abstract**

This study explores the chain mediation effects of physical activity and prosocial behavior on the relationship between family intimacy and adolescent Internet addiction, providing insights for targeted interventions. A cross-sectional survey of 690 middle school students in Shandong Province, China, was conducted using validated scales: the Adolescent Physical Activity Questionnaire (APAQ), Internet Addiction Diagnostic Scale for Students (IADDS), Family Cohesion and Adaptability Scale (FACESII-CV), and Prosocial Tendencies Measure (PTM). Structural equation modeling (SEM) and the Bootstrap method were employed to test the chain mediation model. Results showed a significant negative association between family intimacy and Internet addiction ( $\beta = -0.18$ ,  $p < 0.001$ ), with indirect effects through physical activity and prosocial behavior accounting for 56.3% of the total effect. Physical activity mediated 19.9% (-0.082), prosocial behavior mediated 29.1% (-0.120), and the chain mediation pathway mediated 7.3% (-0.029) of the total effect. These findings highlight the interactive role of physical activity and prosocial behavior in mitigating Internet addiction. The study underscores how family intimacy indirectly reduces adolescent Internet addiction by promoting healthy behaviors and social interaction, aligning with ripple effect and psychological need compensation theories. This provides a theoretical foundation for multi-dimensional intervention strategies. Future research should adopt longitudinal and cross-cultural approaches to validate these findings.

**Key words:** Internet Addiction; Family Cohesion; Physical Activity Prosocial Behavior; Chained Mediation Model

## **Introduction**

The internet has become a pivotal tool in modern society, offering significant advantages while presenting notable challenges. Its use, particularly among adolescents and young adults, has grown exponentially. By 2024, the global internet user population reached 5.44 billion, accounting for approximately two-thirds of the world's total population. Asia remains the leading region for online activity, with China maintaining its position as the largest market in terms of internet users (usage & worldwide, 2024). However, excessive and uncontrolled internet use has given rise to internet addiction (IA), a condition characterized by compulsive engagement with online activities that results in significant distress

and functional impairment (Pan, Chiu, & Lin, 2020). Internet addiction, although not recognized by the WHO or the APA, is a serious and problematic pathology (Lozano-Blasco, Robres, & Sánchez, 2022). IA is associated with a wide range of online behaviors, including gaming, social networking, gambling, online shopping, virtual sex, and information overload (Peris, de la Barrera, Schoeps, & Montoya-Castilla, 2020). It is recognized as a psychological and behavioral disorder caused by the repetitive and excessive use of the internet (Fumero, Marrero, Voltes, & Peñate, 2018). In 2018, the World Health Organization (WHO) formally classified internet gaming disorder as an addictive behavior in its

11th revision of the International Classification of Diseases (ICD-11), further underscoring its association with internet addiction.(WHO, 2020). Consequently, adolescent internet addiction has emerged as a pressing area of research, drawing increasing global attention.

Adolescents represent a substantial proportion of the global online population due to the physical and psychological changes characteristic of this developmental stage(Ryding & Kaye, 2018).As of 2023, internet usage is significantly higher among individuals aged 15 to 24 compared to older generations across all regions(usage & worldwide, 2024). For most young media users, digital engagement is well-integrated into their otherwise rich and diverse lives. However, research highlights the extent of their engagement with media, with one study finding that adolescents spend more time using media than they do sleeping or attending school(Rideout, 2015). Despite the majority managing a healthy balance, a significant subset experiences what has been termed "internet addiction"(Young, 2017) A meta-analysis spanning 31 nations across seven world regions estimated that approximately 6% of adolescents worldwide suffer from internet addiction (Chia et al., 2020). In rural Thailand, 5.4% of secondary school students were found to meet the cutoff criteria for internet addiction (IA)(Taechoyotin et al., 2020). Similarly, in Taiwan, 3.1% of adolescents reached the threshold for IA(Chiu, Pan, & Lin, 2018).In urban China, a study involving 2,666 middle school students reported an IA prevalence of 13.0%(Yang et al., 2020)In contrast, rural South Korea exhibited a significantly higher prevalence of 21.6% among 1,168 adolescents aged 13 to 18(J. Y. Lee et al., 2018).Adolescents have increasingly been identified as a high-risk group for internet addiction(Liu et al., 2023; Sciacca, Dinaro, & Hichy, 2020)This condition has become a significant barrier to the physical and mental health development of adolescents, posing challenges to their overall well-being.

