PIONEER
ACADEMIC PUBLISHING LIMITED

Studies in Psychological Science
ISSN 2959-5266
www.pioneerpublisher.com/sps
Volume 2 Number 2 June 2024

Attention Problems and Academic Achievement in Different Age Groups: The Role of Game Addiction

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doi:10.56397/SPS.2024.06.05

Abstract

Attention problems negatively impact academic achievement in students. Although previous studies have investigated the underlying mechanism of this association, the potential mediating role of game addiction has been understudied, particularly among different age stages. This study examined the mediating effect of game addiction on this relationship among secondary school (n=554, Mage=14.34), high school (n=450, Mage=15.6), and college students (n=572, Mage=19.13). Participants completed questionnaires assessing attention problems, game addiction, and academic achievement. Results showed that game addiction mediated the association between attention problems and academic achievement in secondary school students, but not high school students. College students exhibited an indirect effect of attention problems on academic achievement through game addiction. The study emphasizes the importance of limiting gaming behavior to improve academic performance and mitigate the negative effects of attention problems.

Keywords: attention problems, academic achievement, game addiction, secondary school students, high school students, college students

1. Introduction

The level of students' academic achievement is a critical indicator of their educational success in all educational systems worldwide (Haghbin, Shaterian, Hosseinzadeh, & Griffiths, 2013). Although academic achievement may not be the only criterion for school success, both teachers and parents in Chinese culture are highly concerned about it because it has been shown to determine success in higher education and the possibility of developing one's own life project (Failure, 2014) as well as overall life satisfaction (Lee & Yu, 2020). Among various factors affecting academic achievement, attention capability is considered an essential

neurobiological factor. Despite consistent evidence of academic difficulties among adolescents diagnosed with attention-deficit/hyperactivity disorder (ADHD) diagnosis (Meizhen LV, 2015; Visser et al., 2020), research on the academic achievement of the population-based adolescent with attention problems is limited, and results of adults in post-secondary education has been inconsistent (Gray, Fettes, Woltering, Mawjee, & Tannock, 2016; Lewandowski, Lovett, Codding, & Gordon, 2008).

Internet gaming has become a popular activity among students, and there is evidence of game addiction negatively impact school achievement (Farchakh et al., 2020; Starcevic et al., 2020), particularly in more vulnerable populations such as those with ADHD (Delos Santos, Cornillez, & Carillo, 2020; Hawi, Samaha, & Griffiths, 2018). Therefore, this study aimed to investigate whether game addiction mediates the association between attention problems and academic performance, and whether the pattern of the association differs across age stages.

1.1 Attention Problems and Academic Achievement Among Different Age Stages

ADHD is perhaps the most common manifestation of attention problems. In the DSM-5, ADHD is defined as a persistent pattern of inattention (e.g., difficult to focus on a task at hand) and/or hyperactivity-impulsivity (e.g., restlessness and inability to wait) (APA, 2013). This disorder has been linked to a number of adverse life outcomes, including academic underachievement, higher rates of occupational restrictions, reduced psychosocial functioning, increased substance use disorders, somatic and psychiatric comorbidities, and lower quality of life (Agarwal, Goldenberg, Perry, & Ishak, 2012; Erskine et al., 2016; Schipper et al., 2015). Of these outcomes, the impact of ADHD on educational success has been extensively studied. Academic achievement is considered a crucial indicator of personal educational activities (Haghbin et al., 2013), and ADHD can significantly hinder a person's ability to succeed in educational settings (Lawrence, Houghton, Dawson, Sawyer, & Carroll, 2021). Core behavioral symptoms of ADHD, such as failure to follow instructions, forgetfulness, restlessness, excessive verbal and motor activity, and impulsivity, often result in classroom difficulties (Galera, Melchior, Chastang, Bouvard, & Fombonne, 2009). In conclusion, ADHD is a common manifestation of attention problems that can lead to adverse outcomes, including hindered academic achievement. The association of ADHD with negative outcomes underscores the importance of early detection and intervention.

