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Relationships between Internet Addiction, Self-Control, and Depression among Chinese Adolescents under Confucian Culture: A Cross-Lagged Panel Analysis

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ABSTRACT: Background: Internet addiction and depression are important mental health concerns among adolescents. Although prior research has examined their bidirectional relationship, the underlying mechanisms remain unclear. Drawing on conservation of resources theory, this study examined their bidirectional relationship and tested the mediating role of self-control, with attention to gender differences. **Methods:** A two-wave longitudinal survey (T1: November 2021; T2: May 2022) was conducted in China among 1908 adolescents (1026 females, 882 males; mean age = 13.546, SD = 1.463). At both waves, participants completed self-report measures of internet addiction, self-control, and depression (using the Internet Addiction Scale, Self-Control Scale, and CES-D). **Results:** The cross-lagged model revealed a bidirectional positive association between internet addiction and depression ($\beta = 0.088, p < 0.001$; $\beta = 0.082, p < 0.001$). Although effect sizes were modest, their cumulative effects may be clinically meaningful. The mediation analysis revealed bidirectional indirect effects through self-control. T1 internet addiction indirectly predicted T2 depression through self-control (indirect effect = 0.009, 95% CI [0.003, 0.014]), and T1 depression indirectly predicted T2 internet addiction through self-control (indirect effect = 0.016, 95% CI [0.009, 0.025]). These findings highlight self-control as a key linking mechanism. In addition, the negative effect of T1 internet addiction on T2 self-control was stronger in males than in females ($\beta = -0.156, p < 0.001$; $\beta = -0.049, p = 0.014$; Wald $\chi^2 = 4.903, p = 0.027$). **Conclusions:** Internet addiction and depression show a bidirectional predictive relationship, and reduced self-control serves as the underlying mechanism sustaining this cycle. Males show greater depletion of self-control resources following internet addiction than females.

KEYWORDS: Internet addiction; depression; self-control; Chinese adolescents; cross-lagged analysis

1 Introduction

In recent years, internet addiction has become an increasingly prominent mental health concern among Chinese adolescents [1]. Internet addiction refers to the loss of control over internet usage by an individual without the influence of addictive substances [2,3], often culminating in deleterious effects on an adolescent's physiological and psychological well-being [4]. Depression is a mental health issue marked by a prolonged sense of sadness and a diminished interest in activities once found enjoyable [5]. A systematic review indicates that depression exhibits a stronger correlation with internet addiction compared

to other mental health problems [4]. Both internet addiction and depression can disrupt adolescents' daily functioning and may compromise later social adaptation [6]. Accordingly, it is imperative to clarify the bidirectional pathways connecting internet addiction and depression within the Chinese adolescent context.

While the reciprocal relationship between internet addiction and depressive states has been documented in previous studies [6–8], the mechanisms underlying their interaction remain insufficiently understood. Accordingly, the current research utilizes the COR framework to probe the bidirectional relationship between internet addiction and depression among Chinese adolescents. Specifically, it evaluates the mediating function of self-control and tests for gender differences across these pathways. In doing so, the present study seeks to provide both theoretical and empirical evidence to inform efforts to promote adolescents' well-being.

1.1 Internet Addiction and Depression

In the light of the COR theory, resources are defined as valued factors that facilitate goal attainment [9]. For Chinese adolescents, completing academic tasks is an important developmental goal [10]. Resources such as attentional resources (the capacity to allocate and sustain attention on academic tasks while inhibiting impulsive behaviors such as excessive internet use), emotional regulation resources (the capacity to identify, understand, and manage negative emotions to cope with academic stress), and social support (interpersonal resources that buffer and alleviate negative emotions) all constitute crucial resources that aid in achieving goals [9]. The COR theory underscores that individuals must continually invest and allocate finite resources to pursue goals and cope with stress, and that resource depletion can elicit maladaptive defensive responses [9,11]. From this theoretical perspective, the information overload and withdrawal symptoms associated with internet addiction can be conceptualized as maladaptive responses that continuously consume attentional resources [12]. Consequently, adolescents' psychological resources may be progressively depleted. Academic engagement and daily functioning may be compromised, increasing the risk of depression [13]. Conversely, depression can be conceptualized as a persistent state of negative emotional strain [5]. Under depressive conditions, individuals often must expend emotional regulation resources to maintain emotional and behavioral regulation [9]. At the same time, depression may reduce motivation and opportunities to participate in offline activities, which limits access to social support resource replenishment in offline contexts [5]. When replenishment is limited, individuals may be more likely to seek compensation via relatively low-cost online activities [14]. However, offline contexts are generally more conducive to accumulating and restoring social support, emotional regulation, and other psychological resources than online environments [15]. Accordingly, adolescents with higher levels of depression may experience ongoing resource consumption while struggling to replenish resources effectively, rendering them more likely to rely on the immediate pleasure and short-term relief afforded by internet use and, in turn, increasing the potential risk of internet addiction. Moreover, several studies have demonstrated that depressed adolescents are at an increased risk of developing internet addiction [16,17]. Taken together, internet addiction and depression may mutually reinforce each other through a process of resource depletion coupled with constrained replenishment, gradually developing into a sustained resource-loss spiral and manifesting as reciprocal cross-lagged associations over time.