### **Family Cohesion and Adolescent Internet Addiction**

The family serves as an individual's primary sociocultural environment, significantly influencing its members' health(Park et al., 2018).Family functioning has been shown to play a critical role in shaping members' mental health

and health-related behaviors(Cheng et al., 2017).Among the various dimensions of family functioning, cohesion is particularly important. Family cohesion is defined as the emotional bond that connects family members(Olson, Waldvogel, & Schlieff, 2019). The family ecosystem theory emphasizes that the family serves as one of the most critical microsystems influencing children's behavior. Family cohesion, a key indicator of the family's emotional climate, has been shown to significantly reduce adolescent problem behaviors, particularly addictive behaviors (Milburn et al., 2019). Studies have demonstrated that adolescents with low family cohesion are more likely to seek alternative emotional satisfaction through the Internet(Jiang, Huang, & Tao, 2018). This relationship between family cohesion and adolescents' mental health and behavioral problems is particularly prominent in China(Shek, Leung, Li, & Dou, 2023).

### **The Mediating Effect of Physical Activity**

The social-ecological model posits that health behaviors are shaped by influences across five interconnected levels: intrapersonal, interpersonal, institutional, community, and public policy (Fu, Grimm, Berkel, & Smith, 2020).Socioecological models position individuals within the family unit, recognizing family settings as the most intimate context influencing health behaviors(Hayden, 2022; Newman, Tumin, Andridge, & Anderson, 2015).Family support for exercise, involvement in activities, and intimacy are significant predictors of physical activity among adolescents(Shennar-Golan & Walter, 2018).Participation in physical activity is inherently a healthy behavior(Rhodes, McEwan, & Rebar, 2019).Psychological research indicates that physical activity plays a crucial role in promoting fitness and enhancing mental health among children and adolescents(Opstoel et al., 2020).Physical exercise alleviates stress and negative emotions, thereby reducing the likelihood of cyber-aggressive behaviors. It regulates hormones related to emotions, such as endorphins, increasing feelings of pleasure and enhancing emotional stability(Mikkelsen, Stojanovska, Polenakovic, Bosevski, & Apostolopoulos, 2017) According to self-determination theory, physical activity meets basic psychological needs such as autonomy, competence, and relatedness, thus significantly improving mental health (Ryan, Deci,

Vansteenkiste, & Soenens, 2021). Interventions involving physical activity have been shown to effectively reduce adolescent internet addiction by improving social interaction and emotional regulation (J. Lee & Kim, 2024). Additionally, studies have found that individuals who develop regular exercise habits exhibit lower dependence on the internet, and physical activity levels can significantly predict adolescents' risk of internet addiction (Ryan et al., 2021). Moreover, physical activity can significantly alleviate symptoms of internet addiction and reduce associated risks (S. Li, Wu, Tang, Chen, & Liu, 2020; Throuvala, Griffiths, Rennoldson, & Kuss, 2019). Therefore, physical activity may serve as a mediator in the relationship between family cohesion and internet addiction.

### **The Mediating Effect of Prosocial Behavior**

Prosocial behavior refers to voluntary actions that align with societal expectations and benefit others without offering obvious advantages to the actor. It encompasses a range of positive social behaviors (Crone & Achterberg, 2022). Prosocial behavior is influenced by both internal and external factors. Internal factors include biological influences, individual cognition, self-concept, and personality, while external factors involve family, societal, and school environments (Laguna, Mazur, Kędra, & Ostrowski, 2020). The family, as a key agent of individual socialization, significantly influences family members' prosocial behavior and reduces negative emotions, thereby decreasing addictive behaviors (Yavuz, Dys, & Malti, 2022). Prosocial behavior, as a critical manifestation of socialization, is closely associated with adolescents' mental health and problem behaviors. Caprara found that prosocial behavior enhances social interaction and psychological adaptability, providing positive support for adolescents' academic achievement and mental health. Moreover, prosocial behavior not only reflects the family environment and school education but also serves as an essential protective factor against problem behaviors (Jadoon et al., 2022; Spinrad, Eisenberg, & Morris, 2022). Additionally, studies have shown that the absence of prosocial behavior may lead individuals to seek "pathological compensation" through virtual networks, thereby increasing the risk of internet addiction (Sheng & Yang, 2023; Wu, Meng, & Wu, 2011). Therefore, prosocial

behavior may serve as a mediator in the relationship between family cohesion and internet addiction.

### **The Multiple Mediating Role of Physical Activity and Prosocial Behavior**

Physical activity improves psychological aspects of mental health and facilitates the active social integration of children and adolescents (Laguna et al., 2020). Rodríguez found that physical activity reduces aggressive behavior in adolescents, promoting increased cooperation and sharing tendencies (J. Li & Shao, 2022). Supporting this, Lee found that physical activity enhances individuals' social skills and problem-solving abilities (Durhan, 2021). (Moeijes, Van Busschbach, Lockhart, Bosscher, & Twisk, 2019) demonstrated that adolescents who actively participate in physical exercise exhibit higher levels of prosocial behavior and lower levels of aggressive behavior. Individuals with a high tendency for prosocial behavior are more likely to establish positive social relationships and inhibit maladaptive behaviors, including addictive behaviors (Lens & Vansteenkiste, 2020). Therefore, physical activity and prosocial behavior may serve as multiple mediators in the relationship between family cohesion and internet addiction.