Physical and psychological differences between students of various ages highlight the importance of considering age as a factor in academic research. Adolescence, for example, is a critical period of physical and mental development that poses a high-risk period for psychological conflicts, emotional problems, and personality disorders (Meizhen LV, 2015). In contrast, physical and mental development stabilizes during adulthood. Many previous studies have investigated the impact of attention problems on academic performance with some researchers finding that students with ADHD in secondary and high school exhibit lower academic achievement. For instance, adolescents with ADHD may perform worse than their non-ADHD peers on standardized tests in reading, math, and writing (Lawrence et al., 2021; Visser et al., 2020). Other studies indicate that adolescents with ADHD tend to have poorer academic performance compared to their peers without the diagnosis (Daley & Birchwood, 2010; Flores, Caqueo-Urizar, Lopez, & Acevedo, 2022; Meizhen LV, 2015).

While research consistently suggests that adolescents with ADHD tend to struggle academically (Daley & Birchwood, 2010; Lawrence et al., 2021; Visser et al., 2020), studies examining the academic performance of college students with ADHD have yielded less consistent and robust results. Some researchers have found that university students with greater inattention symptomatology exhibit poorer academic success (Chu, 2022; Henning, Summerfeldt, & Parker, 2022). However, other studies found no evidence of impaired academic performance on standardized tests of GPAs in adults with an ADHD diagnosis (Gray et al., 2016) nor were academic problems sensitive to an ADHD diagnosis (Lewandowski et al., 2008).

1.2 The Mediating Role of Game Addiction Among Different Age Stages

Digital gaming has become increasingly popular worldwide (King & Delfabbro, 2019), with potentially addictive effects on vulnerable individuals when left unrestricted. Gaming disorder is now recognized as a disorder due to

addictive behaviors in ICD-11 (World Health Organization, 2018). Games have permeated students' lives, leading to concerns about addiction. A previous study reported a prevalence of game addiction of 4.6% among Chinese adolescents aged 12-19 (Luo et al., 2021).

The Interaction of Person-Affect-Cognition-Execution (I-PACE) model posits that Internet-use disorders arise from interactions between predisposing factors, moderators, Internet-related cognitive biases, and mediators (Brand, Young, Laier, Wolfling, & Potenza, 2016). One important predisposing factor is attention problems. Reviews have found ADHD as a risk factor for developing game addiction (Salerno, Becheri, & Pallanti, 2022; Weinstein & Weizman, 2012). Students with attentional problems may resort to video gaming as a coping mechanism for their behavioral disorders. (Farchakh et al., 2020). Furthermore, questionnaire studies found a positive relationship between ADHD and game addiction in secondary school students (C.-H. Ko, Yen, Chen, Yeh, & Yen, 2009; Rubia K, 2005; Starcevic et al., 2020), high school students (Du et al., 2017) and college students (Throuvala, Griffiths, Rennoldson, & Kuss, 2020). Individuals with ADHD may be particularly vulnerable to Internet addiction due to their lack of self-control (Rubia K, 2005; Throuvala et al., 2020). Additionally, those with ADHD have higher levels of impulsivity and are more prone to boredom (Steven J. Kass, J. Craig Wallace, & Vodanovich, 2003), which has been associated with addiction (Elhai, Vasquez, Lustgarten, Levine, & Hall, 2017).