Existing research on the bidirectional relationship between internet addiction and depression yields inconsistent findings: a study of 1047 Chinese adolescents found evidence of a bidirectional association [6], whereas a study of 663 Dutch adolescents did not detect a significant bidirectional link [8]. This discrepancy may reflect cultural-context effects. Compared with adolescents in Western countries, Chinese adolescents are profoundly influenced by Confucian culture [18]. Participants were recruited from Shandong Province

in this study, which is the origin for Confucian thought. Within this cultural context, adolescent depression and internet addiction are not only viewed as individual psychological struggles but may also be subject to moral judgment, potentially creating a stronger link between the two [18,19]. Within this cultural framework, adolescent internet addiction is perceived as a failure to meet family expectations, which can make adolescents more susceptible to social criticism and exacerbate negative emotions such as depression [18]. Conversely, predisposed by feelings of shame and stigma, depressed adolescents may prefer anonymous online platforms where diminished social pressure facilitates emotional regulation [19,20]. This behavior can heighten their risk of internet addiction, further strengthening the bidirectional relationship between internet addiction and depression. Therefore, we propose Hypothesis 1 that among Chinese adolescents, internet addiction and depression are linked by a bidirectional relationship.

1.2 Mediating Role of Self-Control

Within the COR theory framework, resources are defined as assets that help individuals obtain valued outcomes and achieve goals [9]. Self-control is conceptualized as both the conscious regulatory capacity for emotions and behaviors and a fundamental psychological resource that sustains self-regulation [21,22]. Drawing on the COR theory, self-control may serve as a key psychological resource that links the bidirectional relationship between internet addiction and depression through persistent self-control depletion and constrained replenishment [9].

On the one hand, internet addiction may increase the risk of depression through the mediating role of self-control. A previous study has indicated that sustained regulatory demands can temporarily deplete self-control resources [22]. Because recurrent failures of behavioral inhibition characterize internet addiction, it may chronically drain self-control resources and ultimately lead to resource exhaustion [23]. In adolescents, depleted self-control resources may manifest in two primary ways. First, diminished self-control may undermine effective pursuit of long-term goals (e.g., academic work), increasing the potential risk of depression [13,21]. Second, weakened regulation of negative emotions may intensify persistent emotional distress, raising the likelihood of depression [24]. Moreover, prior research aligns with the foregoing perspective, demonstrating that adolescent internet addiction negatively predicts self-control [25], and that reduced self-control is linked to higher levels of depression among adolescents [26]. In summary, internet addiction may heighten the risk of depression by eroding adolescents' self-control.

On the other hand, depression may also contribute to the development of internet addiction through the mediating role of self-control. Executive dysfunction accounts suggest that depression impairs prefrontal executive functioning, of which self-control is a key behavioral manifestation [27]. Accordingly, adolescents experiencing higher levels of depression may demonstrate diminished self-control, potentially requiring greater effort to accomplish the same regulatory tasks. Moreover, the sustained emotion-regulation demands inherent in depression may further deplete self-control resources and accelerate resource exhaustion [5]. Consequently, adolescents may have insufficient self-control resources to regulate internet use effectively, increasing the potential risk of internet addiction [28]. Consistent with this view, prior research has shown that depression negatively predicts self-control among adolescents and that self-control serves as a mediator of the association between depression and problem behaviors [29]. Moreover, reduced self-control is linked to an increased risk of internet addiction in adolescents [28].

Taken together, drawing on the above analysis and COR theory [9], internet addiction and depression may predict each other longitudinally through the mediating role of self-control. Therefore, we propose Hypothesis 2 that self-control will serve as a mediator in the bidirectional relationship between internet addiction and depression.