This study adopts a chained mediation model to investigate the complex interplay between family environment and adolescent behavioral development (Krauss, Orth, & Robins, 2020). Family cohesion, as a key variable, influences adolescents' emotional support and sense of social connectedness, which can trigger behavioral and psychological responses affecting internet addiction. This model explores how family cohesion, physical activity, and prosocial behavior collectively impact adolescent internet addiction, grounded in the premise that family functioning indirectly shapes such behaviors through psychological and behavioral pathways (Linyuan, Mengxi, Yumeng, Nan, & Beilei, 2022). By illuminating these interactions, the study provides a foundation for interventions targeting addictive behaviors (H. Qi, Kang, & Bi, 2022).

Although prior research has explored the family environment's role in internet addiction, limited studies address the specific effects of family intimacy on adolescents' internet addiction,

particularly the mediating roles of physical activity and prosocial behavior (Fu et al., 2020). his study bridges this gap by examining how family intimacy reduces adolescents' internet addiction through a positive psychology framework. It also investigates the mediating effects of physical activity and prosocial behavior, aiming to offer actionable recommendations for enhancing mental health and promoting behavioral improvements.

## Methods

### Participants

The primary indicator of this study is the prevalence of internet addiction among middle school students. According to previous research, the prevalence rate of internet addiction among Chinese middle school students ranges from 6.92% to 10.78% (Z. Zhang & Sun, 2018). For this study, the prevalence rate (P) was assumed to be 8%, with a margin of error ( $\delta$ ) of 0.04 and a significance level ( $\alpha$ ) of 0.05 for a two-tailed test, corresponding to a critical value of 1.96.

Substituting into the formula 
$$N = \frac{Z^2 \times (1-P)}{E^2}$$
, the required sample size was calculated as approximately 177 participants. Considering a 10% invalid response rate, a total of 197 participants were needed. Ultimately, after excluding 76 questionnaires, 690 valid responses were included in the analysis. This study employed a simple random cluster sampling method. Between December 2023 and April 2024, students aged 11–14 years from multiple cities in Shandong Province, including Jinan, Weifang, and Linyi, were randomly selected as participants. Data were collected using the online platform. Invalid questionnaires were excluded based on the following criteria: (1) answers displayed a repetitive pattern, (2) 10 or more questions were left unanswered, or (3) more than half of the items were answered identically. After excluding invalid responses, a total of 690 valid questionnaires were retained for analysis. The sample included 334 males (48.4%) and 356 females (51.6%). By grade, there were 119 sixth-grade students (17.2%), 283 seventh-grade students (41.1%), 91 eighth-grade students (13.2%), and 197 ninth-grade students (28.5%). Additionally, 526 participants (76.2%) were day students, while 164 (23.8%) were boarding students; 279 (40.5%) were only children, while 411 (59.5%) had

siblings. Before data collection, the purpose and content of the study were explained in written form, along with assurances of confidentiality. Questionnaires were distributed after obtaining informed consent from both participants and their guardians. This study was approved by the Ethics Committee of the Sports Social Science Research Institute, XXX (SD2024019) and complied with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

## Measure

### Adolescent Physical Activity Questionnaire (APAQ)

The Chinese version of the Adolescent Physical Activity Questionnaire was used to assess the overall physical activity levels of adolescents during the past week (X. Li, Wang, & Li, 2015), including moderate to vigorous physical activities. The questionnaire comprises nine items and uses a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Higher scores reflect greater levels of physical activity. The scale has demonstrated good reliability and validity among student populations (Xie, Ge, & Li, 2023). In this study, the Cronbach's  $\alpha$  coefficient of the scale was 0.825, indicating strong internal consistency.

### Internet Addiction Disorder Diagnostic Scale (IADDS)

The Adolescent Internet Addiction Scale, developed by (Zan, Liu, & Liu, 2008), was used in this study. The scale comprises 13 items and adopts a binary scoring system (yes/no). A total score greater than 5 suggests a potential issue with internet addiction. The scale demonstrates favorable psychometric properties among middle school students (Kuang & Cao, 2011). In this study, the Cronbach's  $\alpha$  coefficient of the scale was 0.811, indicating good internal consistency.

### Chinese version of the Family Adaptability and Cohesion Scale (FACESII-CV)

The Chinese version of the Family Adaptability and Cohesion Evaluation Scale (FACES), translated by Fei Lipeng et al. based on Professor Olson's original scale (M.R. Phillips 1991), was used to assess family cohesion and adaptability. The scale consists of 30 items, using a five-point Likert scale ranging from "never" to "always." In this study, the Cronbach's  $\alpha$  coefficient of the



scale was 0.923, indicating excellent reliability. The scale has been widely applied across various patient populations with different diseases, consistently demonstrating good psychometric properties. Previous studies reported internal consistency  $\alpha$  coefficients ranging from 0.68 to 0.93(Phillips, West, SHEN, & ZHENG, 1998).

