

Chain Mediating Effect of Self-control and Problem Behavior on Depression among Adolescents

Maoming Jiang

Xiamen University

Kai Gao (✉ gaokaiup@163.com)

Shanghai University of Engineering Sciences

Zhengyu Wu

Xiamen University

Peipei Guo

Shanghai University of Engineering Sciences

Research Article

Keywords: Internet addiction, family atmosphere, academic performance, self-control, problem behavior, depressive symptoms, chain mediation

Posted Date: May 20th, 2022

DOI: <https://doi.org/10.21203/rs.3.rs-1663846/v1>

License:   This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Depression has become a prominent psychological problem among young people. The purpose of this study was to investigate the potential relationship between Internet addiction, family climate, academic performance, self-control, behavioral biases and depressive symptoms in adolescents. Based on the survey data of the fifth wave (2017 ~ 2018) and the sixth wave (2019 ~ 2020) of the China Family Panel Studies (CFPS), this study used LISREL8.8 software to analyze 1577 10 ~ 15 data on adolescents. In this study, selected individuals responded to the same depressive symptoms-related questions in both waves of the survey. The study found that Internet addiction had no direct effect on depressive symptoms in adolescents. Family atmosphere was negatively correlated with depressive symptoms. Academic performance was positively associated with depressive symptoms. Mediating effects found that Internet addiction, family climate, and academic performance can indirectly affect depressive symptoms through the independent mediation of behavioral deviations and the chain mediation of self-control and behavioral deviations. This study also found depressive symptoms in adolescents have a certain persistence in time. Based on this study, it is necessary to pay more attention to the depression of adolescents, strengthen the training of self-control, improve the anti-frustration ability and psychological resilience, and reduce the problem behavior of adolescents. It is recommended to try to start from emotional self-regulation to promote the personality health of adolescents.

Background

Depression has become one of the most important psychological problems in today's world (Pooja, 2021) [1]. It can cause people to feel depressed, and reduce their activity and language movements (Smith, 2014) [2]. Studies have shown that depression symptoms are caused by emotional disorder, which leads to physical and mental discomfort in individuals. Specific manifestations include sadness, despair, other emotions, and even suicidal tendencies (Cheung and Dewa, 2007) [3]. According to the results of the World Health Organization survey, at present, about 4.4% of the world's population suffers from depression, and more than 300 million people suffer from depression (WHO, 2017) [4]. Some studies have also found that in recent years, depression has gradually become younger, and there is an increasing number that young people suffering from depression, among which the depression of teenagers is particularly prominent (Servn-Mori et al., 2020) [5]. Adolescents suffering from depression not only affect their physical and mental development but also destroy family harmony, which is not conducive to social harmony and stability. Therefore, it is particularly important to explore the mechanism, possible influencing factors, and development path of adolescent depressive symptoms.

Internet addiction refers to the state that individuals overuse the Internet and even become addicted, which leads to personal psychological barriers and affects their normal life (Davis, 2001) [6]. A large number of studies show that Internet addiction is closely related to depression, and the Internet addiction rate of depressed people is significantly higher than that of normal people (Li et al., 2019) [7]. Studies have found that, Depressed patients with pessimism and anxiety generally have a low willingness to participate in social activities, while the social mode of virtual space can effectively avoid the friction and

harm when people face to face with each other. More depressed people are more inclined to socialize online. Based on the substitution of online socialization, depressed individuals are also more prone to internet addiction (Kraut et al., 1998; Scott et al., 2009) [8–9], meanwhile, Depressed people will regulate their emotions through online media such as online shopping, watching videos and playing games (Kim et al., 2017) [10]. Secondly, some studies have found that Internet addiction is an important factor affecting depression. Long-term Internet use will reduce the communication between relatives and friends, reduce personal social adaptation, and fail to get enough social support. Leading to depression (Liang et al., 2016) [11]. In addition, there is also a scholar who believes that there is no direct correlation between depression and Internet addiction. Although depressed patients can compensate for individual interpersonal communication by using the Internet, it also reduces offline interaction (Anderson, 2001; Yao and Zhong, 2014) [12–13]. And they even think that Internet addiction can alleviate the depression of individuals. To some extent, the use of the Internet makes up for the social deficiency of depressed people (Przepiorka et al., 2019) [14]. Although there are many research on Internet addiction and depression, the relationship between them is still worth further exploring.

As the most primitive environment for an individual to grow up in, the family is generally a system unit formed by the interaction between parents and children. In this simple but complex set unit, the influence of the family atmosphere on individuals is self-evident (Mary et al., 2016) [15]. Relevant research shows that adolescent depression is closely related to the family atmosphere (Ribeiro et al., 2016) [16]. The family model theory holds that the better the atmosphere and environment of the family system, the better the family function, the more flexible the psychological quality and behavior of family members, and a bad family atmosphere will also lead to the risk of depression (Robert et al., 2000) [17]. The hopeless theory of depression also reflects that the family atmosphere has a negative effect on individual depression (Abramson et al., 1989) [18]. Teenagers have strong emotional dependence and emotional impulsiveness, and they are a high incidence of depression, and a good family atmosphere is extremely important for teenagers' emotional guidance and the cultivation of their ability to resist setbacks (Alison et al., 1998) [19]. Harmonious family relationships can promote teenagers' sense of social belonging, and positive parent-child interaction can also help teenagers enhance their psychological resilience (Guo, 2018) [20]. However, there is a complex endogenous relationship between adolescents' psychological state, emotional color, and depression. Therefore, it is of great significance to explore the influence path of the family atmosphere on depression.

Based on China's education system, social culture, expectations of parents and teachers, and peer pressure, teenagers are more likely to suffer from depression due to their academic performance (Zhang et al., 2015) [21], many studies have shown that there is a direct correlation between academic performance and depressive symptoms (Verboom et al., 2013; Katherine et al., 2012) [22–23]. Some studies believe that low academic performance is more likely to produce negative emotions (Pomerantz et al., 2002) [24]. In primary and secondary schools, teenagers' lack of academic performance, learning attitude, learning style, etc leads to negative events, and negative feedback from parents, teachers, and classmates, resulting in self-denial psychology, which makes them more prone to depression. On the other hand, Some scholars also believe that teenagers with good academic performance are at greater

risk of depression. The essence of adolescent depression is the lack of self-worth, and losing self-worth is easy to lose self-confidence, thus falling into depression. Teenagers with good academic performance, parents, teachers, and self-expectations are relatively high, and academic achievement becomes the main source of their sense of value. Therefore, Compared to those with poor academic performance, 90% of them are under greater learning pressure, which makes them more vulnerable to the gap, thus increasing the risk of depression (Çelik, 2019) [25]]. Therefore, the relationship between academic performance and depression needs to be further verified.

Adolescents' problem behavior refers to the violation of general social behavior. The external causes of problem behavior mainly include factors such as family environment disorder, bad social environment, and incorrect guidance of values, while the internal causes are main factors such as mismatch between individual physiological development and psychological development, insufficient social adaptability, and frustration tolerance (Markova and Nikitskaya,2014) [26]. problem behavior can be divided into general problem behavior and extreme problem behavior. General problem behavior, such as smoking, drinking, and truancy, has relatively little impact on teenagers themselves and society, while extreme problem behavior, such as suicide caused by depression symptoms and murder caused by paranoid ideation, will cause immeasurable losses (Benda and Corwyn, 1998) [27]. Studies have found that Internet addiction and adolescents with Internet addiction tendency are more likely to have problem behavior (Lin et al., 2020) [28]. In addition, the theory of the "people in situation" perspective finds that the parent-child relationship is an important factor to reduce adolescent behavior (Pavkov et al., 2010; Li, 2016) [29–30]. Therefore, regarding the relationship between adolescents' problem behavior, internet addiction, family atmosphere, academic performance, and depressive symptoms, Further verification is required.