1.3 Gender Differences

Prior empirical evidence suggests that the longitudinal nexus between internet addiction and depression may differ by gender: depression may serve as a stronger predictor of subsequent internet addiction among males, whereas internet addiction may more strongly predict subsequent depression among females [7]. However, because the mechanisms behind these differences have not been examined, it remains unclear which psychological processes account for them. In addition, the intermediary function of self-control within the relationship of mobile phone addiction and depression was found to vary across genders in a cross-sectional study. Specifically, self-control has been identified as a pivotal mediator linking mobile phone overuse to exacerbated depression in females, yet this indirect effect was not significant in males [13]. Park and Lee (2022) suggested that this pattern may reflect females' self-control being more readily compromised by maladaptive behaviors and the accompanying social-contextual pressures [13]. Because mobile phone addiction and internet addiction are often conceptualized as related forms of digital addiction with shared features [30], similar gender differences may also be observed in the mediating role of self-control between internet addiction and depression. Accordingly, employing a longitudinal framework, the present study tests Hypothesis 3 that the longitudinal associations among internet addiction, self-control, and depression will differ by gender. Specifically, compared with males, internet addiction among females may more strongly predict subsequent lower self-control, which, in turn, may be more strongly associated with subsequent depression.

1.4 The Present Study

Furthermore, existing cross-sectional studies indicate a strong association among mobile phone addiction, self-control, and depression in adolescents [13]. However, such research has yet to systematically explore the potential bidirectional mechanisms linking these three factors. Drawing on the COR theory [9], a dynamic bidirectional relationship may emerge between internet addiction, self-control, and depression through resource depletion and recovery constraints. Cross-sectional designs inherently limit the ability to discern temporal sequences and dynamic changes among variables, which constrains deeper insights into their interactive dynamics. Therefore, grounded in the COR theory and prior empirical research [9,13], this study employs a cross-lagged panel model (CLPM) to examine the bidirectional relationship between internet addiction and depression among Chinese adolescents, as well as the mediating role of self-control. Additionally, we employ multi-group comparison analyses to determine whether these complex associations are moderated by gender.

2 Methods

2.1 Participants

This study employed a two-wave longitudinal survey. Participants were recruited using a convenience sampling method from adolescent populations at six public middle schools in Shandong, China. The schools were chosen to reflect typical educational environments in regional urban and semi-urban areas. Participants were required to be full-time students currently enrolled in grades seven through eleven. The first survey (T1) was conducted in November 2021, recruiting a total of 2056 adolescents. The second survey (T2) was conducted in May 2022. Over the approximately six-month interval between waves, 148 participants were lost to follow-up, representing an attrition rate of 7.20%. Primary reasons for attrition included school transfers, medical leave, scheduling conflicts due to examinations, and other personal circumstances. Little's missing completely at random (MCAR) test suggested that the data were missing

completely at random ($\chi^2 = 49.493$, $df = 63$, $p = 0.893$). Therefore, missing data were handled using full information maximum likelihood (FIML) [31,32]. Ultimately, 1908 participants were included in the final analytic sample. The sample was distributed across five grades: 289 (15.1%) from seventh grade, 797 (41.8%) from eighth grade, 529 (27.7%) from ninth grade, 85 (4.5%) from tenth grade, and 207 (10.9%) from eleventh grade. The mean age of participants was 13.546 years ($SD = 1.463$).

Before data collection, the principal investigator explained the study purpose to each school principal and obtained permission to conduct the survey. Subsequently, trained researchers and school counselors administered the paper-based questionnaires on a class-by-class basis after providing standardized instructions to students. Upon completion, research assistants provided students with a small token of appreciation for their participation. This study was carried out in compliance with the principles outlined in the Declaration of Helsinki. The study was approved by the Human Research Ethics Committee of the School of Education, Ludong University (Approval No. LDU-ES002602011). Informed consent was obtained from all participants, as well as from their parents or legal guardians.

2.2 Measurement

2.2.1 Internet Addiction

The Chinese revised version of the Internet Addiction Scale developed by Young [2] was used in this study. This scale consists of 8 items (e.g., “You feel you need to spend more time online to feel satisfied”). The scale employs a 5-point Likert scale (1 = “completely disagree,” 5 = “completely agree”). Prior research has reported good reliability and validity for this scale among adolescents [7]. Internet addiction was quantified by calculating the average score across all items, where elevated mean scores reflect more severe levels of addiction. Cronbach’s alpha for the internet addiction measure was 0.873 at T1 and 0.883 at T2. Confirmatory factor analysis [CFA] for the internet addiction measure showed acceptable fit at T1 ($\chi^2/df = 590.497/20$, comparative fit index [CFI] = 0.913, Tucker-Lewis index [TLI] = 0.878, root mean square error of approximation [RMSEA] = 0.123, standardized root mean square residual [SRMR] = 0.047) and T2 ($\chi^2/df = 635.468/20$, CFI = 0.914, TLI = 0.879, RMSEA = 0.127, SRMR = 0.047).