### Prosocial Tendencies Measure for Adolescent (PTM)

The Adolescent Prosocial Behavior Tendency Scale, revised by Kou Yu(Kou, Hong, & Tan, 2007),was used to assess prosocial behavior tendencies among middle school students. The scale consists of 26 items and uses a five-point Likert scale ranging from "completely disagree" to "completely agree." Higher scores reflect a stronger tendency for prosocial behavior. The scale demonstrates good reliability and validity among adolescent populations(Z. QI, QI, HAN, HAN, & HAN, 2024). In this study, the Cronbach's  $\alpha$  coefficient for the scale was 0.974, indicating excellent internal consistency.

### Statistical Methods

Data analysis was performed using SPSS 26.0 software. Measurement data were normally distributed and described as mean $\pm$ standard deviation. Harman's single-factor test was first used to examine common method bias. Pearson correlation analysis was conducted, controlling for gender, grade, only-child status, internet use history, internet usage duration, and academic performance, to describe the relationships among variables. Independent sample t-tests and one-way ANOVA were used to examine differences in scale scores across groups with different demographic characteristics. Multiple linear regression analysis was conducted to explore the influence of each scale score on internet addiction scores. Mediation effect models were tested using

IBM SPSS Amos 27 Graphics. Finally, the bias-corrected percentile bootstrap method was used to verify the theoretical model, examining the reciprocal effects of family cohesion and prosocial behavior, as well as the mediating role of physical activity in mitigating internet addiction.

### Results

#### Common Method Bias

This study employed a cross-sectional self-reported questionnaire to collect data, and the potential issue of common method bias was addressed using Harman's single-factor test (Sahoo, 2019; A. Zhang, Xu, Zhang, Chen, & Xiong, 2024).The results revealed eight factors with eigenvalues greater than 1, with the first factor accounting for 27.61% of the variance, which is below the critical threshold of 40%. These findings indicate that there is no significant common method bias in the data.

#### Descriptive Statistics and Correlation Analysis

Descriptive statistics and correlation analyses were conducted for the mean, standard deviation, and relationships among the variables of physical activity, family cohesion, prosocial behavior, and internet addiction (Table 1). Family cohesion (FACESII-CV) was positively correlated with physical activity (APAQ) ( $r = 0.36, p < 0.001$ ) and prosocial behavior (PTM) ( $r = 0.37, p < 0.001$ ), and negatively correlated with internet addiction (IADDS) ( $r = -0.38, p < 0.001$ ). Physical activity was positively correlated with prosocial behavior ( $r = 0.31, p < 0.001$ ) and negatively correlated with internet addiction ( $r = -0.39, p < 0.001$ ), reflecting the multifaceted positive effects of physical activity. The strongest negative correlation was observed between prosocial behavior and internet addiction ( $r = -0.49, p < 0.001$ ), suggesting that prosocial behavior may be a key factor in mitigating internet addiction.

**Table1.The means, standard deviations, and correlation coefficients among the variables (n=690)**

| Variables                 | M    | SD   | 1      | 2       | 3     | 4 | 5 | 6 | 7 |
|---------------------------|------|------|--------|---------|-------|---|---|---|---|
| 1 Sex                     | 1.52 | 0.50 | —      |         |       |   |   |   |   |
| 2 Boarding status         | 1.76 | 0.43 | 0.04   | —       |       |   |   |   |   |
| 3 Only-child status       | 1.60 | 0.49 | 0.13** | -0.58   | —     |   |   |   |   |
| 4 Internet usage duration | 1.28 | 0.45 | -0.03  | -0.38** | -0.01 | — |   |   |   |

|              |        |       |         |        |       |         |         |        |         |
|--------------|--------|-------|---------|--------|-------|---------|---------|--------|---------|
| 5 APAQ       | 3.01   | 0.78  | -0.16** | 0.07*  | 0.05  | -0.09*  | —       |        |         |
| 6 FACESII-CV | 56.62  | 10.50 | -0.11** | -0.08* | 0.03  | -0.03   | 0.36**  | —      |         |
| 7 PTM        | 100.03 | 21.98 | -0.10** | 0.07   | 0.01  | -0.12** | 0.31    | 0.37** | —       |
| 8 IADDS      | 1.71   | 2.72  | 0.12**  | -0.05  | -0.02 | -0.17** | -0.38** | -0.38  | -0.49** |