Researchers are paying attention to game addiction (i.e., IGD) for its adverse impact. Negative consequences of excessive gaming include interfering with basic activities (C. H. Ko, Lin, Lin, & Yen, 2020), hindering social interactions (King & Delfabbro, 2018; Son, Oh, & Jeon, 2021), undermining important responsibilities (Gonzalez-Bueso et al., 2020), producing poorer mental health (Carey, Delfabbro, & King, 2021), reducing satisfaction with life (Samaha & Hawi, 2016) and lower academic achievement (Brunborg, Mentzoni, & Froyland, 2014; Schmitt & Livingston, 2015). Academic achievement is particularly relevant among students, as extensive time spent on gaming can interfere with studying efforts (Kuss & Griffiths, 2012). Numerous longitudinal studies have identified a negative relationship between game addiction and academic achievement (Brunborg et al., 2014; Jackson, von Eye, Witt, Zhao, & Fitzgerald, 2011; Schmitt & Livingston, 2015). For instance, Schmitt and Livingston (2015) found the higher the video game addiction scores were associated with lower first-year college GPAs after controlling for high school GPAs. But one study has found no relationship between game addiction and academic performance among medical students (Al Asqah, Al Orainey, Shukr, Al Oraini, & Al Turki, 2020). Similarly, some researchers found no relationship between game addiction and academic performance among high school students (Chen, Wilhelm, & Joeckel, 2019; Sahin, Gumus, & Dincel, 2014).

Attention problems may trigger game addiction, which could result in decreased academic achievement among students. Game addiction is thought to mediate the link between attention problems and academic achievement. However, prior research has found varying associations among different age groups, suggesting that the mediating effect may differ accordingly.

1.3 The Current Study

While previous studies have explored the relationships among attention problems, game addiction, and academic performance in students, only few have investigated these factors in a single model, or examined model and the mediating role of game addiction across different age stages. Therefore, we conducted a cross-sectional study of 1576 Chinese students to address two research questions at different educational levels: (1) what is the association between attention problems, game addiction, and academic achievement, and (2) can game addiction mediate the relationship between attention problems and academic achievement among secondary school, high school, and college students. The study hypothesized a model, described in Figure 1.

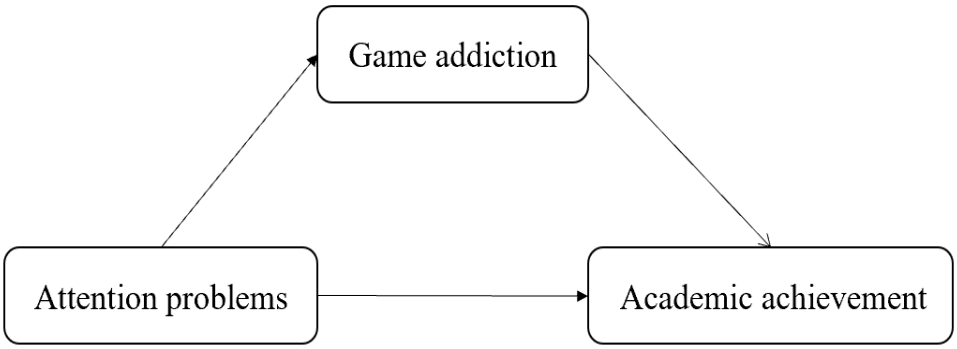

Figure 1. Hypothesis of the mediating effect of game addiction on attention problems and academic achievement of students

2. Method

2.1 Participants and Procedure

A total of 1576 Chinese students from secondary school, high school, and college were recruited to participate in this study. All subjects completed a paper-and-pencil survey in their classrooms. The sample of secondary school students comprised 554 individuals, of whom 58.8% were male, and 41.2% were female. The mean age was 14.34 (SD = 1.117). The high school sample consisted of 450 students, with 59.6% male, and 40.4% female participants. The mean age was 15.6 (SD = 0.677). The college sample included 572 students, with 371 (64.9%) men and 201 (35.1%) women. The mean age was 19.13 (SD = 1.225).

The study has received ethical approval by the ethical committee of Tianjin Normal University. Prior to the start of the study, all participants were informed of the study's purpose and provided written consent. Participants were assured that their data would be kept anonymous and confidential during analysis.

2.2 Measures

2.2.1 Attention Problems

Adult ADHD Self-Report Screening Scale for DSM-5 (ASRS-5) was used to measure ADHD symptoms (Ustun, 2017). The 6-item screen can effectively distinguish whether adults have ADHD or not and has been validated for adolescents (Somma et al., 2021). The 5-point Likert-type scale ranges from "0" (never) to "4" (very often). The higher the score, the more serious the attention problems. The Cronbach's alpha for the secondary, high school, and university groups were 0.606, 0.545, and 0.788, respectively.

