MUNI FSS

JOURNAL OF PSYCHOSOCIAL RESEARCH ON CYBERSPACE
CYBERPSYCHOLOGY

Liu, Q., Li, J., & Jin, X. (2024). Gaming disorder and depression among Chinese left-behind adolescents: Interactions of family, school, and personality factors. *Cyberpsychology: Journal of Psychosocial Research on Cyberspace, 18*(3), Article 4. https://doi.org/10.5817/CP2024-3-4

Gaming Disorder and Depression Among Chinese Left-Behind Adolescents: Interactions of Family, School, and Personality Factors

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Abstract

Gaming disorder and depression of Chinese adolescents have aroused widespread concern. Although there is a close relationship between gaming disorder and depression among ordinary adolescents, few studies have examined this relationship among Chinese left-behind adolescents (adolescents left in rural areas while parents work in urban areas for at least six months annually) from the perspective of environment-individual interactions. This study aimed to analyze whether family, school, and personality factors could interact in predicting left-behind adolescents' gaming disorder and depression. A cross-sectional questionnaire study was conducted between June and December 2020 in four high schools in Central China. A total of 618 left-behind adolescents between 11 and 15 years of age completed the anonymous survey. The results found that gaming disorder acted as a mediator linking parental neglect to depression. Teacher-student relationships and trait self-control uniquely weakened the predictive effect of parental neglect on gaming disorder and the mediating effect of gaming disorder between parental neglect and depression. The three-way interaction of parental neglect, teacher-student relationships, and trait self-control also showed a significant effect on left-behind adolescents' depression through gaming disorder. The protective role of teacher-student relationships on the mediation of gaming disorder was stronger for left-behind adolescents with lower trait self-control, and the protective role of trait self-control on the mediation of gaming disorder was stronger for left-behind adolescents with lower teacher-student relationships. The results promote a better understanding of how family, school, and personality interact to predict left-behind adolescents' gaming disorder and depression. The findings can inform specific practical suggestions for preventing and intervening in gaming disorder and depression.

Keywords: gaming disorder; depression; parental neglect; teacher-student relationships; trait self-control; left-behind adolescents

Editorial Record

First submission received:
May 26, 2023

Revisions received:
February 6, 2024
April 17, 2024

Accepted for publication:
May 3, 2024

Editor in charge:
Maèva Flayell

Introduction

In some developing countries, due to the migration of a significant number of rural populations to urban areas for employment, many children are left behind in rural areas, resulting in a phenomenon known as "left-behind children". Left-behind children are individuals under the age of 18 who are left to stay in rural areas with one or both of their parents going to urban areas for work for at least six months out of the year (K. Li et al., 2021; Zhen et al., 2020). Left-behind children can be classified into two types (i.e., one parent absent and both parents absent) or three types (i.e., father absent, mother absent, and both parents absent; Liu, Tu, et al., 2022; Wang et al., 2015). Left-behind adolescents are minors between the ages of 12 and 18 who fall under the category of left-behind children. Typically, left-behind adolescents live with their grandparents or other relatives when both of their parents are migrant workers. Approximately 6 million Chinese children and adolescents were left at home in 2020 (Ministry of Civil Affairs of the People's Republic of China, 2021). By the end of 2020, 94.7% of rural children and adolescents aged 6–18 had access to the internet, a rate that was almost the same as that of urban children and adolescents (95%; China Internet Network Information Center, 2021). Left-behind children and adolescents mainly access the internet through their mobile phones, which they often use for entertainment activities (e.g., online games; China Internet Network Information Center, 2021).

Rural areas in China have good broadband coverage, enabling rural adolescents to conveniently access online gaming through their mobile phones (China Internet Network Information Center, 2023). Although online games can offer certain advantages to left-behind adolescents, such as helping to alleviate negative emotions, providing an escape from negative events, fostering peer relationships, and fulfilling the need for a sense of belonging, they also pose the potential risk of gaming disorder. Gaming disorder, encompassing both online and offline manifestations, has been incorporated into the 11th edition of the International Classification of Diseases (ICD-11) as a distinct syndrome with clinical relevance (World Health Organization, 2018). It is characterized by a pattern of gaming behavior that causes considerable distress or substantial impairment in various aspects of an individual's life, including personal, family, social, educational, or occupational functioning. According to a recent meta analysis, the overall pooled prevalence of gaming disorder was 3.3%, 95% CI [2.6, 4.0], with a higher prevalence in males (8.5%) than in females (3.5%; H. S. Kim et al., 2022). In the era of the internet, the predominant manifestation of game disorder is internet gaming disorder. Currently, research on gaming addiction predominantly centers on internet gaming disorder.