Note: \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$  ; SD= standard deviation ; APAQ (Adolescent physical activity questionnaire) ; IADDS (Internet Addiction Disorder Diagnostic Scale) ; FACESII-CV (Chinese version of the Family Adaptability and Cohesion Scale) ; PTM (Prosocial Tendencies Measure for Adolescent)

### Differences in Research Variables by Demographic Characteristics

An analysis of physical activity, family cohesion, prosocial behavior, and internet addiction scores based on demographic variables was conducted (Table 2). Significant associations were found between gender and physical activity, family cohesion, and internet addiction, particularly between physical activity and gender. Academic performance was significantly associated with physical activity, internet addiction, and prosocial behavior. Additionally, internet use duration was significantly associated with internet addiction, as

well as with physical activity and prosocial behavior. The length of internet use history was also significantly associated with these variables.

Male students reported higher family cohesion scores than females ( $t = 2.97$ ,  $p < 0.05$ ), and their physical activity levels were significantly higher than those of females ( $t = 4.35$ ,  $p < 0.001$ ). However, the effect size of gender on family functioning was minimal (Su, Han, Yu, Wu, & Potenza, 2020), indicating that the effect of gender on these variables is negligible. Therefore, gender was not included as a control variable in subsequent analyses.

**Table 2** The influence of general characteristics of the participants on FACESII-CV, APAQ, PTM, IADDS and the results of univariate analysis.

| Variables               | n   | APAQ      |        | FACESII-CV    |       | PTM          |        | IADDS       |          |
|-------------------------|-----|-----------|--------|---------------|-------|--------------|--------|-------------|----------|
|                         |     | M ± SD    | t      | M ± SD        | t     | M ± SD       | t      | M ± SD      | t        |
| Sex                     |     |           |        |               |       |              |        |             |          |
| Male                    | 334 | 3.15±0.82 | 4.35** | 57.84 ± 10.76 | 2.97* | 102.31±21.51 | 2.73   | 1.38 ± 2.47 | -3.15*   |
| Female                  | 356 | 2.89±0.72 |        | 55.47±10.13   |       | 97.88±22.23  |        | 2.03 ± 2.91 |          |
| Boarding status         |     |           |        |               |       |              |        |             |          |
| Non-boarding            | 526 | 3.05±0.74 | -2.01  | 56.13±10.44   | 2.19* | 100.92±21.81 | -1.85* | 1.64±2.59   | 1.01     |
| Boarding at school      | 164 | 2.91±0.89 |        | 58.18±10.55   |       | 97.15±22.37  |        | 1.93±3.08   |          |
| Only-child status       |     |           |        |               |       |              |        |             |          |
| only child              | 279 | 2.97±0.76 | -1.3   | 56.27±11      | -0.71 | 100.07±21.83 | -0.045 | 1.76±2.8    | 0.42     |
| Not an only child       | 411 | 3.05±0.79 |        | 56.85±101.5   |       | 99.98±22.11  |        | 1.68±2.67   |          |
| Internet usage duration |     |           |        |               |       |              |        |             |          |
| 0–2 hours/day           | 497 | 3.06±0.74 | 2.18*  | 56.79±10.27   | 0.69  | 101.65±21.13 | 3.13** | 1.43±2.42   | -3.85*** |
| over 2 hours/day        | 193 | 2.91±0.88 |        | 56.17±11.1    |       | 95.84±23.58  |        | 2.43±3.27   |          |

Note:\*\*\*P < 0.001 ; \*\* P < 0.01 ; \* P < 0.05 ; APAQ (Adolescent physical activity questionnaire) ; IADDS (Internet Addiction Disorder Diagnostic Scale) ; FACESII-CV (Chinese version of the Family Adaptability and Cohesion Scale) ; PTM (Prosocial Tendencies Measure for Adolescent)

### Correlation Analysis of Physical Activity, Family Cohesion, Prosocial Behavior, and Internet Addiction

Collinearity diagnostics were conducted on the scores of physical activity, internet addiction, family cohesion, and prosocial behavior. The results revealed that the eigenvalues of multiple dimensions were not close to zero, and the tolerance values for each variable (0.797, 0.835, and 0.825) were greater than 0.1. Additionally, the variance inflation factor (VIF) values (1.255, 1.198, and 1.212) were all below 5, and the correlation coefficient matrix did not approach 1. These findings indicate that there were no severe

multicollinearity issues, confirming that the data were suitable for further mediation effect analysis.

Further investigation was conducted into the chained mediation role of physical activity and prosocial behavior in the relationship between family cohesion and internet addiction. Family cohesion was used as the predictor variable, internet addiction as the outcome variable, and physical activity and prosocial behavior as the mediating variables. Gender, boarding status, only-child status, and internet use duration per session were included as control variables. Regression analysis was performed, and the results are presented in Table 3.