Self-control refers to the process in which individuals control their own behaviors, thoughts, and emotions, and make some corrections to achieve their subjective goals (Inzlicht et al., 2014)[31]. It has been found that the higher the self-control ability, the higher the adjustment ability of an individual's stress ability and emotional response, and the negative behavior can be reduced when negative feedback is received (Glenn, 2000; Finning et al., 2017) [32–33]. At present, more studies have introduced self-control into the field of psychology to improve addiction or aggressive behavior by training self-control ability (Remster, 2014) [34]. Related studies have found that the higher the self-control level of adolescents, the less depressed they are (Jun and Choi, 2013; Yang et al., 2017) [35–36]. At the same time, self-control ability can also play a regulatory role, including reducing external environmental factors such as family conflicts and poor academic performance (Li, 2004; Reisig and Pratt,2011) [37–38].In addition, relevant studies also show that self-control is an important factor affecting problem behavior, and it also plays an important intermediary role in the influence of other factors on problem behavior, such as parent-child relationship and social support (Cho et al., 2017)[39]. In view of this, this study will also explore the mediating role of self-control.

What is the relationship between Internet addiction, family atmosphere, academic performance, and depression among adolescents? Does self-control and problem behavior have mediating effects on adolescent depression? Can adolescents' depression in 2018 affect their depression in 2020? Based on

the existing theoretical basis and literature, the research hypothesis is shown in Fig. 1: H1-1) Internet addiction is positively correlated with adolescent depression; H1-2) Family atmosphere is negatively correlated with adolescent depression; H1-3) Academic performance is positively correlated with adolescent depression; H2) problem behavior has a potential mediating role in the relationship between Internet addiction, family atmosphere, academic performance, and adolescent depression; H3) Self-control plays a potential mediating role in the relationship between Internet addiction, family atmosphere, academic performance, and adolescent depression; H4) problem behavior and self-control have chain mediating effects in the relationship between Internet addiction, family atmosphere, academic performance, and adolescent depression; H5) There are persistent effects in adolescent depression.

< Insert Fig. 1 here >

Materials And Methods

Participants

The data are from China Family Panel Studies, CFPS) in The 5th Wave (2017-2018) and the sixth wave (2019-2020). CFPS is a nationwide, large-scale and multi-disciplinary social follow-up survey project, which mainly covers the subjects of Chinese residents' economic activities, educational achievements, family relationships, family dynamics, health, etc. And that baseline survey was officially carried out in 25 provinces/municipalities/autonomous regions, Finally, 14,960 households and 42,590 individuals were interviewed, which is the permanent tracking object of the CFPS survey and visited every two years. The sample selection of this study is shown in Figure 2. First of all, a total of 37,354 people participated in the 5th Wave survey. According to the characteristics of the research subjects, 34,747 people were selected, and then 1,006 people were selected according to the ID of The 5th Wave and the sixth wave of survey subjects. In addition, After eliminating 7 people with abnormal age and 17 people who didn't go to school in two waves, a final sample of 1577 people was obtained.

< Insert Figure 2 here >

Measures

Internet addiction

Internet addiction is mainly assessed by investigating participants' Internet usage frequency. This study is mainly measured by the following questions. (1) the frequency of using the Internet to socialize; (2) the frequency of using the Internet for entertainment; (3) the Frequency of Internet business activities. Answers are divided into 7 levels (1= never, 2= once every few months; 3= once a month; 4= 2-3 times a month; 5= 1-2 times a week; 6= 3-4 times a week; 7= almost every day). The total score for internet addiction is between 3 and 21 points. The higher the score, the more serious the internet addiction is.

Family atmosphere

The family atmosphere of this study is mainly divided into two parts: parent-child relationship and parent-child interaction. In order to measure the parent-child relationship, this study uses the following questions: "the degree of trust in parents", and the answers include five levels (1= very distrust; 2= distrust; 3= average; 4= Trust; 5= very trusting). To measure parent-child interaction, participants were asked the following questions: "How many times have you talked to your parents in the past month" and "How many times have you had dinner with your family in the past week", the answers include five levels (1= never; 2=1~2 times, 3=3-4 times, 4=5-6 times, 5≥7 times).

Academic performance

The academic performance in the study mainly includes objective academic performance and subjective self-evaluation. The objective academic performance includes the following two questions: "class ranking" and "grade ranking". The question options are divided into five grades (1= the last 24%; 2=51-75%, 3=26-50%, 4=11-25%, 5= the top 10%). Subjective self-evaluation includes: "academic satisfaction" (1= very dissatisfied; 2= dissatisfied, 3= average, 4= satisfied, 5= very satisfied), "How good do you think you are" (1= very not good, 2= not excellent, 3= average, 4= excellent, 5= very excellent) two questions.

Self-control

Since 2012, CFPS has investigated the self-control ability of teenagers aged 10 to 15 in their personal database. This scale mainly consists of 12 items, which are used to evaluate the self-control state of daily behavior. Mainly include: I am always well prepared, I pay attention to details, I like to be organized, I will do things according to my own schedule, I am very careful in my study, I always put things at random, I always mess things up, I always forget to restore them, I do things carefully and thoroughly, I do my homework first and then play, and my homework assignment. I'll start right after "and" I'll clean up when things get messy "twelve questions. Questions 6 (I always put things at random), 7 (I always mess things up) and 8 (I always forget to restore things) are reverse questions, and their answers are scored in reverse before analysis. Each item is rated from 1 to 5, where 1= "strongly disagree", 2= "disagree" and 3= "neither agree nor disagree". 4= "agree", 5= "quite agree". The higher the score, the stronger the self-control ability. The Cronbach alpha coefficient of the self-control scale in this study is 0.871.

Teenagers' problem behavior

In the CFPS2018 Personal Questionnaire, CFPS collected information about adolescent respondents aged 10 to 15 for the first time, including internalizing problem behavior and externalizing problem behavior. In 2018, CFPS adopted a simplified version (Myers et al., 1994) [40] from the Early Childhood Liberal Study in the United States, which contains 14 questions, including 8 internalized questions and 6 externalized questions. Among them, the internalization of adolescent problem behavior is collinear with depression, so this study mainly uses six externalization problems to measure adolescent problem behavior, including quarreling, attention, distraction, homework completion, talkativeness, and fighting. Each entry is rated from 1 to 5, where 1= "completely non-conforming" and 2= "non-conforming", 3= "average", 4=

"relatively consistent" and 5= "completely consistent". The higher the score, the greater the probability of adolescent problem behavior. The Cronbach alpha coefficient of problem behavior in this study is 0.742.

Depressive symptoms

CES-D scale is one of the most widely used scales for measuring depressive symptoms in the world. At present, CES-D is widely used in large-scale international surveys. CES-D scale is not only suitable for adults, but also for teenagers and the elderly. Its measurement contents include depression symptoms such as depression, feeling of worthlessness, despair, loss of appetite, and poor attention (Kohout et al., 1993; Wang et al., 2019; Liu et al., 2020) [41-43]. The original version of the CES-D scale includes 20 questions, but there are also shorter versions, one of which is 11 questions and 8 questions edited by HRS according to the original version (Michelle and Marc, 1999) [44]. This CES-D scale consists of 8 items, which evaluate the depressive symptoms of adolescents in the past week, including 6 positive items: "I feel depressed", "I feel it's hard to do anything", "I feel bad sleep", "I feel lonely", "I feel sad", and "I feel life can't move on". There are two negative entries: I feel happy and I live happily. The answer includes four grades: 1= almost nothing (less than a day); 2= Sometimes (1-2 days); 3= Frequently (3-4 days); 4= Most of the time (5-7 days), reverse questions are negatively scored, and the total score ranges from 8 to 32. The higher the score, the more serious the depressive symptoms are. Cronbach alphas coefficients of the 2018 Depression Scale and the 2020 Depression Scale in this study are 0.752 and 0.812 respectively.