Gaming disorder of left-behind adolescents has become a severe concern in China (B. Yang et al., 2021). Left-behind children and adolescents in China spend significantly more time on mobile games every day than children and adolescents who are not left behind (Xu & Chen, 2020; Zhou, 2018). Moreover, depression is also one of the most troubling problems among left-behind adolescents (Ding et al., 2019). Due to the dysfunction of the family system that cannot effectively buffer the impact of adverse factors, the risk of depression in left-behind adolescents is much higher than that in ordinary adolescents (Fellmeth et al., 2018; Wang et al., 2015). Empirical studies have found that gaming disorder is one of the risk factors for adolescent depression (Brunborg et al., 2014; S.-H. Kim & Hwang, 2020; Loton et al., 2016). Internet gaming disorder can even significantly predict adolescents' well-being a half year later (Teng et al., 2020). The displacement hypothesis and the interference hypothesis are two theoretical models that potentially explain the relationship between gaming disorder and the onset of depression. According to the displacement hypothesis (Kushlev & Leitao, 2020), excessive engagement in mobile games consumes individuals' time and attention that could be allocated to activities such as sleep, physical exercise, and interpersonal interaction. Consequently, gaming disorder may increase the susceptibility to depression in individuals. Furthermore, based on the interference hypothesis of mobile phone use, excessive immersion in online gaming can disrupt individual cognitive development and interpersonal interactions, thereby increasing the risk of depression (Kushlev & Leitao, 2020; Sbarra et al., 2019). Although there is a close relationship between gaming disorder and depression among ordinary adolescents, few studies have examined this relationship among left-behind adolescents through an environment-individual interaction model. This study analyzes whether family environment (e.g., parental neglect), school environment (e.g., teacher-student relationships), and personality factors (e.g., trait self-control) could interact in predicting Chinese left-behind adolescents' gaming disorder and depression.

The Effect of Parental Neglect

Parental neglect is a kind of injury in which parents ignore their children's physiological, psychological, and social needs (Khaleque, 2015; Maughan & Moore, 2010). It has a critical impact on adolescents' mental health (Leeb et al., 2011). In particular, adolescents who are neglected by their parents have a high risk of depression (Kwok & Gu, 2019). According to attachment theory, parental neglect makes it impossible for good attachment relationships between parents and children to be established and maintained, and the two functions of attachment (i.e., emotional warmth and social control) may fail to produce a marked effect (Finzi et al., 2000; Sciarrino et al., 2014). In terms of emotional warmth, parental neglect may lead to dissatisfaction with psychological needs (English et al., 2005). Neglected adolescents may turn to their mobile phones to seek comfort and alleviate the negative thoughts and emotions caused by the frustration of emotional needs (Chang & Lin, 2019; Chang et al., 2018). Among multiple mobile phone functions, online games with high feedback and a strong sense of flow are particularly more likely to become a critical way for adolescents to meet their psychological needs (Lin et al., 2021), and this may, in turn, develop into gaming disorder. In terms of social control, parental education is one of the most crucial influences on the socialization and development of children and adolescents (LeVine, 2003). Parental neglect may lead to a lack of supervision and control of left-behind adolescents' use of mobile phone, which results in the excessive use of these phones for online games. Numerous empirical studies have also confirmed the predictive effects of parental neglect on adolescent internet addiction and smartphone addiction (Chidambaram et al., 2023; Kwak et al., 2018; Jihyun & Misook, 2023). Since parental neglect may significantly predict left-behind adolescents' gaming disorder and gaming disorder may, in turn, significantly predict depression, gaming disorder may play a mediating role between parental neglect and left-behind adolescents' depression.

The Effect of Teacher-Student Relationships

According to the bioecological model of human development, individual development is affected by family, school, peers, and other environmental systems simultaneously, with significant interactions among these environmental factors (Bronfenbrenner, 2005). Therefore, the predictive effect of parental neglect on left-behind adolescents' gaming disorder may be moderated by school environmental variables, such as the teacher-student relationship. The teacher-student relationships consist of the cognitive and emotional connection established between individuals and teachers in the school environment (Wentzel, 1997). Adolescents with poor teacher-student relationships are more likely to develop addictive behaviors such as addictions to the internet (Jia et al., 2017) and mobile phones (Liu et al., 2023). According to attachment theory, when the parent—child relationship is poor and a healthy parent—child attachment cannot be established, adolescents will seek attachment substitutes (Bowlby, 1969), which may be people such as teachers (Riley, 2010) or goods such as mobile phones (Konok et al., 2016). If adolescents who are neglected by their parents can establish a secure attachment with their teachers, teacher-student attachment may alleviate the negative impacts of parental neglect on adolescent development (Verschueren & Koomen, 2012). Existing research results provide empirical support for the complementary role of teacher-student relationships in the association between family risk and its consequences (Roubinov et al., 2020). Thus, positive teacher-student relationships may attenuate the relationship between parental neglect and left-behind adolescents' gaming disorder.

The Effect of Trait Self-Control

Moreover, the bioecological model highlights that physical and mental development is influenced by the interactive effect of environmental and individual factors (Bronfenbrenner, 2005). The impact of the interaction of environmental and individual factors on individual development is far great than that of either factor on its own (Koller et al., 2019; Rankin, 2019). Therefore, the predictive effect of parental neglect on left-behind adolescents' gaming disorder may be affected by individual traits, such as trait self-control. Self-control refers to the ability of individuals to overcome impulsive, habitual, or automatic reactions and consciously regulate their thoughts, emotions, and behaviors to achieve specific goals (Baumeister et al., 2007). Trait self-control is the tendency to control oneself in daily life. Many studies have shown the positive effects of trait self-control on physical and mental health (Duckworth, 2011; Will Crescioni et al., 2011). The negative relationship between trait self-control and various addictive behaviors (e.g., substance use and online gaming disorder) has been tested by many studies (Jeong et al., 2019; Wills et al., 2006). Studies on problematic mobile phone use have consistently identified self-control as a significant predictor, regardless of the age group, whether in young adults (X. Li et al., 2021) or

adolescents (Y. Kim et al., 2016). As an internal control force, self-control can alleviate the risk caused by the lack of an external social control force, which is often absent in a negative family environment (Flouri et al., 2014; Kim et al., 2018). Thus, strong self-control may decrease the relationship between parental neglect and left-behind adolescents' gaming disorder.

