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The relationship between family support and Internet addiction among adolescents in Western China: the chain mediating effect of physical exercise and depression



Yang Liu^{1*†}, Ting Xiao^{1†}, Wei Zhang^{2†}, Lei Xu^{1,3}, Yang Wang⁴ and Tiancheng Zhang¹

Abstract

Objective This investigation was designed to assess the mediating effects of physical exercise and depression on the relationship between family support and Internet addiction (IA) among adolescents in Western China.

Methods A total of 807 adolescents (404 boys and 403 girls, aged 13.80 ± 1.58 years) from Western China completed a self-report questionnaire that measured family support, physical exercise, depression, and IA. We employed SPSS and the Process macro for correlation and mediation analyses.

Results The survey results revealed an inverse association between family support and IA, along with a positive association between family support and physical exercise. IA showed a negative correlation with physical exercise and a positive correlation with depression. Physical exercise was also found to be inversely related to depression. After controlling for age and gender, mediation analysis indicated that physical exercise and depression mediated the relationship between family support and IA in adolescents.

Conclusion This study provides a more profound comprehension of the complex pathways linking family support to adolescent IA. These findings could inform targeted interventions that leverage family support to foster physical activity and mental well-being, thereby mitigating the risk of IA.

Keywords Adolescence, Family support, Internet addiction, Physical exercise, Depression

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Introduction

Internet Addiction (IA), also known as problematic internet use or excessive internet use [1, 2], is a term widely employed due to its striking similarities with behavioral addictions [3, 4], although its classification as a typical behavioral addiction has not been explicitly defined [5]. IA denotes an individual's uncontrollable, excessive, and compulsive engagement with the internet. This compulsive behavior can profoundly affect various facets of an individual's life, including their behavior and social interactions [6, 7]. The prevalence of IA varies across regions and measurement methods. A comprehensive review

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reported a prevalence range of IA from 0.8% to 26.7% [8]. In China, the proportion of adolescents affected by IA is 12.8% [9]. Additionally, it may be hidden in younger age groups [10, 11]. IA manifests in various forms, including social networking, online shopping, and online gaming [12–14]. The widespread use of smartphones enables continuous and convenient Internet access anytime and anywhere [15, 16], further contributing to the global escalation of IA rates. It is crucial to recognize that IA has detrimental effects on individual health, including sleep quality, emotional well-being, and academic performance [17–19, 85, 86]. Consequently, addressing adolescent IA represents an important social concern.

Family support and internet addiction

Adolescents often encounter various pressures, such as peer pressure [20, 21]. Under these pressures, adolescents may turn to the online world as an escape [22]. Therefore, support from the external world plays a crucial role in alleviating these negative pressures [23, 24]. Family support refers to the feeling of being helped and supported by one's family [25]. According to social control theory [26] and social compensation theory [27], the development of adolescent IA can be explained. Moreover, there is a strong negative correlation between family support and IA [28, 87]. Furthermore, other studies have also identified family support as a negative predictor of adolescent IA [29], with divorced families exhibiting higher prevalence of adolescent IA compared to non-divorced families [30]. Notably, a study utilizing family group psychological intervention reported significantly lower IA scores among adolescents in the experimental group than in the control group [31]. Based on the collective findings of these studies, it can be hypothesized that there is a negative correlation between family support and IA (H1).

Mediating effect of physical exercise

Physical exercise is commonly defined as any physical movement performed by skeletal muscles that requires energy expenditure [32]. Studies have found that physical exercise can reduce the effects of adverse environments on sleep [33]. A study conducted in Spain revealed a significant negative association between family support and adolescent screen time, as well as a positive association with moderate physical activity [34]. Another longitudinal study found that higher family support during early adolescence could mitigate the decline in physical exercise during later years [35]. Additionally, family support emerged as the most influential and consistent factor affecting moderate-to-vigorous physical activity (MVPA) in adolescents, according to another study [36]. Social adaptation theory posits that individuals adapt psychologically, physiologically, and behaviorally to achieve societal harmony, thus improving their survival prospects [37]. A body of research has explored the correlation between physical exercise and IA [38-40, 88, 89]. It has been observed that active adolescents have lower levels of IA compared to inactive adolescents [41], and physical exercise can alleviate the psychological and physiological issues associated with IA [40, 90, 91]. Additionally, a review study concluded that physical exercise effectively reduces IA [42]. One study further explored the relationship between physical activity and IA in adolescents from western China, revealing a chain mediating model involving anxiety and inhibitory control [43]. Based on the aforementioned research, increased family support is likely to facilitate greater engagement in physical exercise among adolescents, which, in turn, may decrease the prevalence of IA in this population. Consequently, physical exercise may act as a mediating factor in the relationship between family support and IA (H2).