2.2.2 Self-Control

The Self-Control Scale developed by Tangney et al. [21] was used in this study. This scale consists of 19 items (e.g., “I am good at resisting temptation”) and assesses five domains: Impulse control, healthy habits, work/study performance, moderation in entertainment, and resistance to temptation. The scale employs a 5-point Likert scale (1 = “Never,” 5 = “Always”). Prior research has reported good reliability and validity for this scale in middle school samples [33]. Self-control was operationalized as the mean item score. Following the reverse-coding of 15 specific items, higher aggregate scores represent a superior level of self-control. Cronbach’s alpha for the self-control measure was 0.892 at T1 and 0.899 at T2. CFA for the self-control measure showed acceptable fit at T1 ($\chi^2/df = 1876.535/142$, CFI = 0.854, TLI = 0.825, RMSEA = 0.081, SRMR = 0.060) and T2 ($\chi^2/df = 2732.215/142$, CFI = 0.831, TLI = 0.797, RMSEA = 0.098, SRMR = 0.076).

2.2.3 Depression

The Chinese revision of the Center for Epidemiologic Studies Depression Scale (CES-D) developed by Radloff [5] was used in this study. This scale consists of 20 items (e.g., “I feel depressed”). The scale employs a 4-point Likert scale (1 = “rarely or never,” 4 = “most of the time or constantly”). Prior research has reported good reliability and validity of the CES-D among adolescents [6]. Depression was quantified by calculating the average score across all items, with higher resultant values representing a greater frequency

of depression. Cronbach's alpha for the depression measure was 0.917 at T1 and 0.914 at T2. CFA for the depression measure showed acceptable fit at T1 ($\chi^2/df = 1097.668/164$, CFI = 0.940, TLI = 0.931, RMSEA = 0.055, SRMR = 0.033) and T2 ($\chi^2/df = 1107.068/164$, CFI = 0.943, TLI = 0.934, RMSEA = 0.055, SRMR = 0.032).

2.3 Data Analysis

Data analysis was conducted using JASP 0.19.1 (JASP Team, University of Amsterdam, Amsterdam, The Netherlands) and Mplus 8.3 (Muthén & Muthén, Los Angeles, CA, USA) in a sequential analytical procedure. First, common method bias was assessed using Harman's single-factor test in JASP. Second, longitudinal measurement invariance of the key constructs, including internet addiction, self-control, and depression, was established through confirmatory factor analysis in Mplus. Third, baseline relationships among all study variables were examined through descriptive statistics and bivariate correlation analyses conducted in JASP. Fourth, CLPMs were estimated in Mplus to examine the bidirectional relationship between internet addiction and depression, and a Wald test was conducted to examine whether the two paths differed significantly. Fifth, the longitudinal mediating role of self-control in the association between internet addiction and depression was examined in Mplus. To assess the significance of these indirect effects, a bootstrapping procedure involving 5000 iterations was implemented. A Wald test was further conducted to examine whether the indirect effect from internet addiction to depression via self-control differed significantly from the indirect effect from depression to internet addiction via self-control. Finally, multigroup analysis was performed in Mplus to test gender differences in the mediation model, and a chi-square difference test was conducted to compare the unconstrained and constrained models.

3 Results

3.1 Common Method Bias

A common method variance (CMV) assessment indicated that the largest single common factor explained 28.8% of the variance (<50%), suggesting that CMV was not a significant issue in this study [34].

3.2 Longitudinal Measurement Invariance of Internet Addiction, Self-Control, and Depression

A series of longitudinal measurement invariance tests were conducted to determine if the constructs of internet addiction, self-control, and depression preserved their conceptual meaning and measurement properties throughout the six-month study period. Invariance was supported when $\Delta CFI < 0.01$ and $\Delta RMSEA < 0.015$. The results, as shown in Table 1, demonstrated full measurement invariance for all three scales, indicating that the factor structures, loadings, and intercepts were consistent over time.

Table 1: Results of longitudinal measurement invariance tests for each scale across two time points.