Three-Way Interaction

In addition, the bioecological model highlights that there are significant interactions among multiple environmental and individual factors (Bronfenbrenner, 2005; Koller et al., 2019). Family, school and personality factors may interact to predict adolescent development. Previous research has revealed significant effects of three-way interactions among individual and environmental factors on adolescent development, such as the interactive effect of parental monitoring, peer deviance, and sensation seeking on adolescent delinquency (Mann et al., 2015) and of parenting style, interpersonal relationships, and personality traits on internet addiction (Sun & Wilkinson, 2020). In this study, there may be a complex three-way interactive effect of parental neglect, teacher-student relationships, and trait self-control on gaming disorder.

Hypotheses and Conceptual Model

Drawing on the bioecological model of human development and previous empirical studies, the current study aims to address four research questions: (a) does gaming disorder act as a mediator linking parental neglect and adolescent depression? (b) does teacher-student relationship attenuate the association between parental neglect and adolescent depression? (c) does trait self-control mitigate the relationship between parental neglect and adolescent depression? and (d) do teacher-student relationships and trait self-control interactively moderate the relationship between parental neglect and adolescent depression? The presented hypotheses have been formulated, and the conceptual model is depicted in Figure 1.

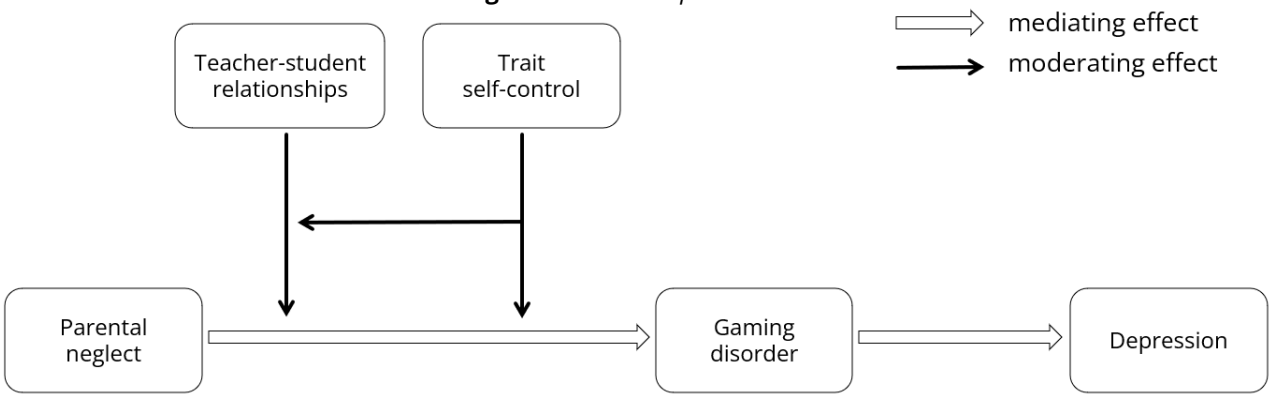
H1: Parental neglect can contribute to an increased risk of gaming disorder, which, in turn, may exacerbate depression among left-behind adolescents.

H2: Positive teacher-student relationships will decrease the relationship between parental neglect and left-behind adolescents' gaming disorder.

H3: Strong trait self-control will decrease the relationship between parental neglect and left-behind adolescents' gaming disorder.

H4: Teacher-student relationships and trait self-control will interactively mitigate the relationship between parental neglect and adolescents' gaming disorder.

Figure 1. *The Conceptual Model.*



Methods

Participants and Procedure

The data were collected between June and December 2020. The present study was approved by the Ethics Committee at the first author's institution. We employed a convenient sampling method to select four secondary

schools. Within each of these schools, we further selected three classes from grades 7 to 9. These four schools were located in two distinct rural areas within the same city. Both of these rural areas are characterized by out-migration. Individuals whose father and/or mother migrated to urban areas for work and had not been living together with them for at least six months were defined as left-behind students. The anonymous survey was conducted in classrooms under the supervision of teachers. Participation in the study was voluntary, and no mandatory requirements were imposed on the students. A total of 36 students declined to participate, while 32 students were excluded from the analysis due to incomplete responses. As a result, our final analysis included a total of 618 students. Of note, the questionnaire achieved a response rate of 90.09%. The characteristics of these left-behind adolescents are presented in Table 1. These left-behind adolescents were between 11 and 15 years old (M_{age} = 13.22, SD_{age} = 0.97). Among the participants, 319 (51.62%) left-behind adolescents were boys, and 299 (48.38%) were girls. A total of 280 (45.31%) adolescents had one parent who went to the city for work, and 338 (54.69%) adolescents had both parents heading to the city for work.