**Table3 Regression analysis of Family Cohesion, physical activity, internet addiction, and prosocial behavior**

| Dependent Variable | Predictor Variable      | R Value | R <sup>2</sup> Value | F Value  | Beta Coefficient | t Value   |
|--------------------|-------------------------|---------|----------------------|----------|------------------|-----------|
| internet addiction | Sex                     | 0.42    | 0.18                 | 28.84*** | -0.46            | -2.39*    |
|                    | Boarding status         |         |                      |          | 0.13             | 0.53      |
|                    | Only-child status       |         |                      |          | 0.09             | 0.46      |
|                    | Internet usage duration |         |                      |          | -0.91            | -3.97***  |
| physical activity  | Family Cohesion         |         |                      |          | -0.09            | -10.39*** |
|                    | Sex                     | 0.41    | 0.16                 | 26.29*** | 0.21             | 3.80***   |
|                    | Boarding status         |         |                      |          | -0.17            | -2.37*    |
|                    | Only-child status       |         |                      |          | -0.10            | -1.76     |
|                    | Internet usage duration |         |                      |          | 0.09             | 1.29      |
|                    | Family Cohesion         |         |                      |          | 0.03             | 9.81***   |
|                    | Sex                     | 0.39    | 0.16                 | 25.74*** | 2.73             | 1.74      |
|                    | Boarding status         |         |                      |          | -3.73            | -1.89     |
| prosocial behavior | Only-child status       |         |                      |          | 0.03             | 0.02      |
|                    | Internet usage duration |         |                      |          | 4.07             | 2.19*     |
|                    | Family Cohesion         |         |                      |          | 0.77             | 10.37***  |
|                    | Sex                     | 0.58    | 0.33                 | 48.77*** | -0.19            | -1.09     |
|                    | Boarding status         |         |                      |          | -0.15            | -0.69     |
|                    | Only-child status       |         |                      |          | 0.02             | 0.11      |

|                    |                         |  |  |  |       |           |
|--------------------|-------------------------|--|--|--|-------|-----------|
|                    | Internet usage duration |  |  |  | -0.67 | -3.25***  |
| internet addiction | Family Cohesion         |  |  |  | -0.04 | -4.69***  |
|                    | physical activity       |  |  |  | -0.72 | -5.95***  |
|                    | prosocial behavior      |  |  |  | -0.04 | -10.00*** |

Note: \*\*\* $P < 0.001$  ; \*\*  $P < 0.01$  ; \*  $P < 0.05$

### Model and Mediation Effect Testing

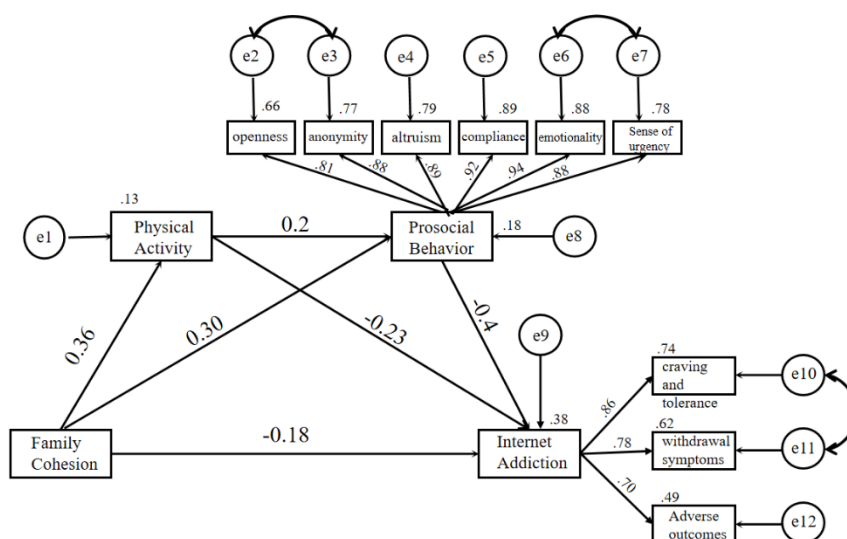
Amos 27.0 was used to construct a structural equation model (SEM) and test theoretical hypotheses. The maximum likelihood estimation method was applied within the covariance structure model. Family cohesion scores were set

as the independent variable, physical activity and prosocial behavior scores as mediating variables, and internet addiction scores as the dependent variable to construct the model. The resulting structural equation model, as illustrated in Figure 1, represents a saturated model.