Variable	Model	CFI	RMSEA	SRMR	ΔCFI	$\Delta RMSEA$	$\Delta SRMR$
Internet Addiction	Configural Invariance	0.926	0.080	0.041	-	-	-
	Metric Invariance	0.926	0.077	0.042	0.000	0.003	0.001
	Scalar Invariance	0.925	0.075	0.042	0.001	0.002	0.000
Self-Control	Configural Invariance	0.816	0.068	0.068	-	-	-
	Metric Invariance	0.814	0.066	0.071	0.002	0.002	0.003
	Scalar Invariance	0.811	0.065	0.071	0.003	0.001	0.000
Depression	Configural Invariance	0.856	0.061	0.051	-	-	-
	Metric Invariance	0.855	0.060	0.053	0.001	0.001	0.002
	Scalar Invariance	0.845	0.062	0.055	0.010	0.002	0.002

Note: CFI, comparative fit index; RMSEA, root mean square error of approximation; SRMR, standardized root mean square residual.

3.3 Preliminary Analysis

Among the 1908 valid participants, 882 were males (46.2%), and 1026 were females (53.8%). At the initial assessment, participants ranged in age from 11 to 17 years (Mean = 13.546, SD = 1.463), spanning Grades 7 through 11. In subsequent data analysis, participants' gender and age were included in the model as control variables. Gender was determined by asking participants to specify their gender (1 = males, 2 = females), while age was recorded by asking participants their age at T1, which was then treated as a continuous variable.

The means, standard deviations (SDs), and correlation coefficients for all variables are presented in Table 2. The results showed that self-control was negatively correlated with depression and internet addiction at both waves. Internet addiction was positively correlated with depression at both waves.

Table 2: Descriptive statistics and correlation analysis for each variable.

Variables	Mean	SD	1	2	3	4	5	6	7	8
1. Gender	-	-	-							
2. T1 Age	13.546	1.463	0.022	-						
3. T1 Internet Addiction	2.182	0.935	-0.060**	0.051*	-					
4. T2 Internet Addiction	2.157	0.929	-0.017	0.113***	0.681***	-				
5. T1 Self-Control	3.613	0.670	-0.043	-0.079***	-0.630***	-0.540***	-			
6. T2 Self-Control	3.580	0.695	-0.068**	-0.158***	-0.496***	-0.597***	0.668***	-		
7. T1 Depression	1.735	0.579	0.103***	-0.015	0.507***	0.406***	-0.581***	-0.467***	-	
8. T2 Depression	1.664	0.578	0.109***	0.079***	0.409***	0.490***	-0.468***	-0.579***	0.667***	-

Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; SD, standard deviation.

3.4 Cross-Lagged Panel Model for Internet Addiction and Depression

First, we examined the bidirectional relationship between internet addiction and depression using a CLPM. After controlling for gender and age, the model showed acceptable fit ($\chi^2 = 59.76$, $df = 4$, CFI = 0.978, TLI = 0.950, RMSEA = 0.085, SRMR = 0.031). The results showed that (see Fig. 1) T1 internet addiction significantly positively predicted T2 depression ($\beta = 0.088$, $p < 0.001$), and T1 depression significantly positively predicted T2 internet addiction ($\beta = 0.082$, $p < 0.001$). A Wald test further showed that the predictive magnitudes of these two reciprocal pathways did not differ significantly from one another (Wald $\chi^2 = 0.034$, $p = 0.853$).

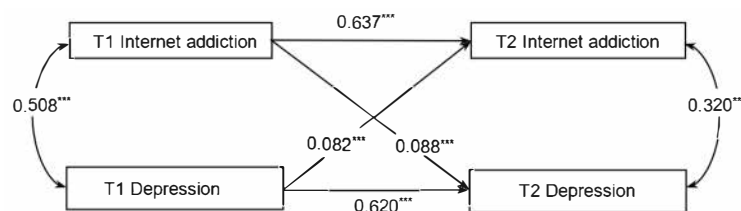


Figure 1: Cross-lagged panel model between internet addiction and depression. Note: *** $p < 0.001$; The numbers in the figure represent β s.