Data analysis

Python3.9, SPSS22, and LISREL8.80 software were used for statistical analysis. Python3.9 was used to combine Wave5 and Wave6 data based on personal ID. SPSS was used to analyze the correlation between variables. Cronbach alpha coefficient was used to evaluate the internal consistency of the scale, and LISREL was used to construct chain structure equation. Frequency was used in counting data, mean and standard behavior was used in measuring data, and the structural equation model is used to test the intermediary effect. Mediation variables are self-control and problem behavior; Independent variables are internet addiction, family atmosphere, and academic performance; Dependent variables are depressive symptoms in 2018 and depressive symptoms in 2020 (Figure 1). When the values of comparison fitting index (CFI), non-normed fitting index (NNFI), incremental fitting index (IFI), and modified goodness of fit index (AGFI) are higher than 0.90, it indicates that the fitting results of the data are good (Bentler, 1990; Hu and Bentler, 1999) [45-46], The approximate root means error (RMSEA) value < 0.05 means "close fit" (Steiger, 1990; Browne and Cudeck, 1992) [47-48]. The critical value (CN) of Hoelter greater than 200 indicates that the model has a good fitting degree (Bollen, 1986) [49].

Results

Descriptive Data

Table 1 shows the main demographic characteristics of the respondents. Among the 1,577 participants, there is little difference in the ratio of males to females. Most of the respondents attend primary schools. Among the Internet addicts, 18.71% use the Internet to socialize almost every day and 19.40% use the Internet for entertainment almost every day. In the family atmosphere, the average score of trust in parents is 4.76(SD=0.62), 55.51% of teenagers have never talked to their parents for nearly a month, while 1.98% of participants have never had dinner with their families for nearly a week; In terms of academic performance, 26.12% and 20.98% of teenagers ranked in the top 10% of classes and grades, respectively. 11.99% of the respondents were very satisfied with their self-study, and 5.08% of teenagers thought they were excellent. The average score for self-control is 42.40(SD=6.79), the average score for problem behavior is 12.59 (SD = 4.00), the average score of depressive symptoms in 2018 was 11.88 (SD = 3.04), and the average score for depressive symptoms in 2020 was 7.64(SD=2.20).

< Insert Table 1 here >

Mediation Analyses

According to the structural equation model, the insignificant path is removed from the initial model by t value ($t < 1.96$) to get the final model. Compared with the initial model, the fitting result is improved to some extent, RMSEA = 0.046, NNFI = 0.90, CFI = 0.90, IFI = 0.90, AGFI = 0.94 and CN = 0.94. The family atmosphere has a significant negative impact on adolescent problem behavior and 18-year depression, and a significant positive impact on self-control. Academic performance has a significant negative effect on adolescent problem behavior and a significant positive effect on self-control and depression. Self-control is directly and negatively related to adolescent problem behavior; problem behavior was positively correlated with depressive symptoms at 18 years. At the same time, 18-year depression symptoms of adolescents are directly and positively correlated with 20-year depression symptoms.

< Insert Table 2 here >

< Insert Figure 3 here >

First of all, Table 3 lists the paths of various factors affecting adolescent depressive symptoms. The study found that Internet addiction has a positive effect on adolescent depression symptoms, with a total effect of 0.02($p < 0.001$), but no direct effect. The family atmosphere has a direct influence on adolescent depression symptoms ($\beta = -1.07, p < 0.001$), and the total effect is -1.25($p < 0.001$); At the same time, we found that academic performance had a significant direct impact on adolescent depression ($\beta = 0.12, p < 0.005$). Due to the influence of intermediary factors, the total effect decreased to 0.03($p < 0.001$). Therefore, hypothesis 1(H1) is partially supported.

< Insert Table 3 here >

Secondly, the results show that adolescent problem behavior has a direct impact on depression symptoms in DP18 ($\beta = 0.37, p < 0.001$) and a negative impact on depression symptoms in DP20, with a total effect of -0.07($p < 0.001$). Self-control has no direct effect on adolescents' depressive symptoms in

DP18, but the total effect is $-0.14(p < 0.001)$, and it has a significant positive effect on adolescents' depressive symptoms in DP20, with the total effect being $0.18(p < 0.001)$. And self-control has a significant negative influence on adolescent problem behavior ($\beta = -0.38, p < 0.001$). In addition, Internet addiction, family atmosphere, and academic performance all have indirect effects on adolescents' 20-year depression symptoms, and the total effects are $-0.60, 0.01, \text{ and } 0.02$, respectively ($p < 0.001$). Therefore, Hypothesis 2, 3, and 4(H2, H3, H4) are supported to some extent.

Finally, the study shows that the depressive symptoms of adolescents are persistent over time, specifically, 18-year depressive symptoms have a significant positive effect on 20-year depressive symptoms, with a total effect of $0.48(p < 0.001)$, which indicates that adolescents suffering from depressive symptoms in 18 years are more likely to suffer from depressive symptoms in 20 years. Therefore, hypothesis 5(H5) is supported.

Discussion

The chain mediation model was used to test the influence of Internet addiction, family atmosphere, and academic performance on adolescent depression. The results showed that Internet addiction had no direct influence on adolescent depression, the family atmosphere had a negative correlation with depressive symptoms, and the academic performance had a positive correlation with depressive symptoms. Intermediary effect discovery, Internet addiction, family atmosphere, academic performance, and depressive symptoms can be influenced by independent mediation of problem behavior and chain mediation of self-control and problem behavior. At the same time, this study also found that the depressive symptoms of adolescents are persistent over time.

Internet addiction can indirectly affect adolescent depressive symptoms.

It is found that the total effect of Internet addiction on adolescent depression is $0.02(p < 0.001)$, which indicates that there is a certain correlation between them. The higher the level of Internet addiction, the higher the adolescent depression. Some studies show that people with high depression levels have high anxiety and low self-confidence in social interaction, and are often reluctant to participate in face-to-face social activities. Spending too much time on the Internet will inevitably reduce their social participation, thus making it impossible to obtain enough social support and emotional comfort (Cao et al., 2020)[50]. At the same time, low social interaction will also reduce the social belonging of teenagers, thus increasing the risk of depression. In addition, some related studies show that when the individual's psychological demands can't be met in face-to-face communication, it will alleviate psychological deficiency through network channels (Pontes, 2017) [51], but the results of this study confirm that virtual network can't make up for the psychological deficiency of teenagers, but will aggravate the level of depression. Therefore, it is suggested that the school joint family should further limit the frequency of teenagers using the Internet, guide teenagers to have a correct view of the Internet, appropriately strengthen social activities, and alleviate their emotional problems.

Family atmosphere can effectively relieve adolescent depressive symptoms.