2.2.2 Academic Performance

We used the grade as an indicator of academic performance. Specifically, we asked the participants to rate their class rank on a five-point scale from 1= very low, 2 = relatively low, 3 = middle, 4 = relatively high, and 5 = very high. The rate was used as a continuous variable. A higher score represents better academic performance. In the current study, the Mean of the self-reported rank of secondary school students was 2.700, SD = 0.974, Skewness was -0.005, and Kurtosis was -0.221. The Mean of the self-reported rank of high school students was M = 2.780, SD = 0.983, Skewness was -0.16, and Kurtosis was -0.526. The Mean of the self-reported rank of college students was M = 3.182, SD = 0.955, Skewness was -0.092, and Kurtosis was -0.004.

2.2.3 Game Addiction

The Chinese version of the Internet Gaming Disorder Scale–Short Form (IGDS9-SF) was administered to assess IGD in high school and college students (Pontes & Griffiths, 2015; Yam et al., 2019). It is a 9-item scale with each item representing a DSM-5 criterion. The responses were rated on a 5-point scale (1 = never; 5 = very often). A higher score indicates a higher level of game addiction. The Cronbach's alpha values for high school and college subjects were 0.854 and 0.868.

The Gaming Disorder Test (GDT) was used in secondary school students (Pontes et al., 2019). It is a brief four-item measure rated on a 5-point Likert scale. Higher scores indicate higher degrees of disordered gaming. The Cronbach's alpha was 0.804.

2.3 Statistical Analyses

Firstly, descriptive statistics and analyses of variance and correlation using IBM SPSS 26.0. Then, Mplus 8.0 was used to analyze the mediating relationships between attention problems, game addiction, and academic achievement. The bootstrapping method was utilized with 5000 resamples to test the significance of the effects, and 95% bias-corrected confidence intervals were produced. Significant effects were identified by confidence intervals that did not include zero. Acceptable model fit was defined as TLI and CFI exceeding 0.90, SRMR smaller than 0.06, and RMSEA smaller than 0.08 (Stephen G. West, Aaron B. Taylor, & Wu, 2012).

3. Results

3.1 General Characteristics

The major features of the 1576 students included in the final analysis are displayed in Table 1. The Mean age of the whole sample was 16.44 years. The distribution of academic performance among participants was approximately normal, as indicated by a skewness of -0.118 and kurtosis of -1.411. Furthermore, given that these values lie within the ±3 range, the distribution can be considered as normal (Ghasemi & Zahediasl, 2012).

Table 1. General features of the study subjects (N=1576)

Features	*N* (%)	Mean (SE)
Sex		
Men	965(61.20)	
Women	611(38.80)	
Age		16.44(2.34)
Grade		
Secondary school	554(35.20)	
High school	450(28.60)	
College	572(36.30)	
Academic Performance		
very low	147(9.30)	
relatively low	336(21.30)	
middle	703(44.60)	
relatively high	314(19.90)	
very high	76(4.80)	

3.2 Correlation Analysis

Correlation analysis for attention problems, game addiction, academic achievement was conducted in SPSS 26.0. Results (Table 2) showed that attention problems were negatively correlated with academic performance and positively correlated with game addiction in all three age groups. In addition, there was a negative correlation between game addiction and academic achievement among secondary school students and college students, but no correlation was found among high school students ($r = -0.04$, $p > 0.05$).

Table 2. Correlation analysis results

Variables	Secondary school students			High school students			College students		
	1	2	3	1	2	3	1	2	3
1. attention problems	1			1			1		
2. game addiction	0.31**	1		0.38**	1		0.59**	1	
3. academic achievement	-0.13**	-0.15**	1	-0.12**	-0.04	1	-0.10*	-0.19**	1

M	7.28	8.14	2.70	6.77	20.14	2.78	5.73	18.21	3.18
SD	3.75	3.96	0.95	3.10	7.31	0.98	4.31	6.55	0.96

Note: * $p < 0.05$, ** $p < 0.01$.