3.5 Cross-Lagged Panel Model for Internet Addiction, Self-Control, and Depression

Subsequently, after controlling for the adolescents' gender and age, a mediation model was constructed to validate the mediating effects of self-control. The results, as shown in Fig. 2, showed that the mediation effect model fit acceptably ($\chi^2 = 76.505$, $df = 6$, $p < 0.001$, CFI = 0.983, TLI = 0.949, RMSEA = 0.078, SRMR = 0.029). The results found that T1 internet addiction significantly negatively predicted T2 self-control ($\beta =$

-0.106 , $p < 0.001$). T1 self-control significantly negatively predicted T2 depression ($\beta = -0.082$, $p = 0.001$) and T2 internet addiction ($\beta = -0.164$, $p < 0.001$). T1 depression significantly negatively predicted T2 self-control ($\beta = -0.099$, $p < 0.001$). The path from T1 internet addiction to T2 depression was significant ($\beta = 0.052$, $p = 0.026$), whereas the path from T1 depression to T2 internet addiction was not significant ($\beta = 0.026$, $p = 0.226$).

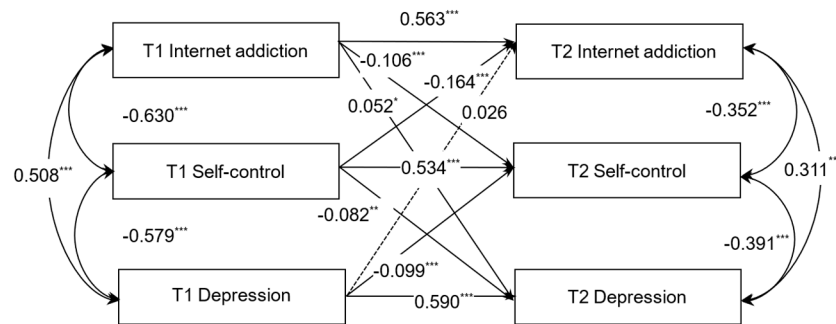


Figure 2: Cross-Lagged Panel Model among Internet addiction, Self-Control, and Depression. Note: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; The numbers in the figure represent β s.

A bootstrap procedure (5000 resamples) was used to test the longitudinal indirect effect of self-control as a mediator in the association between internet addiction and depression. As shown in Table 3, self-control played a mediating role between T1 internet addiction and T2 depression, with a mediating effect size of $-0.106 \times (-0.082) = 0.009$ (95% CI [0.003, 0.014]). Similarly, self-control played a mediating role between T1 depression and T2 internet addiction, with a mediating effect size of $-0.164 \times (-0.099) = 0.016$ (95% CI [0.009, 0.025]). Furthermore, a Wald test was performed to compare these two mediation paths, indicating no significant difference between the magnitude of the two indirect effects (Wald $\chi^2_{(1)} = 1.940$, $p = 0.163$).

Table 3: Mediating effects of self-control between internet addiction and depression.

Path	Effect Size	Bootstrap SE	Bootstrap 95% LLCI	Bootstrap 95% ULCI	Effect Size Proportion
Total effect 1	0.088	0.020	0.048	0.128	
Indirect Effect 1	0.009	0.003	0.003	0.014	0.102
Total effect 2	0.082	0.020	0.043	0.121	
Indirect Effect 2	0.016	0.004	0.009	0.025	0.195

Note: Total effect 1: Internet Addiction $\rightarrow$ Depression; Indirect Effect 1: Internet Addiction $\rightarrow$ Self-control $\rightarrow$ Depression; Total effect 2: Depression $\rightarrow$ Internet Addiction; Indirect Effect 2: Depression $\rightarrow$ Self-control $\rightarrow$ Internet Addiction. Effect size proportion refers to the ratio of the indirect effect to the total effect. SE, standard error; LLCI, lower limit of confidence interval; ULCI, upper limit of confidence interval.

3.6 Gender Differences Test

To further examine gender differences in the associations among internet addiction, self-control, and depression, multigroup analyses were conducted. After controlling for age, both an unconstrained model (where paths were freely estimated) and a constrained model (where paths were set to be equal across genders) were estimated and compared. A chi-square difference test indicated a significant difference between the unconstrained and constrained models ($\Delta\chi^2_{(9)} = 20.006$, $p = 0.032$), suggesting that at least one structural path differed by gender. Follow-up tests indicated that internet addiction significantly predicted lower subsequent self-control in both groups, and the magnitude of this path differed significantly by gender. Specifically, among males, T1 internet addiction significantly predicted lower T2 self-control ($\beta = -0.156$,

$p < 0.001$). Among females, this path was also significant but smaller in magnitude ($\beta = -0.049$, $p = 0.014$). A Wald test indicated that the T1 internet addiction $\rightarrow$ T2 self-control path was stronger for males than for females (Wald $\chi^2_{(1)} = 4.903$, $p = 0.027$).