It is proved that family atmosphere has a reverse effect on adolescents' depression, with a total effect of $-1.25(p<0.001)$ and a direct effect of $-1.07(p<0.001)$. Therefore, it can be seen that the adolescents with a better family atmosphere have a lower risk of depression, which is consistent with the existing research results (Ribeiro et al., 2016) [16]. As a special group, teenagers' personality characteristics are not sound enough, their ability to cope with setbacks is lacking, their self-defense mechanism is not sound enough, their sense of social responsibility is relatively lacking, and they are prone to negative emotions leading to depression (Gunnell et al., 2018) [52]. And adolescence is the key period of life development and values establishment. How to guide teenagers to form the correct outlook on life and values, The formation of sound psychological characteristics and the avoidance of depression can not be separated from a harmonious family atmosphere (Kenan and Aysel, 2012) [53], and at the same time, the family function has a strong constraint on the individual's psychological state and behavior to a certain extent (Edela and Brendan; 2013) [54]. Therefore, we should pay attention to the family environment, create a harmonious family atmosphere and improve the socialization function of the family. Provide a solid support for the growth of teenagers.

Academic performance is an important factor affecting adolescent depression.

Through model verification, the study found that academic performance has a positive effect on adolescent depression, with a direct effect of $0.12(p<0.001)$ and a total effect of $0.03(p<0.001)$. This shows that the better academic performance, the greater the risk of depression, and the intermediary factors can effectively alleviate the influence of academic performance on adolescent depression. The better academic performance, the higher the expectation, When academic achievement is contrary to effort and ideal expectation, self-confidence is more easily impacted, which leads to pessimism and negative emotions (Khan et al., 2022) [55]. Secondly, teenagers' self-regulation ability is relatively lacking, and their psychological resilience is relatively weak. When the learning pressure is too high, and they lose their self-worth, if they are not given psychological counseling in time, they are more likely to go to extremes (Zhu et al., 2021) [56]. In addition, Most Chinese parents have the mentality of "looking forward to their children's success". When their children's academic performance falls short of their expectations, they tend to show irritability, anxiety, and other emotions, which in turn leads to parent-child conflicts and increases the risk of depression among teenagers (Warikoo et al., 2020) [57]. Therefore, it is necessary to strengthen the psychological construction of teenagers, at the same time reduce their learning pressure and establish correct values for teenagers.

Chain Mediating Effect of Self-control and problem behavior

The results show that self-control and problem behavior have a significant chain mediating effect, in which self-control has a significant negative impact on problem behavior and problem behavior has a significant positive impact on adolescent depressive symptoms. First of all, the control and restriction of teenagers' online behavior and frequency can reduce the level of Internet addiction; The control of self-emotion can ease the contradiction between parents and children; The regulation of cognitive activities can also relieve learning pressure and thus reduce adolescent problem behavior. Teenagers with high self-

control can actively adjust their emotions, behaviors, and cognition according to their goals, which can also effectively reduce the risk of depression (Finning et al., 2017) [33]. Secondly, To reduce adolescents' problem behavior, to some extent, it is necessary to enhance their social adaptability and anti-frustration ability, which can effectively relieve depression (Chen and Lien, 2018) [58]. Therefore, it is necessary to strengthen the training of teenagers' self-control ability, so as to improve their internet addiction and aggressive behavior. At the same time, we should focus on teenagers' anti-frustration ability and psychological resilience. Starting from emotional self-regulation, promoting adolescent's personality health.

The persistence of depressive symptoms in adolescents.

This study also found that the depressive symptoms of adolescents persist in time, which is consistent with the previous research results (Lee et al., 2020; Li et al., 2021)[59-60]. That is to say, the depression of teenagers in 2017~2018 will greatly affect the depression in 2019~2020. Therefore, from the perspective of prevention, early detection and early guidance should be made. At the same time, we should choose diversified educational paths, Create an elastic psychological state. Actively respond to the combination of home and school, and take the premise of respecting teenagers' physical and mental development, so that they can establish correct values, outlook on life, and world outlook.

Limitations

Some limitations to this study warrant consideration. First, internet addiction, family atmosphere, academic performance, Self-control, problem behavior, and depression are cross-sectional in the study and can be further validated using longitudinal data in the future. Second, since the information was gathered from the participants in the study, self-report/recall bias may have existed. However, it is not easy to achieve continued participation among cohorts of adolescents in a cohort study, and the sample size should not be ignored. As a result, our findings with acceptable goodness-of-fit indices deserve paying more attention.

Conclusions

The depressive symptoms of adolescents should be paid constant attention, and the depressive symptoms are persistent on the time baseline. The Chain Mediating Effect of Self-control and problem behavior on depression among adolescents, Internet addiction, family atmosphere, and academic performance are important factors affecting depressive symptoms.

Abbreviations

IA: internet addiction; FA: family atmosphere; AP: academic performance; SC: self-control; PB: problem behavior; DP18: depression in 2017-2018; DP20: depression in 2019-2020; CFA: confirmatory factor analysis; M: Mean; SD: Standard behavior; DE: Direct Effect; IE: Indirect Effect; TE: Total Effect; SEM: Structural Equation Modeling.

Declarations

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Author Contributions

Jiang Maomin and Gao Kai designed the study, analyzed results, drafted and revised the manuscript. SNL designed the study, drafted and revised the manuscript. Jiang Maomin and Wu Zhengyu drafted and revised the manuscript. Gao Kai and Guo Peipei analyzed results, and revised the manuscript. Jiang Maomin and Gao Kai acquisition of funding. All authors read and approved the final article.

Funding

This work was supported by the [National Natural Science Foundation of China](#) (grant numbers 72074187) The sponsors of the project had no role in the study design, data collection, data analysis, data interpretation, and writing the manuscript.

Ethics Approval and Consent to Participate

This study was approved by the Ethical Review Committee of Peking University Biomedical(IRB00001052-14010), and all participants signed the informed consent.

Consent for Publication

Not Applicable.

Availability of Data and Materials

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

Acknowledgments

The authors thank all the participants, assistants, and researchers for their contribution to this study. In particular, Thank Peking university China Social Science Research Center (ISSS) provided data (China family panel studies, [CFPS] team for providing the data).

References

1. Pooja, A. C., and Mihir, P. R. (2021). *High-risk health behaviors predict depression among school-going adolescents: the need for integration of mental health with school health program in India. Journal of Community Psychology, ()*, -. doi:10.1002/jcop.22627