Table 1. *Descriptive Statistics of the Participants.*

	Number	Age *M(SD)*	Number of one parent heading to city	Number of both parents heading to city
1 Total sample	618	13.22(0.97)	280	338
2 Male sample	319	13.19(0.98)	153	166
3 Female sample	299	13.25(0.96)	127	172

Measurements

Gaming Disorder

The Mobile Game Addiction subscale of the Mobile Phone Addiction Type Scale (MPATS, Liu, Xu, et al., 2022) that was developed for Chinese adolescents and young adults was used. The MPATS emphasizes four key addiction characteristics: inability to control cravings, anxiety and feeling lost, withdrawal and escape, and productivity loss (Liu, Xu, et al., 2022). These factors are essential in both substance addiction and technology addiction (Griffiths, 2017; M. Kwon et al., 2013; Leung, 2008), closely resembling the diagnostic criteria of ICD-11 and DSM-5. The Mobile Game Addiction subscale consists of six items (e.g., *My family or friends complain that I spend too much time playing mobile games*) rated on a five-point scale (1 = *never*, 5 = *always*). Two items assess the inability to control cravings, two items gauge anxiety and feeling lost, one item evaluates withdrawal and escape, and one item examines productivity loss. Previous research conducted among Chinese adolescents (Liu, Xu, et al., 2022; Tu et al., 2023) has demonstrated that this subscale exhibits high levels of reliability and validity. Cronbach's α for this measure was .86. The index of confirmatory factor analysis (CFA) showed a good fit: χ^2/df = 1.34, RMSEA = .02, CFI =.99, NFI = .99, GFI = .99.

Depression

The Depression Subscale of the Chinese version (Gong et al., 2010) of the Depression-Anxiety-Stress Scale (Lovibond & Lovibond, 1995) was used. This subscale includes seven items rated on a four-point scale (0 = *never*, 3 = *always*). Sample items include *I could see nothing in the future to be hopeful about* and *I felt that life was meaningless*. This subscale has exhibited strong reliability and validity in prior studies conducted among Chinese adolescents (e.g., Cao et al., 2023; X. Yang et al., 2019). Cronbach's α for this measure was .79. The index of CFA showed a good fit: χ^2/df = 3.10, RMSEA = .056, CFI = .98, NFI = .98, GFI = .96.

Parental Neglect

A four-item scale revised by Kwak et al. (2018) based on the parental neglect subscale of the Parent–Child Conflict Tactics Scales (Straus et al., 1998) was used. This scale was used among Chinese left-behind adolescents after a strict translation and back-translation procedure. The participants reported their experiences of being neglected by their parents in the past 12 months on a five-point scale (0 = *never*, 1 = *1–2 times*, 2 = *3–5 times*, 3 = *6–9 times*, and 4 = *more than 10 times*). One of the example items is *My parents left me alone, even though I had to stay with them*. The measure's reliability and validity have been previously demonstrated in research conducted among

adolescents (Kwak et al., 2018; Liu, Tu, et al., 2022). Cronbach's α for this measure was .70. The index of CFA showed a good fit: χ^2/df = 1.09, RMSEA = .01, CFI = .99, NFI = .98, GFI = .99.

Teacher-Student Relationships

The teacher-student relationship subscale of the Chinese version of the Delaware School Climate Survey-Student (DSCS-S, Bear et al., 2014) was utilized. Participants rated five items (e.g., *Teacher treat students with respect*) on a four-point scale (1 = *strongly disagree*, 4 = *strongly agree*). Previous research has demonstrated that DSCS-S exhibits satisfactory levels of both reliability and validity (Nie et al., 2018; Pan et al., 2023). Cronbach's α for this measure was .74. The index of CFA showed a good fit: χ^2/df = 3.75, RMSEA = .07, CFI = .99, NFI = .98, GFI = .99.

Trait Self-Control

The Chinese version (Situ et al., 2016) of the Brief Self-control Scale developed by Tangney et al. (2004) was used. Participants rated 13 items (e.g., *I am good at resisting temptation*) on a five-point scale (1 = *not like me at all*, 5 = *very much like me*). Numerous previous studies have consistently confirmed the high validity and reliability of this scale among Chinese adolescents in China (e.g., Dou et al., 2020; J.-B. Li et al., 2018). Cronbach's α for this measure was .832. The index of CFA showed a good fit: χ^2/df = 3.10, RMSEA = .06, CFI = .96, NFI = .95, GFI = .97.

Main Statistical Analyses

The independent sample *t* test was used to analyze whether there were differences in core variables among left-behind adolescents with different characteristics. A mediation analysis was conducted to examine the mediation of gaming disorder between parental neglect and left-behind adolescents' depression using Model 4 of the PROCESS macro for SPSS (Hayes, 2013). An interactive mediation model analysis was performed to reveal the two-way and three-way interactions of parental neglect, teacher-student relationships and trait self-control using Model 11 of the PROCESS macro for SPSS (Hayes, 2013). Gender and age were included as covariates due to the elevated risk of gaming disorder among males compared to females, as well as the higher propensity for young individuals to engage in gaming disorder compared to older individuals (Stevens et al., 2021; Yu et al., 2021).