3.3 Testing for the Mediation Effect

3.3.1 Mediation Model Results of Secondary School Students

In our study, we constructed a structural equation model (SEM) with attention problems as the independent variable, academic achievement as the dependent variable, and game addiction as the mediator. Model fit results: RMSEA was 0.00; CFI was 1.00; TLI was 1.00; SRMR was 0.00. The path coefficients were shown in Figure 2. The results showed that both attention problems (β = -0.096, p = 0.022, 95% CI = [-0.178, -0.014]) and game addiction (β = -0.117, p = 0.009, 95% CI = [-0.206, -0.031]) were negatively related to academic achievement. The results showed that attention problems were positively related to game addiction (β = 0.307, p < 0.001, 95% CI = [0.224, 0.337]). The indirect effect of attention problems on academic achievement was significant through game addiction (β = -0.036, p = 0.017, 95% CI = [-0.070, -0.010]). Thus, the mediating effect of game addiction in the association between attention problems and academic achievement was supported.

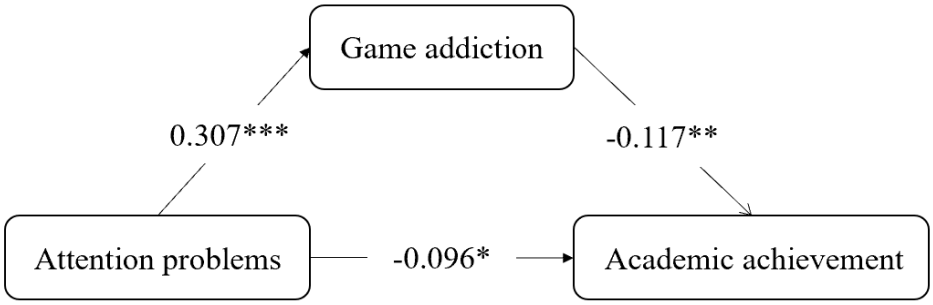

Figure 2. The mediation model of secondary school students' attention problems on academic achievement

3.3.2 Mediation Model Results of High School Students

Results shown in Figure 2 suggested that the mediation model for high school students is not supported. The model fit statistics indicated a good fit: RMSEA = 0.00, CFI = 1.00, TLI = 1.00, SRMR = 0.00. The path coefficients of the models of high school students were shown in Figure 3. The results showed that attention problems were negatively related to academic achievement (β = -0.124, p = 0.018, 95% CI = [-0.228, -0.023]). Attention problems were positively related to game addiction (β = 0.382, p < 0.001, 95% CI = [0.287, 0.473]). Game addiction was not related to academic achievement (β =0.004, p = 0.940, 95% CI = [-0.100, 0.110]). The indirect effect of attention problems on academic achievement was not significant through game addiction (β = -0.026, p = 0.941, 95% CI = [-0.040, 0.043]). Thus, the mediation model is not supported among high school students.

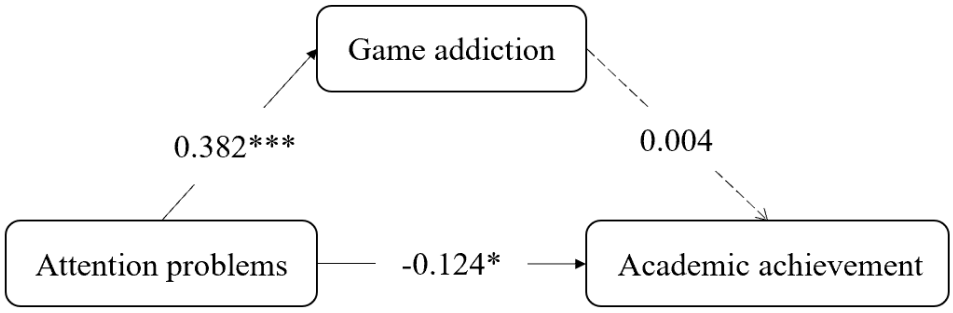

Figure 3. The mediation model of high school students' attention problems on academic achievement