2. Smith, K. (2014). *Mental health: A world of depression*. *Nature*, 515(7526), 180–181. doi:10.1038/515180a
3. Cheung, A. H., and Dewa, C. S. (2007). *Mental Health Service Use among Adolescents and Young Adults with Major Depressive Disorder and Suicidality*. *The Canadian Journal of Psychiatry*, 52(4), 228–232. doi:10.1177/070674370705200404
4. World Health Organization WHO (2017). *Depression and Other Common Mental Disorders, Global Health Estimates*. <http://apps.who.int/iris/bitstream/10665/254610/1/WHO-MSD>
5. Servín-Mori, E., Gonzalez-Robledo, L. M., Nigenda, G., Quezada, A. D., González-Robledo, M. C., Rodríguez-Cuevas, F. G. (2020). *Prevalence of Depression and Generalized Anxiety Disorder Among Mexican Indigenous Adolescents and Young Adults: Challenges for Healthcare*. *Child Psychiatry & Human Development*, (), –. doi:10.1007/s10578-020-01001-9
6. Davis, R. A. (2001). *A cognitive-behavioral model of pathological Internet use.*, 17(2), 187–195. doi:10.1016/s0747-5632(00)00041-8
7. Li, G. M., Hou, G. Y., Yang, D., Jian, H., and Wang, W. (2019). *Relationship between anxiety, depression, sex, obesity, and internet addiction in Chinese adolescents: A short-term longitudinal study*. *Addictive Behaviors*, 90(), 421–427. doi:10.1016/j.addbeh.2018.12.009
8. Kraut, R., Patterson, M., Lundmark, V., Kiesler, S., Mukophadhyay, T., and Scherlis, W. (1998). *Internet paradox: A social technology that reduces social involvement and psychological well-being?* *American Psychologist*, 53(9), 1017–1031. doi:10.1037/0003-066X.53.9.1017
9. Scott, C., Dmitri W., and Nick Y. (2009). *Problematic Internet use and psychosocial well-being among MMO players.*, 25(6), 1312–1319. doi:10.1016/j.chb.2009.06.006
10. Kim, D. J., Kim, K., Lee, H., Hong, J., Cho, M. J., Fava, M., Mischoulon, D., Heo, J., and Jeon, H. J. (2017). *Internet Game Addiction, Depression, and Escape from Negative Emotions in Adulthood*. *The Journal of Nervous and Mental Disease*, (), 1–. doi:10.1097/NMD.0000000000000698
11. Liang, L. C., Zhou, D., Yuan, C. Y., Shao, A. H., and Bian, Y. F. (2016). *Gender differences in the relationship between internet addiction and depression: A cross-lagged study in Chinese adolescents*. *Computers in Human Behavior*, 63(), 463–470. doi:10.1016/j.chb.2016.04.043
12. Anderson, K. J. (2001). *Internet Use Among College Students: An Exploratory Study*. *Journal of American College Health*, 50(1), 21–26. doi:10.1080/07448480109595707
13. Yao, M. Z., and Zhong, Z. J. (2014). *Loneliness, social contacts and Internet addiction: A cross-lagged panel study*. *Computers in Human Behavior*, 30(), 164–170. doi:10.1016/j.chb.2013.08.007
14. Przepiorka, A., Blachnio, A., and Cudo, A. (2019). *The role of depression, personality, and future time perspective in internet addiction in adolescents and emerging adults*. *Psychiatry Research*, 272(), 340–348. doi:10.1016/j.psychres.2018.12.086
15. LeCloux, M., Maramaldi, P., Thomas, K., and Wharff, E. (2016). *Family Support and Mental Health Service Use Among Suicidal Adolescents*. *Journal of Child and Family Studies*, 25(8), 2597–2606. doi:10.1007/s10826-016-0417-6

16. Ribeiro, J. D., Franklin, J. C., Fox, K. R., Bentley, K. H., Kleiman, E. M., Chang, B. P., and Nock, M. K. (2016). *Self-injurious thoughts and behaviors as risk factors for future suicide ideation, attempts, and death: a meta-analysis of longitudinal studies*. *Psychological Medicine*, 46(2), 225–236. doi:10.1017/s0033291715001804
17. Robert B., and Robert B. H. (2000). *The Beavers Systems Model of Family Functioning*. , 22(2), 128–143. doi:10.1111/1467-6427.00143
18. Abramson, L. Y., Metalsky, G. I., and Alloy, L. B. (1989). *Hopelessness depression: A theory-based subtype of depression*. *Psychological Review*, 96(2), 358–372. doi:10.1037/0033-295x.96.2.358
19. Alison T., Ian M. G., and Joe H. (1998). *Family functioning and parent general health in families of adolescents with major depressive disorder.*, 48(1), 1–13. doi:10.1016/s0165-0327(97)00105-5
20. Guo, X. M. (2018). *Coping as a Mediator Between Parental Attachment and Resilience: An Examination of Differential Effects Between Chinese Adolescents from Single Parent Families Versus Those from Intact Families*. *Psychological Reports*, (), 003329411876541–. doi:10.1177/0033294118765418
21. Zhang, W. X., Chen, L., Yu, F. J., Wang, S. Q., and Nurmi, J. (2015). *Hopes and Fears for the Future Among Chinese Adolescents*. *Journal of Research on Adolescence*, 25(4), 622–629. doi:10.1111/jora.12166
22. Verboom, C. E., Sijtsema, J. J., Verhulst, F. C., Penninx, B. W. J. H., and Ormel, J. (2013). *Longitudinal Associations Between Depressive Problems, Academic Performance, and Social Functioning in Adolescent Boys and Girls.*, (), –. doi:10.1037/a0032547
23. Katherine, L. D., Phillip T. S., Michael J. L., and John P. K. (2012). *Implementation quality of whole-school mental health promotion and students' academic performance*. , 17(1), 45–51. doi:10.1111/j.1475-3588.2011.00608.x
24. Pomerantz, E. M., Altermatt, E. R., and Saxon, J. L. (2002). *Making the grade but feeling distressed: Gender differences in academic performance and internal distress*. *Journal of Educational Psychology*, 94(2), 396–404. doi:10.1037/0022-0663.94.2.396
25. Çelik, E. (2019). *Stress regarding academic expectations, career exploration, and school attachment: The mediating role of adolescent–parent career congruence*. *Australian Journal of Career Development*, 28(1), 51–60. doi:10.1177/1038416218792314
26. Markova, S., and Nikitskaya, E. (2014). *Coping strategies of adolescents with deviant behaviour*. *International Journal of Adolescence and Youth*, (), 1–11. doi:10.1080/02673843.2013.868363
27. Benda, B. B., and Corwyn, R. F. (1998). *Adolescent problem behavior*. *Journal of Social Service Research*, 24(1-2), 29–59. doi:10.1300/j079v24n01_02
28. Lin, S., Yu, C. F., Chen, J., Sheng, J., Hu, Y. S., and Zhong, L. (2020). *The Association between Parental Psychological Control, Deviant Peer Affiliation, and Internet Gaming Disorder among Chinese Adolescents: A Two-Year Longitudinal Study*. *International Journal of Environmental Research and Public Health*, 17(21), 8197–. doi:10.3390/ijerph17218197

29. Pavkov, T. W., Travis, L., Fox, K. A., King, C. B., and Cross, T. L. (2010). *Tribal youth victimization and delinquency: Analysis of Youth Risk Behavior Surveillance Survey data.. Cultural Diversity and Ethnic Minority Psychology, 16(2), 123–134.* doi:10.1037/a0018664
30. Liu, J.(2016) *Parental Attachment, Peer Connection and Adolescent problem behavior [J]. Youth Exploration, (04):52-58.* DOI: 10.13583/j.cnki.issn1004-3780.2016.04.008.
31. Inzlicht, M., Schmeichel, B. J., and Macrae, C. N. (2014). *Why self-control seems (but may not be) limited. Trends in Cognitive Sciences, 18(3), 127–133.* doi:10.1016/j.tics.2013.12.009
32. Glenn, D. W. (2000). *Behavioral self-control training for problem drinkers: A meta-analysis of randomized control studies. , 31(1), 135–149.* doi:10.1016/s0005-7894(00)80008-8
33. Finning, K., Richards, D. A., Moore, L., Ekers, D., McMillan, D., Farrand, P. A., O'Mahen, H. A., Watkins, E. R., Wright, K. A., Fletcher, E., Rhodes, S., Woodhouse, R., and Wray, F. (2017). *Cost and outcome of behavioural activation versus cognitive behavioural therapy for depression (COBRA): a qualitative process evaluation. BMJ Open, 7(4), e014161–.* doi:10.1136/bmjopen-2016-014161
34. Remster, B. (2014). *Self-Control and the Depression–Delinquency Link. problem behavior, 35(1), 66–84.* doi:10.1080/01639625.2013.822226
35. Jun, M. H., and Choi, J. A. (2013). *The longitudinal effects of parental monitoring and self-control on depression in Korean adolescents: A multivariate latent growth approach. Children and Youth Services Review, 35(9), 1327–1332.* doi:10.1016/j.childyouth.2013.05.004
36. Yang, X. L., Zhao, J. B., Chen, Y., Zu, S. M., and Zhao, J. B. (2017). *Comprehensive self-control training benefits depressed college students: a six-month randomized controlled intervention trial. Journal of Affective Disorders, (), S0165032717303488–.* doi:10.1016/j.jad.2017.10.014
37. Li, S. D. (2004). *the impacts of self-control and social bonds on juvenile delinquency in a national sample of midadolescents. problem behavior, 25(4), 351–373.* doi:10.1080/01639620490441236
38. Reisig, M. D., Pratt, T. C. (2011). *Low Self-Control and Imprudent Behavior Revisited. problem behavior, 32(7), 589–625.* doi:10.1080/01639621003800505
39. Cho, Sujung., Hong, J. S., Sterzing, P. R., and Woo, Y. (2017). *Parental Attachment and Bullying in South Korean Adolescents: Mediating Effects of Low Self-Control, Deviant Peer Associations, and Delinquency. Crime & Delinquency, 63(9), 1168–1188.* doi:10.1177/0011128717714968
40. Myers, N. A., Perris, E. E., and Speaker, C. J. (1994). *Fifty Months of Memory: A Longitudinal Study in Early Childhood. Memory, 2(4), 383–415.* doi:10.1080/09658219408258956
41. Kohout, F. J., Berkman, L. F., Evans, D. A., and Cornoni-Huntley, J. (1993). *Two shorter forms of the CES-D depression symptoms index. J. Aging Health 5, 179–193.* doi: 10.1177/089826439300500202
42. Wang, Z. J., Yang, H. M., Guo, Z., Liu, B., and Geng, S. (2019). *Socio-demographic characteristics and co-occurrence of depressive symptoms with chronic diseases among older adults in China: the China longitudinal ageing social survey. BMC Psychiatry 19:310.* doi: 10.1186/s12888-019-2305-2
43. Liu, Q., He, H., Yang, J., Feng, X., Zhao, F., and Lyu, J. (2020). *Changes in the global burden of depression from 1990 to 2017: findings from the global burden of disease study. J. Psychiatr. Res. 126, 134–140.* doi: 10.1016/j.jpsychires.2019. 08.002