Results

Preliminary Analysis

The results of the independent sample *t* test indicate that there were no significant differences between adolescents with one parent absent and adolescents with both parents absent in scores of teacher-student relationships (t = −0.11, p = .911), self-control (t = −0.36, p = .720), and gaming disorder (t = −0.30, p = .767), but there were significant differences in scores of parental neglect (t = −5.00, p < .01) and depression (t = −4.12, p < .01). Adolescents with both parents absent had higher levels of parental neglect and depression than those with one parent absent. Moreover, the results of the independent samples *t*-test for the core variables indicate that there are no significant gender differences observed in parental neglect (t = −1.12, p = .263), teacher-student relationships (t = −0.74, p = .461), self-control (t = −0.21, p = .835), gaming disorder (t = 0.14, p = .891), or depression (t = 0.68, p = .495) among left-behind children. The correlational relationships among the variables are presented in Table 2. Significant correlations were observed among all core variables in left-behind boys and girls.

Table 2. *Descriptive Statistics and Correlations Between Variables.*

Variables	Boys (*M*±*SD*)	Girls (*M*±*SD*)	1	2	3	4	5
1. Parental neglect	2.17±0.68	2.23±0.69	—	−.33**	−.25**	.31**	.38**
2. Teacher-student relationships	2.88±0.71	2.92±0.66	−.28**	—	.13*	−.41**	−.43**
3. Trait self-control	3.64±0.73	3.66±0.69	−.11*	.16**	—	−.36**	−.35**
4. Gaming disorder	2.15±0.96	2.14±0.93	.31**	−.51**	−.37**	—	.44**
5. Depression	6.01±5.39	5.71±5.08	.23**	−.46**	−.24**	.47**	—

Note. N = 618. Values above and below the diagonal represent female and male sample, respectively. *p < .05, **p < .01.

Testing for the Mediation Model

The mediation analysis results are presented in Table 3. Parental neglect positively predicted depression and gaming disorder. When parental neglect and gaming disorder were included in the regression model of depression, they both significantly predicted left-behind adolescents' depression. The mediating effect of gaming disorder was 0.13, with a 95% confidence interval of [0.08, 0.18]. The mediation of gaming disorder accounted for 40.81% of the total effect.

Table 3. *Mediation Analysis of Gaming Disorder.*

Regression equation		Significance of regression coefficients				Bootstrap	
Outcome variables	Independent variables	β	*SE*	*t*	*p*	LLCI	ULCI
Depression	Gender	−.04	.11	−0.38	.707	−.26	.18
	Age	−.03	.04	−0.78	.438	−.11	.05
	School code	−.03	.05	−0.58	.562	−.13	.07
	Parental neglect	.31***	.05	6.55	< .001	.21	.40
Gaming disorder	Gender	.03	.12	0.27	.787	−.20	.26
	Age	.05	.04	1.28	.201	−.03	.12
	School code	.02	.05	0.40	.686	−.08	.13
	Parental neglect	.31***	.05	5.82	< .001	.20	.41
Depression	Gender	−.05	.10	−0.55	.586	−.25	.14
	Age	−.05	.04	−1.40	.163	−.12	.02
	School code	−.04	.05	−0.83	.407	−.13	.05
	Parental neglect	.18***	.05	3.70	< .001	.08	.28
	Gaming disorder	.41***	.05	8.41	< .001	.31	.50

Note. N = 618. Bootstrap sample size = 5,000. LL = low limit, CI = confidence interval, UL = upper limit. ***p < .001.

Testing for the Interaction Model

The results of the interactive model analysis are presented in Table 4. The interaction of parental neglect and teacher-student relationships had a significantly negative effect on gaming disorder. Similarly, the interaction of parental neglect and trait self-control also had a notable impact on gaming disorder. Furthermore, the three-way interaction involving parental neglect, teacher-student relationships, and trait self-control exhibited a significant influence on gaming disorder in left-behind adolescents. Conditional analysis showed that the association between parental neglect and gaming disorder was strong for left-behind adolescents with low teacher-student relationships but was not significant for left-behind adolescents with high teacher-student relationships. The association between parental neglect and gaming disorder was strong for left-behind adolescents with low self-control but was not significant for left-behind adolescents with high trait self-control.

Table 5 presents the three-way (parental neglect × teacher-student relationships × trait self-control) interactive effect on depression through gaming disorder. For left-behind adolescents with a low teacher-student relationship, the mediating effect of gaming disorder was significant at low self-control but not significant at high self-control. However, for left-behind adolescents with high teacher-student relationships, the mediation of gaming disorder was not significant at low or high levels of self-control. Therefore, the protective effect of self-control on the mediation of gaming disorder was more potent for adolescents with low teacher-student relationships than for those with high teacher-student relationships. For left-behind adolescents with low self-control, the mediating effect of gaming disorder was significant at low teacher-student relationships, but not significant at high teacher-student relationships. For left-behind adolescents with high self-control, however, the mediation of gaming disorder was not significant at low and high teacher-student relationships. Therefore, the protective effect of the teacher-student relationship on the mediation of gaming disorder was more potent for adolescents with low self-control than for those with high self-control.