3.3.3 Mediation Model Results of College Students

The path coefficient and corresponding results of the mediation model analysis were shown in Figure 4. The mediation model shows a good model fit (RMSEA = 0.00; CFI = 1.00; TLI = 1.00; SRMR = 0.00). The standardized path coefficient between attention problems and academic achievement was non-significant (β = 0.020, p = 0.728, 95 % CI = [-0.088, 0.137]). Attention problems were positively related to game addiction (β = 0.592, p < 0.001, 95 % CI = [0.512, 0.658]). Game addiction was negatively related to academic achievement (β = -0.206, p < 0.001, 95 % CI = [-0.319, -0.094]). Our analysis revealed that the mediation effect was full mediation, as we found that the direct effect of attention problems (via game addiction) on academic achievement was non-significant while the indirect effect was significant (β = -0.122, p = 0.001, 95 % CI = [-0.196, -0.057]). This indicates that game addiction fully accounts for the relationship between attention problems and academic achievement.

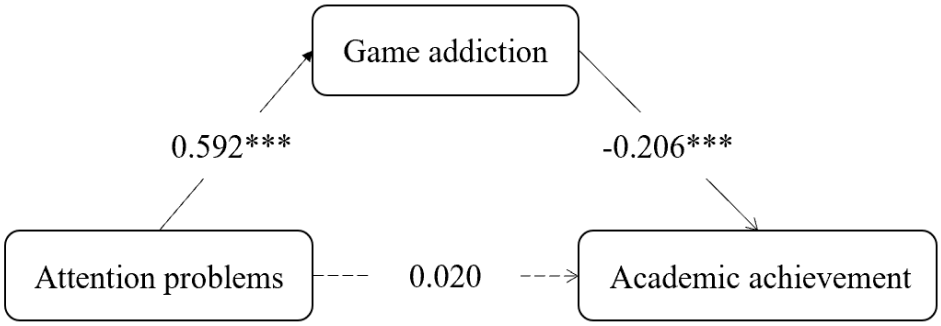

Figure 4. The mediation model of college students' attention problems on academic achievement

4. Discussion

This study investigated attention problems, game addiction, and academic achievement across different age stages. Results showed significant correlations, except for high school students' game addiction and academic achievement. Game addiction mediated the association between attention problems and academic achievement in secondary school students, while college students exhibited an indirect effect of attention problems on academic achievement through game addiction. These results advance our knowledge of how attention problems relate to academic achievement across various age groups.

4.1 Attention Problems and Academic Achievement

The results of the current study showed that attention problems are correlated with academic achievement in different stages, this is consistent with previous studies (Galera et al., 2009; Henning et al., 2022; Lawrence et al., 2021). Attention problems might be one of the most important externalizing mental health factors with respect to academic achievement (Daley & Birchwood, 2010). ADHD hinders academic performance; students face challenges with timed tests, meeting deadlines, and needing to work harder than non-ADHD peers for good

grades. (Lewandowski et al., 2008) As a result, the impact of attention problems on academic achievement is noteworthy and warrants further exploration.

4.2 Game Addiction as a Mediator

High attention problems and game addiction in secondary school students relate to poor academic performance. In other words, attention problems increase game addiction (C.-H. Ko et al., 2009), negatively impacting grades (Brunborg et al., 2014). In fact, students with ADHD are tended to be drawn to games with stimulating graphics and instant reward systems (Zentall, Tom-Wright, & Lee, 2013) such as exciting game and media, and are likely to engage with such media repeatedly (Chen et al., 2019). In addition, individuals with ADHD commonly experience high levels of impulsivity and boredom (Kass, Wallace, & Vodanovich, 2003), the common reaction to feeling bored is often to give up on the task (Eastwood et al., 2012). At this point, individuals may turn to easier tasks with less cognitive load, like games, leading to game addiction (Elhai et al., 2017). However, excessive gaming harms academic performance, acting as a harmful distraction that reduces learning time and concentration in class (Hawi et al., 2018; Jackson et al., 2011).