44. Michelle, D., and Marc, A. P. (1999). *Resilience in Adolescents: Protective Role of Social Support, Coping Strategies, Self-Esteem, and Social Activities on Experience of Stress and Depression.* , 28(3), 343–363. doi:10.1023/a:1021637011732
45. Bentler, P. M. (1990). *Comparative fit indexes in structural models.* *Psychol. Bull.* 107, 238–246. doi: 10.1037/0033-2909.107.2.238
46. Hu, L. T., and Bentler, P. M. (1999). *Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives.* *Struct. Equal. Model.* 6, 1–55. doi: 10.1080/10705519909540118
47. Steiger, J. H. (1990). *Structural Model evaluation and modification: an interval estimation approach.* *Multivariate. Behav. Res.* 25, 173–180. doi: 10.1207/s15327906mbr2502_4
48. Browne, M. W., and Cudeck, R. (1992). *Alternative ways of assessing model fit.* *Soc. Methods Res.* 21, 230–258. doi: 10.1177/004912419021002005
49. Bollen, K. (1986). *Sample size and bentler and Bonett's nonnormed fit index.* *Psychometrika* 51, 375–377. doi: 10.1007/BF02294061
50. Cao, R. L., Gao, T. T., Ren, H., Hu, Y. Y., Qin, Z. Y., Liang, L. L., and Mei, S. L. (2020). *The relationship between bullying victimization and depression in adolescents: multiple mediating effects of internet addiction and sleep quality.* *Psychology, Health & Medicine*, (), 1–11. doi:10.1080/13548506.2020.1770814
51. Pontes, H. M. (2017). *Investigating the differential effects of social networking site addiction and Internet gaming disorder on psychological health.* *Journal of Behavioral Addictions*, (), 1–10. doi:10.1556/2006.6.2017.075
52. Gunnell, D., Kidger, J., and Elvidge, H. (2018). *Adolescent mental health in crisis.* *BMJ*, (), k2608–. doi:10.1136/bmj.k2608
53. Kenan, D., and Aysel, K. (2012). *Students' Families and Family Values.* , 47(none), –. doi:10.1016/j.sbspro.2012.06.688
54. Edel, E., and Brendan, P. B. (2013). *Family burden, family health and personal mental health.* , 13(1), 255–. doi:10.1186/1471-2458-13-255
55. Khan, A., Sriyanto, S., Baranovich, D., and Baranovich, E. (2022). *DL. The relationship between positive mental health, academic stress and suicide ideation among Malaysian adolescents residing in Johor Bahru.* *Journal of Current Psychology*, doi:10.1007/s12144-022-02885-7
56. Zhu, X., Haegele, J. A., Liu, H., and Yu, F. (2021). *Academic Stress, Physical Activity, Sleep, and Mental Health among Chinese Adolescents.* *International Journal of Environmental Research and Public Health*, 18(14), 7257. doi:10.3390/ijerph18147257
57. Warikoo, N., Chin, M., Zillmer, N., and Luthar, S. (2020). *The Influence of Parent Expectations and Parent-Child Relationships on Mental Health in Asian American and White American Families.* *Sociological Forum*, (), socf.12583–. doi:10.1111/socf.12583
58. Chen, C. Y., and Lien, Y. J. (2018). *Trajectories of co-occurrence of depressive symptoms and problem behaviors: The influences of perceived social support and personal characteristics.* *Children and*

Youth Services Review, 95(), 174–182. doi:10.1016/j.chidyouth.2018.10.037

59. Lee, S. W., Choi, J. S., and Lee, M. H. (2020). *Life satisfaction and depression in the oldest old: a longitudinal study. Int. J. Aging Hum. Dev. 91, 37–59.*doi: 10.1177/0091415019843448

60. Li, A., Wang, D. W., and Lin, S. N.(2021).*Depression and Life Satisfaction Among Middle-Aged and Older Adults: Mediation Effect of Functional Disability.Frontiers in Psychology.November. 25, 1-12.*doi:10.3389/fpsyg.2021.755220

Tables

Table 1

Descriptive statistics variables of the sample (n=1577)

Variable	n [#]	%	Mean	SD
<u>Control variable</u>				
Sex				
Male	803	50.92		
Female	774	49.08		
Education				
primary school	956	60.62		
junior school	592	37.54		
Technicalsecondary school/high school/higher vocational school or above	29	1.84		
<u>Independent variables</u>				
Internet addiction				
The frequency of using the Internet to socialize				
never	780	49.46		
Once every few months	25	1.59		
Once a month.	17	1.08		
2-3 times a month	57	3.61		
Once or twice a week	192	12.18		
3-4 times a week	211	13.38		
Almost every day	295	18.71		
Frequency of using the Internet for entertainment				
never	673	42.68		
Once every few months	19	1.20		
Once a month.	20	1.27		
2-3 times a month	65	4.12		
Once or twice a week	223	14.14		
3-4 times a week	271	17.18		
Almost every day	306	19.40		
Frequency of Internet business activities				

never	1290	81.80	
Once every few months	61	3.87	
Once a month.	58	3.68	
2-3 times a month	82	5.20	
Once or twice a week	56	3.55	
3-4 times a week	24	1.52	
Almost every day	6	0.38	
Family atmosphere			
Trust in parents [1-5]			4.76 0.62
The number of times parents talk.			
never	872	55.51	
1~2 times	299	19.03	
3-4 times	198	12.60	
5-6 times	103	6.56	
≥7 times	99	6.30	
Number of dinners with family members			
never	31	1.98	
1~2 times	255	16.26	
3-4 times	97	6.19	
5-6 times	49	3.13	
≥7 times	1136	72.45	
Academic performance			
Class rank			
The last 24%	101	7.83	
51-75%	148	11.47	
26-50%	353	27.36	
11-25%	351	27.21	
Top 10%	337	26.12	
Grade ranking			

The last 24%	82	7.61	
51-75%	187	17.36	
26-50%	320	29.71	
11-25%	262	24.33	
Top 10%	226	20.98	
Academic satisfaction			
Very dissatisfied	68	4.31	
Dissatisfied	122	7.74	
common	771	48.92	
be satisfied	426	27.03	
Very satisfied	189	11.99	
Think how good you are.			
Not very good.	62	3.93	
Not good	196	12.44	
common	855	54.25	
excellent	383	24.30	
Very good	80	5.08	
<i><u>Mediating variables</u></i>			
Self-control [12-60]		42.40	6.79
problem behavior [6-30]		12.59	4.00
<i><u>Dependent variable</u></i>			
Depression 2018[8-32]		11.88	3.04
Depression 2020[8-32]		7.64	2.20

The total number < n = 1577 due to missing.