Mediating effect of depression

Family support is posited to alleviate negative emotional states in adolescents, which may consequently lower the prevalence of IA, particularly depression. Recent studies have highlighted that the prevalence of depression in Chinese adolescents surpasses 25% [44], with an astonishing peak of 36.6% during the COVID-19 pandemic [45]. Research indicates that increased levels of family support are linked to decreased levels and occurrences of depression [46], while the inverse relationship has also been observed [47]. Numerous studies have revealed a significant negative correlation between family support and adolescent depression [48, 49]. Family support serves as a protective factor against adolescent depression [50]. Additionally, there exist alternative psychological pathways for reducing depression levels [51]. Moreover, a consistent body of research has demonstrated a significant link between depression and IA [52, 53, 92, 93], with depression acting as a mediating factor that amplifies negative experiences in adolescents, thus increasing their vulnerability to IA [54, 55]. Based on the aforementioned studies, it is suggested that higher levels of family support are related to lower levels of depression in adolescents. Moreover, elevated depression levels are associated with a heightened risk of IA among adolescents. Consequently, it can be inferred that depression potentially mediates the relationship between family support and IA in this population (H3).

The chain mediating effect of physical exercise and depression

Various studies have suggested that physical exercise can help alleviate depression in adolescents [56, 57, 94]. Besides, physical exercise not only helps to mitigate depression symptoms in adolescents but also enhances functional connectivity between brain structures responsible for emotion regulation and hormone levels, leading to further reduction of depression symptoms [58]. Conversely, lower levels of physical activity are associated with a higher likelihood of developing depression [59]. Considering the aforementioned studies, family support may encourage adolescent participation in physical exercise, thereby curbing depression levels and reducing the risk of IA. Therefore, physical exercise and depression could act as mediators between family support and adolescent Internet addiction (H4).

The current study

This study has developed a chain mediation model (see Fig. 1) to investigate the relationship between family support and adolescent IA, as well as the mediating effect of physical exercise and depression. Building on previous research, this study proposes the following hypotheses:

H1: Greater family support is associated with lower levels of IA among adolescents in western China.

H2: Higher levels of family support are linked to greater physical activity and lower IA levels among adolescents in western China.

H3: Stronger family support is associated with reduced depression, which would in turn decrease IA levels among adolescents in western China.

H4: Higher levels of family support are related to increased physical activity, decreased depression, which would in turn decrease IA levels among adolescents in western China.

Methods

Participants and procedure

The study was conducted in the fall 2023 semester by sampling first-year students (N=856) from 3 junior high schools in the western region of Hunan Province, China, through convenience sampling. The study was approved by the ethics committee of the authors' university before initiation. The participants volunteered and participated free of charge. Prior to questionnaire distribution,

the tester informed participants about the survey's general content, including anonymity, confidentiality, and the general location of the survey data. The tester also informed participants that they had the right to withdraw at any time. Of the participants initially sampled, 807 participants (404 boys and 403 girls; 135 only children and 672 non-only children) with a mean age of 13.80 years (SD = 1.58) were included in the final analysis after incomplete and irregular responses were excluded.

To standardize data collection, all researchers received centralized training in advance and supervised the participant filling-out process during the survey in the field. The entire survey was conducted intensively by the students in their classrooms prior to lunch break, with completion taking nearly 30 min. Informed consent was obtained from the school, all participants and their guardians by means of a written letter.

Measures

Family support

The Perceived Social Support Scale, developed by Zimet et al. [60] and sinicized and tested by Huang et al. [61], was used in this study. This study utilized the family support section, consisting of 4 items, to assess the level of family support received by adolescents (e.g., "My family can help me in concrete ways"). Respondents rated each item on a scale from 1 (strongly disagree) to 7 (strongly agree), and the mean of all items was calculated. Higher scores indicated greater levels of family support for the adolescent. The Cronbach's alpha coefficient for the current sample was 0.87.

Internet addition

The Internet Addiction Scale, derived from the Facebook Addiction Questionnaire (FAQ) [62] and validated by Wei Qi [63], was used in this study. This 8-item scale aims to measure the severity of IA among young individuals (e.g., "Using social networking sites distracts me from my studies"). Participants rated each item on a scale



Fig. 1 Hypothesized chain mediating model

ranging from 1 (Strongly disagree) to 5 (Strongly agree), and the mean score of all items was calculated. Higher scores indicated a greater level of IA among the adolescents. The Cronbach's alpha coefficient for the present sample was 0.83.