4 Discussion

4.1 Significant Bidirectional Associations

Consistent with Hypothesis 1, the results demonstrated that internet addiction and depression significantly predicted each other over time, echoing previous longitudinal evidence [6]. According to the COR theory [9], internet addiction and depression may be embedded in a vicious cycle of resource depletion coupled with constrained replenishment. Internet addiction may erode critical resources (e.g., memory and attention) in adolescents [12], and this depletion may increase the likelihood of task failure and intensify negative affect, increasing the risk of depression. Conversely, depression may function as a state of emotional exhaustion that constrains resource replenishment [5]. Adolescents experiencing depression and limited resources may seek compensation through frequent internet use, thereby increasing their risk of developing internet addiction. Our findings indicate that the strength of these cross-lagged paths is statistically equivalent. This pattern suggests that either condition may precipitate the other, thereby maintaining resource depletion over time [9]. Future work should examine both pathways concurrently and clarify the mechanisms through which they mutually reinforce each other to inform strategies to disrupt this cycle.

Notably, these findings differ from those reported by Van den Eijnden et al. [8], who found no evidence of bidirectional prospective associations between internet addiction and depression. This discrepancy may reflect differences in sociocultural context. In their Dutch adolescent sample, online activities largely functioned as an extension of offline peer communication and were embedded within pre-existing face-to-face social networks [8]. Under such circumstances, relatively stable and supportive offline ties may buffer reciprocal reinforcement between negative affect and problematic internet use. This could weaken the bidirectional link between internet addiction and depression, potentially preventing it from reaching statistical significance [8]. In contrast, in China, a society deeply influenced by Confucian culture, adolescent internet addiction is viewed as a serious deviation from family responsibilities, while depression is regarded as a source of shame [18,19]. Both conditions make it difficult to obtain offline social support; instead, they are more likely to trigger negative social evaluations in real-life contexts, reinforcing the bidirectional relationship between them [18,20,35]. Collectively, these patterns suggest that the internet addiction–depression relationship is not invariant. It is shaped by sociocultural norms and should be interpreted within specific cultural contexts.

4.2 Self-Control as a Mediator

The present study found that self-control served as a mediator within the reciprocal relationship between internet addiction and depression, supporting Hypothesis 2. This pattern aligns with and extends the COR theory [9]. Specifically, repetitive and compulsive online behaviors characteristic of internet addiction may deplete self-control resources over time, undermining adolescents' stress tolerance and emotion regulation and, in turn, increasing the risk of depression. Similarly, depression may increase the risk of internet addiction by further constraining the availability of self-control resources. In the internet addiction $\rightarrow$ depression pathway, recurrent inhibitory failures associated with internet addiction may erode self-control capacity. However, internet addiction–related decreases in self-control may intensify reliance on the immediate gratification of online activities, undermine sustained engagement in long-term goals,

increase the risk of academic failure, and make it harder for adolescents to manage academic pressures and regulate negative emotions, thus increasing the likelihood of depression [36]. In the depression → internet addiction pathway, results showed that depression indirectly and positively predicted subsequent internet addiction through the mediator of self-control over time. In particular, higher levels of depression may be associated with impairments in prefrontal executive functioning [27], potentially requiring greater self-control expenditure to complete comparable regulatory tasks. Reduced self-control resources may further compromise behavioral regulation [21], increase dependence on immediately rewarding activities such as online engagement, and increase the potential risk of internet addiction.

It is noteworthy that the direct effect of depression on internet addiction was not significant, whereas the indirect effect was significant. This suggests that the relationship is primarily explained through indirect pathways. This may be attributed to the recent updates in anti-addiction systems, which limit adolescents' online time [1], making it difficult for depressed students to develop internet dependence directly by using the internet to escape reality or seek emotional comfort. Instead, depressed adolescents are more likely to experience depletion of self-control resources, which increases the risk of network dependence and ultimately leads to internet addiction.

4.3 Gender Differences in the Relationship between Internet Addiction, Self-Control, and Depression

This study found that, compared with females, males showed a stronger negative effect of internet addiction on subsequent self-control. This result did not support Hypothesis 3 and diverged from prior findings [13]. Prior research showed that mobile phone addiction was more strongly associated with lower self-control among females [13]. One possible explanation is that this study focused on Korean adolescents, where parenting styles may be stricter toward females [13]. Such dynamics may expose Korean females to greater criticism following problematic mobile phone use, which may be linked to greater self-control impairment. However, gender-differentiated mechanisms observed in Korean samples may not fully generalize to Chinese adolescents.