[]:The range of a single item

Table 2

Measures of goodness-off-fit for depression model of the adolescents

Model	Chi-Square	df	RMSEA	NNFI	CFI	IFI	AGFI	CN
Initial model	2508.88	1044	0.046	0.90	0.90	0.90	0.94	309.89
Delete IA→PB	2510.43	1045	0.046	0.90	0.90	0.90	0.94	309.98
Delete GEN→DP18	2511.86	1046	0.046	0.90	0.90	0.90	0.94	310.09
Delete IA→DP18	2512.20	1047	0.046	0.90	0.90	0.90	0.94	310.33
Delete SC→DP18#	2512.53	1048	0.046	0.90	0.90	0.90	0.94	310.57

Note: IA, Internet addiction; PB, problem behavior, GEN, gender, SC, Self-control, DP18, depression in 2017-2018

#The goodness-of-fit of the Final model

Table 3

Direct and indirect effects of depression in adolescents

Variables	DP in 2018			DP in 2020		
	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect	Total effect
<i>Independent variables</i>						
Internet addiction	—	0.02	0.02	—	0.01	0.01
Family Atmosphere	-1.07	-0.18	-1.25	—	-0.60	-0.60
Academic Performance	0.12	-0.09	0.03	—	0.02	0.02
<i>Mediation variables</i>						
Self-control	—	-0.14	-0.14	—	-0.07	-0.07
problem behavior	0.37	—	0.37	—	0.18	0.18

Figures

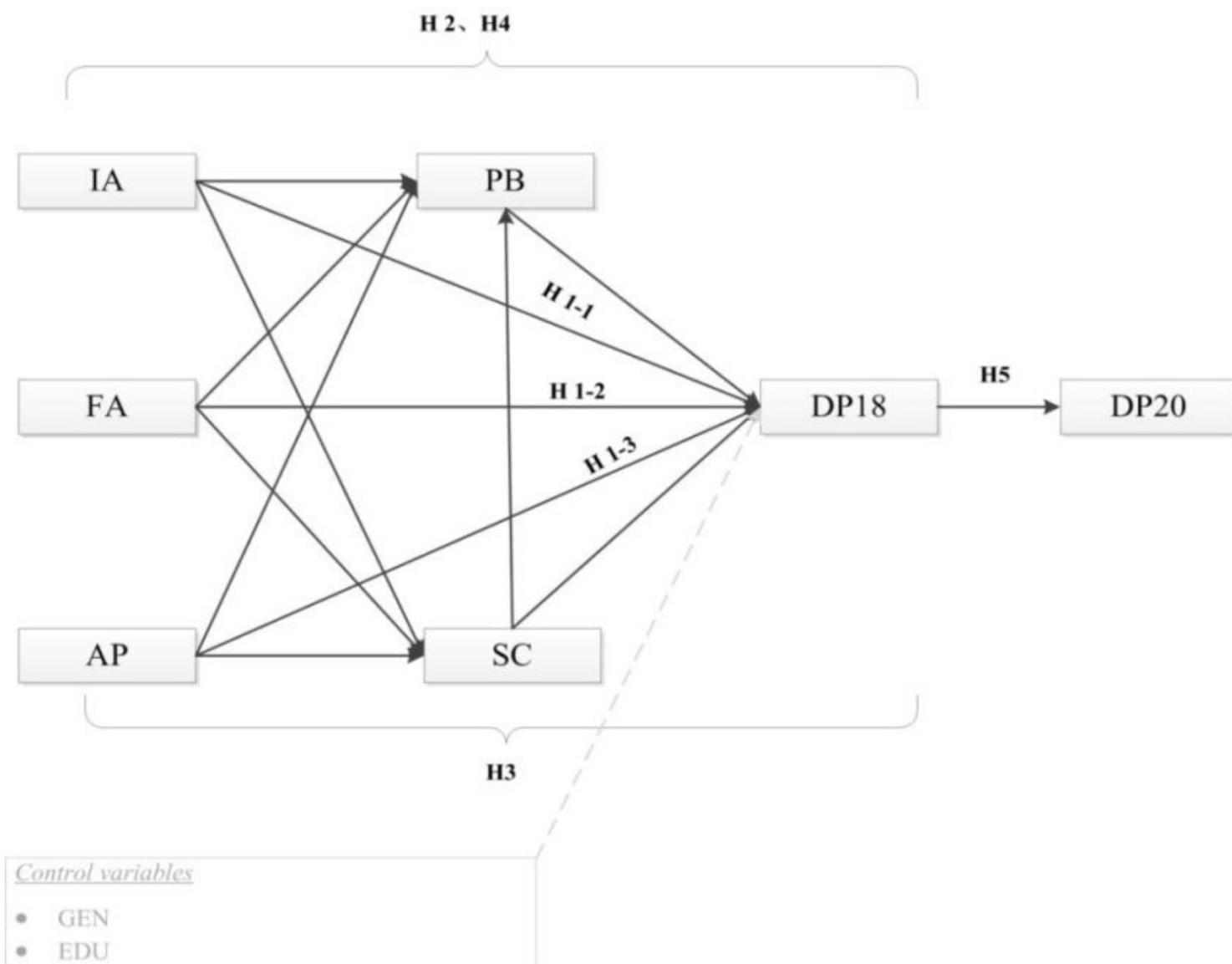


Figure 1

Hypothesized model of the research framework. IA: Internet Addiction; FA: Family Atmosphere; AP: Academic Performance; SC: Self-control; PB: problem behavior; DP18: Depression in 2017-2018; DP20: Depression in 2019-2020; H1-1) Internet addiction is positively correlated with adolescent depression; H1-2) Family atmosphere is negatively correlated with adolescent depression; H1-3) Academic performance is positively correlated with adolescent depression; H2) problem behavior has a potential mediating role in the relationship between Internet addiction, family atmosphere, academic performance, and adolescent depression; H3) Self-control plays a potential mediating role in the relationship between Internet addiction, family atmosphere, academic performance, and adolescent depression; H4) problem behavior and self-control have chain mediating effects in the relationship between Internet addiction, family atmosphere, academic performance, and adolescent depression; H5) There are persistent effects in adolescent depression.