Physical exercise

The Physical Exercise Scale, originally developed by Hashimoto [64] and translated and validated by Liang et al. [65], was used in this study. This 3-item questionnaire was employed to evaluate the level of physical exercise, encompassing intensity (e.g., "How hard do you do physical exercise"), time, and frequency. Participants rated each item on a 5-point scale, with intensity and frequency ratings ranging from A (1) to E (5), while time was scored from A (0) to E (4). The physical exercise score was calculated as the product of the 3 option scores, that is, physical exercise score = intensity × time × frequency. Higher scores indicated increased levels of physical exercise among adolescents. The Cronbach's alpha coefficient for this measure in the current sample was 0.69.

Depression

The Depression Anxiety Stress Scale (DASS-21), originally developed by Lovibond and Lovibond [66] and subsequently revised and validated by Gong et al. [67], was used in this study. Specifically, the present study utilized the depression section of the DASS-21, comprising 7 items that assessed the severity of adolescent depression (e.g., "I feel like I have nothing to look forward to, you know"). Each item was rated on a 4-point scale, ranging from 1 (Strongly disagree) to 4 (Strongly agree). The average score across all items was calculated to indicate the level of depression experienced by adolescents. Higher scores were indicative of greater depression severity. The Cronbach's alpha coefficient for the current sample was 0.86.

Covariates

In analyzing the results, we took into account the potential impact of demographic factors, specifically gender and age [20], and we controlled for these variables during the analysis process.

Statistical analyses

All statistical analyses were conducted using SPSS 26.0 software. Initially, we explored potential methodological biases associated with self-report questionnaires. Subsequently, we conducted difference analysis to explore differences in the primary variables between genders. Following this, we performed correlation analyses between age and the main variables of interest. Subsequently, data standardization was carried out to prepare for further analysis. To test our hypothesis, we employed the PROCESS macro for in SPSS (model 6) [68], enabling us to examine the chain mediating relationship in our model. Notably, the PROCESS macro plug-in employed model tests with 95% confidence interval (95% CI) estimates based on 5000 Bootstrap resamples. The relationship was considered statistically significant when the 95% CI did not include zero. Moreover, we included gender and age as covariates in the analysis to control for their potential effects.

Results

Common method Bias test

To examine the potential influence of common method bias, Harman's single-factor test was conducted. The analysis revealed that there were 2 factors with eigenvalues greater than 1. Notably, the first factor accounted for 36.34% of the total variance [69] when the principal component factors were not rotated. This percentage was less than the recommended threshold of 40%, indicating that there was no significant evidence of common method bias in this study.

Difference analysis

Table 1 presents the findings, which indicate that there are statistically significant differences in family support (t=2.13, p < 0.05), physical exercise (t=9.47, p < 0.001), depression (t = -5.34, p < 0.001), and adolescent IA (t = -4.97, p < 0.001) between boys and girls. Specifically, the data show that boys receive significantly greater family support and engage in more physical exercise than girls, while they report significantly lower levels of depression and IA compared to girls.

Correlation analysis

The correlations among variables involved in the study are shown in Table 2. Family support was negatively

Table 1 Gender difference analysis

Variables	Family support		Physical exercise		Depression		Internet addiction	
	Mean	sd	Mean	sd	Mean	sd	Mean	sd
Boys	17.85	4.82	36.29	28.99	11.49	4.53	17.52	7.18
Girls	17.14	4.67	19.11	22.12	13.24	4.75	20.03	7.20
t	2.13		9.47		-5.34		-4.97	
р	< 0.05		<0.001		< 0.001		< 0.001	

Table 2 Correlations analysis

Variables	м	SD	1	2	3	4
1 Age	13.80	1.85	-			
2 Family support	14.79	4.76	0.25***	-		
3 Physical exercise	27.71	27.17	-0.11**	0.074*	-	
4 Depression	12.36	4.72	0.19***	-0.30***	-0.21***	-
5 Internet addition	18.77	7.30	0.12***	-0.17***	-0.26***	0.36***

* *p* < 0.05; ** *p* < 0.01; ****p* < 0.001.