**Table 4 Fitness indexes of the model**

According to Table 4, all the model's fit indices fall within an acceptable range (Sahoo, 2019).

|              | CMIN/DF      | GFI        | CFI        | TLI        | NFI        | RMSEA       |
|--------------|--------------|------------|------------|------------|------------|-------------|
| Standard     | $\leq 5$     | $\geq 0.8$ | $\geq 0.9$ | $\geq 0.9$ | $\geq 0.9$ | $\leq 0.05$ |
| Actual value | 3.546        | 0.94       | 0.97       | 0.959      | 0.964      | 0.045       |
| Decision     | Good fitting |            |            |            |            |             |



**Figure1. A multiple mediation model of the association between family cohesion and internet addiction, exploring the mediating roles of physical activity and prosocial behavior.**

To clearly demonstrate the relationships among variables, bootstrap analysis was employed to test the mediating effects while controlling for gender, boarding status, only-child status, and internet use duration per session. The number of bootstrap resampling iterations was set to 5000. Table 5 presents the specific path coefficients for physical activity's effects on internet addiction.

Family cohesion was negatively associated with internet addiction ( $\beta = -0.18$ ,  $p < 0.001$ ), consistent with previous research findings,

indicating its direct inhibitory effect on internet addiction.

Family cohesion was positively associated with physical activity ( $\beta = 0.36$ ,  $p < 0.001$ ), while physical activity was negatively associated with internet addiction ( $\beta = -0.23$ ,  $p < 0.001$ ).

Family cohesion was positively associated with prosocial behavior ( $\beta = 0.3$ ,  $p < 0.001$ ), and prosocial behavior was negatively associated with internet addiction ( $\beta = -0.4$ ,  $p < 0.001$ ).



Family cohesion also indirectly inhibited internet addiction through the reciprocal promoting effects of physical activity and prosocial behavior ( $\beta = 0.038$ ,  $p < 0.001$ ). In the pathway "Family Cohesion  $\rightarrow$  Physical Activity  $\rightarrow$  Internet Addiction", family cohesion had an indirect effect value of -0.082, accounting for 19.9% of the total effect. In the pathway "Family Cohesion  $\rightarrow$

Prosocial Behavior  $\rightarrow$  Internet Addiction", the indirect effect value was -0.12, accounting for 29.1% of the total effect. Additionally, in the chained mediation pathway "Family Cohesion  $\rightarrow$  Physical Activity  $\rightarrow$  Prosocial Behavior  $\rightarrow$  Internet Addiction", the effect value was -0.029, accounting for 7.3% of the total effect (Wen & Ye, 2014).

**Table 5 : Mediating Effect Analysis of the Chain Mediating Model**

| Items                  | Effect size | The Proportion of Effect Size% | Boot SE | Bootstrap95%CI |        |
|------------------------|-------------|--------------------------------|---------|----------------|--------|
|                        |             |                                |         | Lower          | Upper  |
| direct effect          | -0.18       | 43.7%                          | 0.043   | -0.264         | -0.099 |
| Indirect effect 1      | -0.082      | 19.9%                          | 0.18    | -0.122         | -0.051 |
| Indirect effect 2      | -0.120      | 29.1%                          | 0.22    | -0.166         | -0.079 |
| Indirect effect 3      | -0.029      | 7.3%                           | 0.008   | -0.048         | -0.017 |
| Total indirect effects | -0.231      | 56.3%                          | -       | -              | -      |
| total effect           | -0.411      | 100%                           | 0.035   | -0.478         | -0.343 |

Note: Indirect effect 1: Family Cohesion- physical activity- internet addiction; Indirect effect 2: Family Cohesion- prosocial behavior- internet addiction; Indirect effect 3: Family Cohesion- physical activity- prosocial behavior- internet addiction

## Discussion

This study aimed to explore the chained mediation effects of physical activity and prosocial behavior in the relationship between family cohesion and adolescent internet addiction, providing theoretical support and empirical evidence for understanding this complex mechanism. The findings demonstrated that family cohesion not only directly reduces the tendency for internet addiction but also exerts significant inhibitory effects through the indirect pathways of physical activity and prosocial behavior. Among the total effect (-0.411), the direct effect accounted for 43.7%, while the indirect effect contributed 56.3%, highlighting the critical role of family cohesion in interventions targeting internet addiction.

### The Relationship between Family Cohesion and Adolescent Internet Addiction

The direct effect value of family cohesion on internet addiction was -0.18, while the indirect effect was -0.231. This suggests that while the direct impact of family cohesion on internet addiction is significant, its primary influence operates through indirect effects mediated by other variables. These findings align with the

cumulative ecological risk theory, which posits that the accumulation of familial environmental issues significantly increases the risk of adolescent internet addiction, thereby affecting their behavioral and psychological development (Bell, Audrey, Gunnell, Cooper, & Campbell, 2019). Furthermore, the psychological needs compensation theory explains the indirect mechanism by which family cohesion influences internet addiction. In low-cohesion family environments, adolescents may experience insufficient emotional support or unmet psychological needs (Chang & Kim, 2020) and consequently rely on the virtual world to seek psychological solace (A. Zhang et al., 2024). Based on attachment theory, high levels of family cohesion provide adolescents with emotional support and psychological security, making them more likely to seek real-world support when facing challenges rather than relying excessively on the internet or other escapist behaviors. Enhancing family cohesion can also reduce adolescents' tendency to become immersed in virtual environments by improving emotional regulation abilities and fostering a sense of social connectedness. These findings underscore the importance of strengthening family interactions as

a means of mitigating internet addiction and improving adolescent mental health(Yan, 2010).