Table 4. *Three-Way Interaction Model Analysis.*

Regression equation		Significance of regression coefficients				Bootstrap	
Outcome	Independent variables	β	SE	*t*	*p*	LLCI	ULCI
Gaming disorder	Gender	−.01	.10	−0.15	.881	−.21	.18
	Age	.06	.03	1.65	.099	−.01	.12
	School code	.02	.04	0.39	.697	−.07	.10
	Parental neglect	.11**	.04	2.92	.004	.04	.19
	Teacher-student relationships	−.25***	.05	−5.34	< .001	−.34	−.16
	Trait self-control	−.24***	.04	−6.06	< .001	−.32	−.16
	Parental neglect × Teacher-student relationships	−.09*	.04	−2.10	.036	−.17	−.01
	Parental neglect × Trait self-control	−.14**	.05	−2.88	.004	−.23	−.04
	Teacher-student relationships × Trait self-control	−.15**	.05	−2.87	.004	−.25	−.05
	Three-way interaction	.12**	.04	2.67	.008	.03	.20
Depression	Gender	−.05	.10	−0.55	.586	−.25	.14
	Age	−.05	.04	−1.40	.163	−.12	.02
	School code	−.04	.05	−0.83	.407	−.13	.05
	Parental neglect	.18***	.05	3.70	< .001	.08	.28
	Gaming disorder	.41***	.05	8.41	< .001	.31	.50

Note. N = 618. Bootstrap sample size = 5,000. SE = standard error. Three-way interaction = parental neglect × teacher-student relationships × trait self-control. *p < .05, **p < .01. ***p < .001.

Table 5. *Conditional Mediating Effects of Gaming Disorder at Different Values of the Two Moderators.*

Values of teacher-student relationships	Values of trait self-control	Mediating effect	*SE*	Bootstrap LLCI	Bootstrap ULCI
	M−SD	0.18**	.03	.12	.25
M−SD	*M*	0.08**	.02	.04	.13
	M+SD	−0.02	.03	−.08	.05
	M−SD	0.10**	.03	.05	.16
M	*M*	0.05**	.02	.02	.08
	M+SD	−0.01	.02	−.06	.04
	M−SD	0.02	.04	−.05	.09
M+SD	*M*	0.01	.02	−.03	.06
	M+SD	0.00	.04	−.07	.08

Note. N = 618. Bootstrap sample size = 5,000. SE = standard error. LL = low limit, CI = confidence interval, UL = upper limit. ** p < .01.

Discussion

The prevalence of gaming disorder and depression in children and adolescents, particularly those in disadvantaged environments, has become a significant concern. Numerous studies have investigated the correlation between gaming addiction and depression (e.g., Brunborg et al., 2014; S.-H. Kim & Hwang, 2020; Loton et al., 2016). However, research on the combined impact of family, school, and personality traits on mobile gaming addiction and depression among left-behind children is still insufficient. To the best of our knowledge, this research is one of the first studies focusing on the unique and interactive effects of family, school, and personality factors on left-behind adolescents' gaming disorder and depression. The findings make significant contributions to the research field.

Firstly, Hypothesis 1 was supported. Consistent with previous research conducted before and during the COVID-19 pandemic on the correlation between problematic mobile phone use and depression, the present study discovered a significant association between gaming disorder and depression. Studies conducted prior to the onset of the COVID-19 pandemic reported a range of correlation coefficients, from 0.15 to 0.55, between

problematic mobile phone use and depression (e.g., T. Gao et al., 2017; Ithnain et al., 2018; Jun, 2016; X. Yang et al., 2019). Similarly, studies conducted during the COVID-19 pandemic have also revealed correlation coefficients within the range of 0.20 to 0.50, indicating a similar relationship (e.g., W.-J. Gao et al., 2023; Lee et al., 2021; X. Yang et al., 2021). Our study further confirms the mediating role of gaming disorder between parental neglect and left-behind adolescents' depression. The mediating effect of gaming disorder indicates that left-behind adolescents' gaming disorder is influenced by the developmental environment in which they are located, such as parental neglect. Negative environmental factor not only contributes to behavioral addiction but also may further affect adolescents' depression. Depression in adolescents should be analyzed, not only in the family system, but also in the bioecological techno-subsystem (e.g., mobile internet) because the bioecological techno-microsystem is an important environmental system that exerts a critical impact on adolescent development in the internet era (Johnson & Puplampu, 2008).

In line with previous studies that revealed the positive roles of teacher-student relationships in alleviating the risk of negative family environments (Luo et al., 2021; Roubinov et al., 2020), the present study showed that teacher-student relationship can weaken the direct and indirect effects of parental neglect on gaming disorder. These two effects were strong in left-behind adolescents with poor teacher-student relationships, but weak in adolescents with good teacher-student relationships. As a result, Hypothesis 2 was also supported. The reason why the teacher-student relationship plays a protective role in decreasing the negative impacts of parental neglect on left-behind adolescents may be that high teacher-student attachment can effectively compensate for low parent–child attachment. First, teacher-student attachment can provide emotional warmth and compensate for the emotional damage of parental neglect that adolescents have endured. If teachers establish close teacher-student relationships with their students, they can help meet adolescents' psychological needs for emotional warmth (Verschueren & Koomen, 2012). In addition, teacher-student attachment can act as a source of social control. According to social control theory, the family environment and school education are fundamental social control forces. They can shape individual rules and standardize individual behaviors (Sharp et al., 2017). When parents fail to guide and regulate adolescents' mobile phone use behaviors due to the neglect of education, teachers can strengthen the connection with adolescents, inform them of the potential harm of mobile games, and correct adolescents' bad mobile game habits, which will greatly help in preventing gaming disorder.