Table 3 Chain mediation model test

Outcome variables	Predictive variables	β	SE	t	R ²	F
Internet addiction	Family support	-0.197	0.035	-5.619***	0.082	23.954***
	Gender	0.164	0.034	4.841***		
	Age	0.0.176	0.035	5.042***		
Physical exercise	Family support	0.087	0.034	2.539*	0.123	37.412***
	Gender	-0.315	0.033	-9.508***		
	Age	-0.146	0.034	-4.269***		
Depression	Family support	-0.351	0.033	-10.722***	0.205	51.795***
	Physical exercise	-0.113	0.034	-3.375**		
	Gender	0.133	0.033	3.982***		
	Age	0.268	0.033	8.156***		
Internet addiction	Family support	-0.088	0.036	-2.324*	0.178	34.708***
	Physical exercise	-0.171	0.034	-4.976***		
	Depression	0.275	0.036	7.643***		
	Gender	0.064	0.034	1.867		
	Age	0.073	0.035	2.094*		

*: *p* < 0.05; **: *p* < 0.01; ***: *p* < 0.001

Table 4 Path analysis of chain mediation model

	Effect value	95%CI		Effect ratio
		LLCI	ULCI	
Total effect	-0.197	-0.265	-0.128	
Direct effect	-0.083	-0.153	-0.013	42.13%
Total indirect effect	-0.114	-0.159	-0.075	57.87%
Family support \rightarrow Physical exercise \rightarrow Internet addiction	-0.015	-0.029	-0.003	7.61%
Family support \rightarrow Depression \rightarrow Internet addiction	-0.096	-0.139	-0.062	48.73%
Family support \rightarrow Physical exercise \rightarrow Depression \rightarrow Internet addiction	-0.003	-0.006	-0.001	1.52%

correlated with IA (r = -0.17, p < 0.001), depression (r = -0.30, p < 0.001) and positively correlated with physical exercise (r = 0.074, p < 0.05). IA was negatively correlated with physical exercise (r = -0.26, p < 0.001) and positively correlated with depression (r = 0.36, p < 0.001). Finally, physical exercise was negatively correlated with depression (r = -0.21, p < 0.001).

The chain mediating effect testing

After controlling for covariates, family support was found to have a significant negative impact on adolescent IA (β = -0.197, *SE* = 0.035, *p* < 0.001). Furthermore, during the indirect effect analysis, it was identified that family support remained a significant negative predictor of adolescent IA (β = -0.088, *SE* = 0.036, *p* < 0.05). Additional indirect effects showed that family support could predict an increase in physical exercise (β = 0.087, *SE* = 0.034, p < 0.05), which, in turn, could lead to a decrease in IA ($\beta = -0.171$, SE = 0.034, p < 0.001). It was also observed that family support negatively predicted adolescent depression ($\beta = -0.351$, SE = 0.033, p < 0.001), while depression positively predicted adolescent IA ($\beta = 0.275$, SE = 0.036, p < 0.001). Finally, physical activity negatively predicted adolescent depression ($\beta = -0.113$, SE = 0.034, p < 0.01). depression positively predicted adolescent IA (see Table 3). The mediating effects of family support and IA in adolescents are analyzed in Table 4; Fig. 2.

Discussion

The objective of this study is to elucidate the association between family support and IA among adolescents, while also examining potential mediating factors, namely physical exercise and depression. Our findings indicate a robust negative correlation between family support and



Fig. 2 The chain mediation model

adolescent IA, a relationship that persists with significance both before and after accounting for the mediating variables. This research delves into the underlying mechanisms through which family support impacts adolescent IA, specifically through behavioral (engagement in physical exercise) and emotional (levels of depression) pathways. By doing so, it contributes to the existing literature on the interplay between family dynamics and the emergence of negative behaviors in adolescents.

The relationship between family support and internet addiction among adolescents

The findings of this study support our H1 hypothesis, indicating that family support is negatively associated with adolescent IA. This suggests that adolescents who experience greater levels of family support are less likely to develop IA. This conclusion aligns with previous research studies [48, 49], thereby reinforcing the credibility of our conclusions. Enhanced family support is likely to boost adolescents' self-esteem and alleviate their loneliness [70, 95, 96], which in turn may reduce their risk of developing IA. Thus, it is crucial to provide adequate family support to adolescents to prevent the onset of IA. To summarize, our study supports the hypothesis that greater levels of family support are associated with a reduced likelihood of adolescent IA.