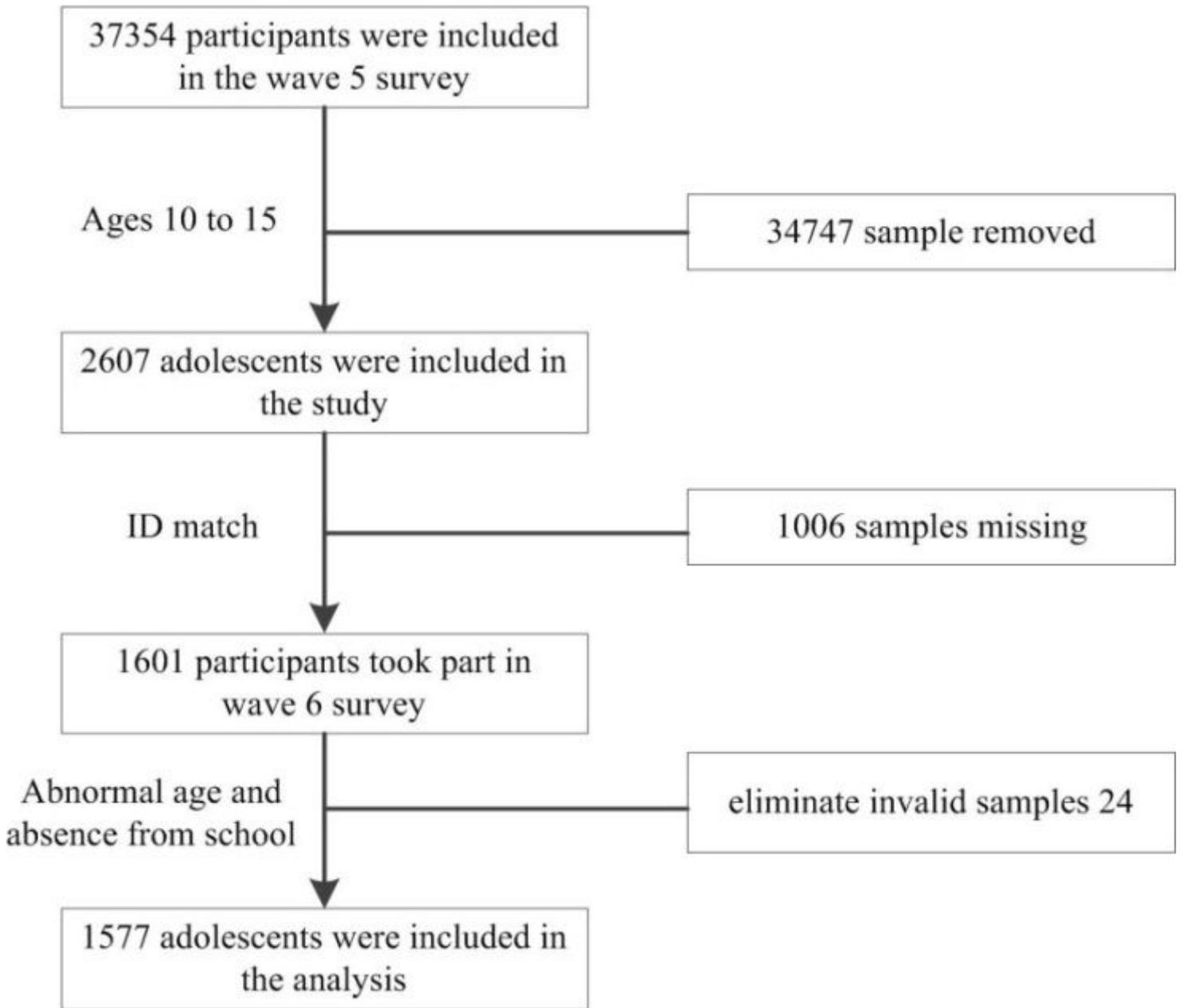


Figure 2

Flow chart of the inclusion and exclusion of participants.

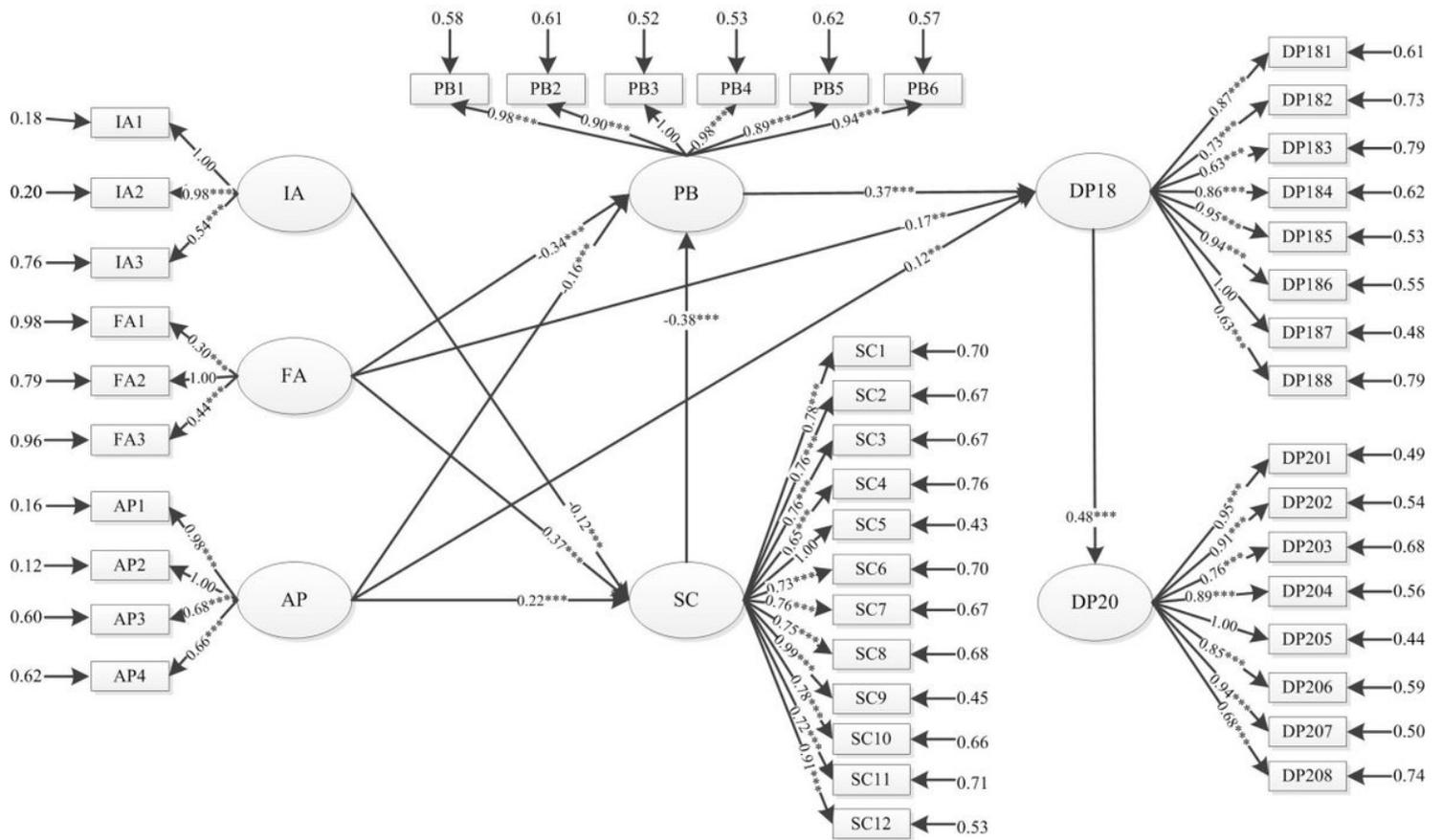


Figure 3

A Chain-mediated model of Self-control and problem behavior on Adolescent depression. IA: Internet Addiction; FA: Family Atmosphere; AP: Academic Performance; SC: Self-control; PB: problem behavior; DP18: Depression in 2017-2018; DP20: Depression in 2019-2020; ** $p < 0.01$, *** $p < 0.001$