Consistent with previous research that highlighted the protective moderating role of trait self-control in alleviating the impact of negative family factors (Flouri et al., 2014; Kim et al., 2018), the present study revealed that trait self-control can decrease the direct and indirect effects of parental neglect on gaming disorder. These two effects were strong in left-behind adolescents with low self-control but weak in those with high self-control. Therefore, Hypothesis 3 was also supported. It is necessary to emphasize self-control among left-behind adolescents, because, compared to ordinary adolescents, left-behind adolescents need to rely more on their own efforts in the development process. On the one hand, adolescents with high self-control can better regulate their emotions (Tice & Bratslavsky, 2000; Wills et al., 2006), which may help weaken the harm of parental emotional neglect. They will not have too many negative emotions because of parental emotional neglect, and they will not need to alleviate these negative emotions through mobile phones. Moreover, adolescents with high self-control can better overcome behavioral impulses (Hofmann et al., 2009), thus weakening the risk of parental education neglect. They can better restrain their psychological craving for mobile phones, restrain their impulsive response to mobile phones (Khang et al., 2012), and develop good mobile phone use habits.

In line with Hypothesis 4, parental neglect, teacher-student relationships, and trait self-control significantly interacted in predicting adolescents' gaming disorder and depression. The interactive effect of parental neglect and teacher-student relationships on gaming disorder was strong in left-behind adolescents with low the trait self-control, but not significant in those with high trait self-control. The interactive effect of parental neglect and the trait self-control on gaming disorder was strong in left-behind adolescents with poor teacher-student relationships, but not significant in those with good teacher-student relationships. These results coincide with the bioecological model of human development (Bronfenbrenner, 2005) and the individual-environment interaction model (Rankin, 2019), which highlight that there are significant multilevel interactions between individual and environmental factors. The complementary moderating role of teacher-student relationships and the trait self-control suggests that various protective factors do not need to exist simultaneously for the healthy development of adolescents and that the protective factors can effectively cooperate.

From an integration perspective, our research shows that individual development is influenced by complex environmental and individual factors. Multiple factors do not function independently of each other. The integrated model does not overemphasize the role of a certain environmental or individual factor, and its implications for

practice are more ecologically valid than those of examining any single influencing factor. Our findings suggest that parents and educators cannot analyze the psychology and behavior of adolescents by considering only the role of family, school, or individuals. Parental neglect, teacher-student relationships, and self-control are key interventions for gaming disorder and depression among left-behind adolescents, but some comprehensive interventions may be more effective than individual interventions for any one of these factors.

Implications and Limitations

In practical settings, it is crucial to recognize and effectively leverage the beneficial effects of teacher-student relationships and self-control, while also implementing interventions that consider their interaction. For left-behind adolescents whose parents are unable to accompany and whose teacher-student relationship is poor, it is particularly important to strengthen their self-control ability to control problematic behaviors and maintain their mental health. For left-behind adolescents whose parents are unable to accompany them and whose self-control is fragile, teachers should focus more on developing teacher-student relationships, making up for the lack of warmth in their families, and promoting their formation of good habits. Previous research has indicated that both the teacher-student relationship and trait self-control can be greatly improved through educational interventions. For example, a comprehensive review study identified four effective approaches to improving the quality of the teacher-student relationship, which include increasing closeness, decreasing conflict, promoting social-emotional learning, and emphasizing relationship-driven classroom management (Poling et al., 2022). A review article conducted an analysis of different cognitive and behavioral interventions of self-control, revealing consistencies in the effectiveness of effort exposure, reward discrimination, reward bundling, interval schedules of reinforcement, and impulse control training in enhancing self-control (Smith et al., 2019). These approaches could be applied in future intervention practices focusing on teacher-student relationships and trait self-control.

The present study focuses on gaming disorder; however, its findings may have implications for other types of addictive behaviors as well. Various addictive behaviors, such as social media addiction, gambling addiction, and pornography addiction, can all be influenced by a combination of family, school, peer, and individual factors. Therefore, it is crucial to analyze and intervene in diverse addictive behaviors by considering the complex interaction between the individual and environmental factors that influence them. Furthermore, while our study is primarily focused on left-behind children in China, its findings also have implications for the psychological well-being of children in other developing and even developed countries. Similar to China, several developing nations have a significant population of left-behind children residing in rural areas. Additionally, in some developed countries, children from single-parent families or households where parents work long hours in high-stress jobs may also experience neglect and face increased risks of gaming disorder and depression. Hence, future researchers could examine the intricate interactions among family, school, and individual factors across different cultures to facilitate interventions that align with the unique characteristics of each country and region.