The mediating role of physical exercise

The finding of a significant positive association between family support and adolescent physical activity is supported by previous research [35, 36]. Parents and other family members not only encourage adolescents to engage in physical activity [71, 72], but also play a role in fostering possible involvement [73]. A longitudinal investigation spanning five years, focusing on the relationship between family support and exercise in adolescents, further validates these findings [74]. Therefore, it can be inferred that higher levels of family support are associated with increased physical exercise among adolescents. Furthermore, our study revealed a significant inverse association between physical activity and adolescent IA, which is consistent with evidence from similar studies [75, 76]. This suggests that adolescents with higher levels of physical activity are less likely to experience IA. In conclusion, family support plays a crucial role in promoting higher levels of physical activity among adolescents, consequently reducing the occurrence of IA.

The mediating role of depression

Consistent with previous research studies, family support has been found to be significantly negatively associated with adolescent depression [50, 51, 77]. Research shows that both internal and external family support [51] and parental social support [77] can significantly negatively predict adolescents' depression. Thus, higher levels of family support are associated with lower levels of adolescent depression. Additionally, our study demonstrates a significant positive association between depression and IA among adolescents, which is consistent with previous research findings [53, 54] and corroborated by a casecontrol study [78]. Therefore, adolescents with lower levels of depression may be less prone to developing IA. In conclusion, family support may serve as a buffer against adolescent depression, which in turn reduces the likelihood of IA.

The chain mediating effect of physical exercise and depression

In addition to the aforementioned findings, the current study established a significant inverse association between physical exercise and adolescent depression, consistent with previous research [79]. Prior studies have demonstrated that physical exercise significantly reduces subjective depression scores among adolescents with IA [80, 81]. Consequently, physically active adolescents may experience reduced levels of depression. To summarize, engaging in physical exercise may mitigate the development of depression in adolescents, thus reducing the occurrence of IA.

Implications and future directions

This study offers substantial evidence that family support is a key determinant in lessening the incidence of IA among adolescents, with physical exercise and depression confirmed as pivotal mediators. The findings emphasize the critical need to cultivate a nurturing family setting to decrease IA risk in this demographic. Future interventions should focus on bolstering familial support frameworks, advocating for increased physical activity, and managing depressive symptoms among adolescents. It is also crucial for future research to assess the long-term efficacy of these interventions and to consider how cultural differences in family structures might affect IA. Moreover, we must recognize the additional potential benefits of family support in fostering physical exercise and reducing depression in adolescents. Physical exercise could offer a more positive peer environment for adolescents [82], which is beneficial for their development. Furthermore, alleviating negative emotions beyond depression [97], such as anxiety—a variable closely linked to IA [98]—could provide further insights into preventing IA in young people [83, 84, 99, 100]. These considerations are instrumental in formulating strategies to prevent the onset of IA among adolescents.

Limitations and future research

This study has several limitations. Firstly, the study focused on the western region of Hunan Province, China, which is just one part of the entire western region. Consequently, the findings may have limited generalizability due to variations in economic development levels and ethnic distributions across different regions. Therefore, future research should consider including other western regions in the survey sampling. Secondly, this study primarily adopted a cross-sectional survey design, which restricts the ability to establish causal relationships between variables. To address this limitation, future studies could employ longitudinal research designs or explore alternative methodologies to investigate causal relationships. Lastly, it is important to acknowledge that the questionnaire survey, as the primary measurement tool in this study, may suffer from subjective biases. This introduces potential challenges in interpreting the results. To enhance the credibility of self-reported subjective evaluations, it is recommended to incorporate multi-perspective judgments from sources such as family members, classmates, or teachers.

Conclusion

This study further elucidated the underlying mechanisms linking family support and adolescent IA. Family support was found to have a direct negative predictive effect on IA in adolescents. Additionally, it exerted an indirect negative predictive effect on IA through the mediating factors of physical exercise and depression.

Acknowledgements

Jinyi Peng, Yuanyuan Ma, Yiyi Chen.

Author contributions

Yang Liu12345, Ting Xiao12345, Wei Zhang12345, Lei Xu16, Yang Wang156, Tiancheng Zhang161 Conceptualization; 2 Methodology; 3 Data curation; 4 Writing - Original Draft; 5 Writing - Review & Editing; 6 Funding acquisition.

Funding

Not applicable.

Data availability

The datasets generated and/or analysed during the current study are not publicly available due [our experimental team's policy] but are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the Biomedicine Ethics Committee of Jishou University before the initiation of the project (Grant number: JSDX-2023-0034). And informed consent was obtained from the participants and their guardians before starting the program. We confirm that all the experiment is in accordance with the relevant guidelines and regulations such as the declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

Received: 19 December 2023 / Accepted: 5 May 2025 Published online: 19 May 2025

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