### **The Mediating Effects of Physical Activity and Prosocial Behavior**

The results further demonstrate that physical activity serves as a significant mediating variable in the relationship between family cohesion and internet addiction, with an indirect effect value of -0.082, accounting for 19.9% of the total effect. Physical activity not only reduces internet usage by occupying time but also mitigates internet addiction by improving adolescents' emotional state and psychological well-being, enhancing their social interaction skills, and strengthening self-control abilities(Y. Z. l. li, 2021).Additionally, research has shown that physical activity enhances brain function, improves executive function, and regulates dopamine levels, thereby reducing internet addiction behaviors(Shi, 2014; Xia & Ding, 2018).The role of family cohesion in promoting adolescents' participation in physical activity further underscores the importance of the family environment in behavioral interventions, particularly through family-based activities that foster long-term healthy behavioral habits(Hui et al., 2022).This study supports existing literature suggesting that physical activity is a health-promoting behavior that not only benefits physical health but also plays a crucial role in improving psychological health and mitigating addictive behaviors(Ouyang & Liu, 2023; A. Zhang et al., 2024).

Prosocial behavior serves as another critical mediating variable, with an independent indirect effect value of -0.12, accounting for 29.1% of the total effect. Research indicates that prosocial behavior helps adolescents establish and maintain high-quality social relationships, enhance their sense of social responsibility, and reduce their reliance on virtual social interactions and internet-based gratification(Kasap, Kaymaz, Aylanç, & Battal, 2023). Moreover, according to reciprocity theory, engaging in prosocial behavior provides individuals with a sense of psychological achievement and fulfillment, which can substitute for the temporary pleasure derived from internet use, thereby suppressing tendencies toward internet addiction(Caprara et al., 2014).The significant role of prosocial behavior highlights its bridging effect between family cohesion and

internet addiction, addressing a gap in existing research.

The emotional security theory posits that conflicts between parents and children lead to adolescents' emotional insecurity, thereby increasing negative emotions and negatively impacting prosocial behavior(You, Guo, & Zhang., 2024).In contrast, family systems theory emphasizes that close emotional bonds and healthy family functioning can enhance children's psychological and physical well-being by reducing negative emotions. These factors encourage children to engage more positively with others and extend positive family behaviors to their social interactions, thereby increasing prosocial behavior(Neverkovich et al., 2018).The ripple effect theory and the sequential mediation model provide a foundation for understanding how family cohesion influences both short-term and long-term internet addiction outcomes through chained mediation pathways.

Despite the relatively small effect of the chained mediation pathway (-0.029, accounting for 7.3% of the total effect), its significance supports the validity of the ripple effect theory. This finding highlights how family cohesion generates multilayered transmission mechanisms that influence internet addiction through the interactive effects of physical activity and prosocial behavior.

This study also provides critical evidence for the ecological systems perspective, reinforcing the notion that families serve as key ecological systems in adolescent behavioral development. By fostering emotional connections and behavioral support, families have a profound impact on adolescents' psychological well-being and behavioral issues, such as internet addiction.

### **Limitations and Future Directions**

This study has certain limitations. First, the cross-sectional design employed in this study reveals correlations between variables but does not establish causality. Future research should adopt longitudinal designs or randomized controlled trials (RCTs) to better determine the causal relationships between family cohesion, physical activity, prosocial behavior, and internet addiction.

Second, the sample was limited to middle school students in Shandong Province, which may introduce regional and cultural biases, thereby

limiting the generalizability of the findings. Future studies should expand the sample to include adolescents from diverse sociocultural backgrounds to enhance the applicability of the results.

Additionally, this study did not fully account for critical variables that may influence internet addiction, such as mental health status, socioeconomic background, and school environment. Future research should incorporate these factors to refine the research framework and explore potential mediating and moderating variables that may impact the model's outcomes.

## Conclusion

This study demonstrated the indirect influence of family cohesion on adolescent internet addiction through physical activity and prosocial behavior using a chained mediation model, highlighting the pivotal role of the family environment in behavioral interventions. These findings provide theoretical support for understanding the complex ecological mechanisms underlying internet addiction and offer practical guidance for designing multi-level and comprehensive intervention strategies.

By optimizing family interactions, promoting participation in physical activities, and fostering prosocial behavior, the risk of adolescent internet addiction can be effectively reduced, thereby improving their mental health and social adaptability.

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