The present study has several limitations. Firstly, the self-reported data and the cross-sectional questionnaire design were insufficient to establish a strict causal relationship between variables. Future research could utilize a longitudinal tracking design to more rigorously confirm the impact of family, school, and personality factors on adolescent gaming disorder and depression. Secondly, this study focused on only one type of problematic mobile phone use and did not compare different types of problematic mobile phone use. There are many types of adolescent problematic mobile phone use, and some researchers have also emphasized the problems of mobile social addiction (H. E. Kwon et al., 2016) and short-form video addiction (Zhang et al., 2019). Future research can test whether different types of problematic mobile phone use play different roles in predicting adolescent depression and whether the interaction effects of family, school, and personality on different types of problematic mobile phone use of left-behind adolescents are different. Third, this study was conducted during the COVID-19 pandemic, which may have had an impact on the research outcomes. Although China had made substantial progress in controlling the pandemic during that period and the effects of the COVID-19 pandemic on rural areas where we conducted our study were comparatively limited, it is possible that the long-term effects of the pandemic on psychological and behavioral factors such as depression and problematic mobile phone use persist. In future research, we will conduct follow-up studies to compare problematic mobile phone use and depression among left-behind children during and post-pandemic, thereby enhancing understanding of the association between these two factors.

Conclusion

In the present study, we found that parental neglect was positively associated with gaming disorder, which in turn was positively associated with depression. Teacher-student relationships and trait self-control can independently and jointly decrease the predictive effect of parental neglect on gaming disorder and the mediating effect of gaming disorder. The moderating role of teacher-student relationships in the mediation of gaming disorder was stronger for left-behind adolescents with lower trait self-control. The moderating role of trait self-control in the mediation of gaming disorder was stronger for left-behind adolescents with lower teacher-student relationships. The present study is one of the first to examine the unique and combined roles of parental neglect, teacher-student relationships and trait self-control in explaining adolescent gaming disorder and depression. The findings of the proposed integration model can provide practical implications with more ecological validity.

Conflict of Interest

The authors have no conflicts of interest to declare.

Authors' Contribution

Qingqi Liu: conceptualization, methodology, investigation, data curation, formal analysis, writing—original draft. **Jingjing Li:** resources, investigation, writing—review & editing. **Xiaoshi Jin:** investigation, writing—review & editing.

Acknowledgement

We would like to thank all the adolescents who participated in the study.

All authors contributed to the article and approved the submitted version.

This work was supported by the Program of the Fund of Philosophy and Social Science of Guangdong Province (No. GD20CXL05).

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Appendix

Mobile Game Addiction Subscale

Please rate the extent to which the following statements fit your actual situation. The applicability rating scale is:
1 = *Never*
2 = *Rarely*
3 = *Occasionally*
4 = *Often*
5 = *Always*

1. *I think the amount of time I spend playing mobile games each day is too short.*
2. *My family or friends complain that I spend too much time playing mobile games.*
3. *I get irritable when I can't play mobile games for a period of time.*
4. *When I quit the mobile game, I feel very lost and unhappy.*
5. *When I'm depressed, I pick up my phone and play games.*
6. *My relationship with my family has suffered because I'm addicted to mobile gaming.*

Depression Subscale of the Depression-Anxiety-Stress Scale (DASS-21)

Please read each statement and circle a number 0, 1, 2, or 3 to indicate how much the statement applied to you over the past week. There are no right or wrong answers. Do not spend too much time on any statement.
The applicability rating scale is:
0 = *Did not apply to me at all*
1 = *Applied to me to some degree or some of the time*
2 = *Applied to me to a considerable degree or a good part of the time*
3 = *Applied to me very much or most of the time*

1. *I couldn't seem to experience any positive at all.*
2. *I found it difficult to work up the initiative to do things.*
3. *I felt that I had nothing to look forward to.*
4. *I felt downhearted and blue.*
5. *I was unable to become enthusiastic about anything.*
6. *I felt I wasn't worth much as a person.*
7. *I felt that life was meaningless.*

Parental Neglect Subscale

Please report on neglect experiences that occurred in the past 12 months. The applicability rating scale is:
1 = *Never*
2 = *1–2 times*
3 = *3–5 times*
4 = *6–9 times*
5 = *More than 10 times*

1. *My parents left me alone, even though I had to stay with them*.
2. *My parents didn't give me a meal on time*.
3. *My parents didn't take me to the hospital when I needed treatment*.
4. *My parents didn't care for me because drank alcohol or drugs*.

Teacher-Student Relationship Subscale

Please read each statement and mark the response that best shows how much you agree. The applicability rating scale is:
1 = *Strongly disagree*
2 = *Disagree*
3 = *Agree*
4 = *Strongly agree*

1. *Teachers care about their students*.
2. *Teachers listen to students when they have problems*.
3. *Adults who work here care about the students*.
4. *Teachers like their students*.
5. *Students like their teachers*.

Brief Self-Control Scale

Using the scale provided, please indicate how much each of the following statements reflects how you typically are. Items were rated on a 5-point scale, anchored from 1 *not at all like me* to 5 *very much like me.*

1. *I am good at resisting temptation.*
2. *I have a hard time breaking bad habits.*
3. *I am lazy.*
4. *I say inappropriate things.*
5. *I do certain things that are bad for me, if they are fun.*
6. *I refuse things that are bad for me.*
7. *I wish I had more self-discipline.*
8. *People would say that I have iron self-discipline.*
9. *Pleasure and fun sometimes keep me from getting work done.*
10. *I have trouble concentrating.*
11. *I am able to work effectively toward long-term goals.*
12. *Sometimes I can't stop myself from doing something, even if I know it is wrong.*
13. *I often act without thinking through all the alternatives.*

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