Among Chinese adolescents, gender differences in the associations among internet addiction, self-control, and depression may reflect differences in motives for internet use. Males may use the internet more for entertainment and escapism, whereas females may use it more for interpersonal communication and information seeking [7]. This pattern aligns with social role theory, which posits that societal expectations of "masculine traits" often compel males to demonstrate greater independence, while females are generally perceived as requiring more care and protection [37]. Consequently, males may be more likely to cope with stress by engaging in solitary and potentially risky online gaming. This coping mechanism may increase the risk of immersive online behaviors and may activate dopamine-driven reward circuits, ultimately undermining self-regulatory capacity and self-control [38]. Concurrently, existing research indicates that parents are more likely to provide proactive supervision of their daughters' online activities than those of their sons [39]. Parents are more likely to restrict their daughters' participation in video games and impose greater protective measures and behavioral limits on their internet use [40]. These differences may partially explain why the association between internet addiction and subsequent decreases in self-control tends to be stronger among males than among females. In summary, gender differences in the associations among internet addiction, self-control, and depression appear to be complex, and further research is warranted to clarify potential moderators and contextual factors.

4.4 Implications for Practice

The current investigation utilized a CLPM to disentangle the reciprocal links between internet addiction and depression, alongside the mediating function of self-control, and potential gender differences. These findings offer several critical implications for psychological intervention. First, the bidirectional association underscores that persistent internet use may not yield the anticipated pleasurable experiences; instead, it may contribute to or exacerbate depression. In turn, adolescents experiencing depression who resort to intensive online entertainment are at a heightened risk of developing maladaptive usage patterns. Accordingly, schools may consider expanding offline activities to strengthen students' offline support networks, reduce their reliance on the internet, and encourage healthier, in-person regulation of negative emotions [41]. Second, the results suggest that self-control is a core internal mechanism through which internet addiction and depression mutually reinforce each other. These two pathologies collectively drain self-control reservoirs and compromise the capacity of an individual to inhibit maladaptive impulses and regulate negative affect. These findings suggest that when individuals' resources are depleted or replenished slowly, providing effective external support (e.g., fostering a supportive school environment and promoting physical activity) may facilitate the restoration of adolescents' self-control resources [42]. Such support may not only facilitate the effective replenishment of adolescents' self-control resources but may also help disrupt the mutually reinforcing cycle between internet addiction and depression. Finally, given that the negative impact of internet addiction on subsequent self-control was more pronounced in males, educators should implement gender responsive intervention strategies with a particular focus on monitoring and mitigating digital addiction risks among male students.

4.5 Potential Limitations and Future Directions

Despite its contributions, the current investigation is subject to several limitations that warrant consideration. First, the participants were recruited from a specific region in China, which may restrict the generalizability of these findings to adolescents in other regions or cultural contexts. To improve the generalizability of the findings and examine potential differences across groups, future research could involve adolescents from various regions in China and diverse cultural backgrounds. Second, although this study discussed the potential influence of Confucian values, it did not empirically measure specific variables related to this cultural framework. Subsequent studies could incorporate validated scales to rigorously quantify the underlying mechanisms through which Confucian culture shapes the interplay between internet addiction and depression. Third, the reliance on self-report measures may have introduced social desirability bias or compromised the objective accuracy of the data. To achieve a more robust profile, future investigations should adopt a multi-informant approach by integrating perspectives from parents and teachers alongside adolescent self-reports. Fourth, the dynamic associations among internet addiction, self-control, and depression were evaluated using a two-wave design with a relatively short follow-up interval. The limited time span may have constrained inference regarding longer-term dynamics among these constructs. Future studies could employ multi-wave longitudinal designs to better characterize the reciprocal and time-varying dynamics among internet addiction, self-control, and depression. Finally, although the mechanisms linking internet addiction and depression are likely multifaceted, this study focused only on self-control as a mediator. Future research should examine additional mediators (e.g., social support, emotion regulation) to clarify the broader set of processes that connect internet addiction and depression.

5 Conclusions

This study found three main conclusions. First, internet addiction and depression predicted each other longitudinally among adolescents, with no significant difference in the magnitude of the cross-lagged effects. Second, self-control served as a mediator in the bidirectional association between internet addiction and depression among adolescents, with no significant difference between the two indirect effects. Finally, gender differences were observed, such that the T1 internet addiction → T2 self-control path was stronger in males than in females.

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