For high school students, the present study found that game addiction may not be correlated to academic performance, this is in line with some previous studies (Haghbin et al., 2013; Sahin et al., 2014). One possibility is the cognitive development and maturity that comes with high school age. This period is marked by growth in self-regulation, impulse control, and executive functioning, which involves skills like task-switching, prioritization, and goal-setting (Blakemore & Choudhury, 2006). High school students' cognitive abilities may help them better manage their gaming habits, preventing interference with academic performance. Additionally, other factors may contribute to the link between attention problems and academic performance in high school students. For example, a study found that depressive symptoms mediated a significant portion of the association between ADHD symptoms and academic performance (Riboldi et al., 2022). More targeted research would be required to substantiate these hypotheses.

The present study found attention problems indirectly affect academic achievement through game addiction in college students. No direct impact found. Review study identified factors like performance self-efficacy, personality traits, motivation, self-regulatory learning strategies, approaches to learning, and psychosocial contexts as key determinants (Abraham, Richardson, & Bond, 2013). In college, the direct impact of attention problems on academic performance might be suppressed. However, attention problems can still have an indirect effect through game addiction. This implies that college students with attention problems may be more prone to engaging in problematic gaming behavior, which ultimately negatively affects their academic performance (Delos Santos et al., 2020; Throuvala et al., 2020). College students must manage their time and commitments independently, without parental supervision. The college environment offers more autonomy, which can pose challenges with addictive behaviors. To improve academic outcomes, our study emphasizes the importance of a comprehensive approach that addresses attention problems and game addiction in college students.

4.3 Implications and Limitations

The implications of this study are two-fold. Theoretically, it sheds light on the risk factors for lower academic performance across different age stages and how attention problems are linked to academic achievement. Practically, the findings suggest that attention symptoms must be regulated and managed to improve academic outcomes. Additionally, since students with attention problems are at risk for poor academic performance, regulating their game usage is also crucial. Encouraging them to engage in serious games (Montes, Hijon-Neira, Perez-Marin, & Montes, 2021; Yeşilbağ, Korkmaz, & Çakir, 2020) or participate in physical activities (Owen et al., 2022), may be beneficial for improving their academic performance. Furthermore, teachers play a vital role in supporting students with attentional problems. Through enthusiastic teaching (Mishra & Malhotra, 2020), they can effectively engage and motivate these students to excel academically. Additionally, teachers can identify students at risk and offer targeted interventions to help them overcome attention challenges and enhance their academic achievement.

It's important to acknowledge the limitations of this study. Firstly, the cross-sectional design used limits the ability to establish causal

relationships. Secondly, reliance on self-report measures for attention problems, game addiction, and academic achievement may introduce bias and measurement error (Richardson, Simmering, & Sturman, 2009). Future studies should include objective measures for more accurate results. Thirdly, the study only examined overall game addiction without considering specific gaming behaviors. Future research should explore the impact of different types and modes of games on academic performance. Fourthly, the study did not determine if developmental or educational factors influenced the observed outcomes across age groups. Further research should investigate these factors. Future studies could use longitudinal designs, larger samples, multiple objective measures, and a nuanced approach to gain a better understanding of the relationships between attention problems, game addiction, and academic achievement.

5. Conclusion

In summary, this study revealed that attention problems have a negative impact on academic achievement. Game addiction mediated the relationship between attention problems and academic achievement among secondary school students, and there was an indirect effect of attention problems on academic achievement through game addiction among college students. However, the mediation effect was not established in high school students.

Fund Project

This work was supported by the National Social Science Fund of China under Grant number 21CSH050.

Declaration of Competing Interest

All authors declare that they have no conflicts of interest with this study.

Data Availability

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

Acknowledgments

None.

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