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A chain mediation model reveals the association between parental mediation and smartphone addiction of Chinese adolescents

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The family plays an immensely crucial role in the development of adolescents, significantly influencing their behavioral patterns. To explore the impact mechanism of the parental mediation (active mediation, restrictive mediation, and parental monitoring) on adolescents' smartphone addiction, and analyze the chain-mediating role of basic psychological needs and fear of missing out (FoMO). Parental Mediation Scale, Smartphone Addiction Scale, Basic Psychological Needs Scale and Fear of Missing Out Scale were administered to 5,841 adolescents. The sample comprised 2,772 boys (47.46%) and 3,069 girls (52.54%) with an age range of 11.5 to 15.3 years ($M = 13.35$, $SD = 1.29$). The results indicated that active mediation could negatively predict adolescents' smartphone addiction, whereas restrictive mediation and parental monitoring could positively predict adolescents' smartphone addiction; and after controlling for sex and age, basic psychological needs had a separate mediating effect on parental mediation and smartphone addiction. Moreover, this study observed a chained mediating effect between basic psychological needs and FoMO on the relationship between parental mediation and smartphone addiction. Meanwhile, FoMO did not have a mediating effect on the relationship between parental mediation and smartphone addiction. Based on social cognitive theory and self-determination theory, this study innovatively integrates parental mediation, adolescents' basic psychological needs, fear of missing out, and smartphone addiction into a coherent model. More importantly, it separately examines the effects of active mediation, restrictive mediation, and parental monitoring within the same group of participants, allowing for a cross-comparison of the three types of parental mediation in the study. This provides a theoretical reference for reducing adolescents' smartphone addiction.

Keywords Parental mediation, Smartphone addiction, Basic psychological needs, Fear of missing out, Adolescents

Current study

With the development of mobile digital media, smartphones have become the main tool for adolescents to acquire knowledge, exchange ideas, and experience leisure entertainment. According to the fifth edition of the national survey on internet usage among minors, smartphones are the primary internet access device for 97.2% of underage Chinese internet users¹. While smartphone use contributes to adolescents' academic development, interpersonal communication, and leisure entertainment², uncontrolled and excessive use can lead to smartphone addiction³. Smartphone addiction can affect adolescents' sleep quality⁴ and academic performance³ and cause interpersonal tension⁵ and even serious mental illnesses⁶. Different from adults, adolescents have relatively poor self-control and are thus more prone to smartphone addiction⁷. Adolescence is a critical period for individual development, and adolescents are at a high risk for smartphone addiction. Therefore, the scientific prevention and effective mediation of smartphone addiction among adolescents are of urgent practical significance.

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According to the social cognitive theory, human behaviors are the result of the interaction between the environment and the individual⁸. The home is the primary place where adolescents use smartphones and other electronic devices⁹. As the first teachers of their children, parents play an important role in carrying out media education among the youth and in intervening in children's mobile phone use¹⁰. The parental mediation has a significant impact on adolescents' smartphone addiction^{11–13}. The parental mediation includes active mediation, restrictive mediation, and parental monitoring. This study will explore the roles of these three types of parental mediation separately. According to self-determination theory, parental mediation may effectively influence adolescents' smartphone addiction by affecting the fulfillment of adolescents' basic psychological needs^{14,15}. The parental mediation may also have an impact on adolescents' fear of missing out (FoMO)^{16,17}. FoMO may increase the risk of smartphone addiction among adolescents¹⁸. Based on this, the present study will explore the relationship between parental mediation, adolescents' basic psychological needs, FoMO, and smartphone addiction from a family perspective. While previous studies have separately examined the roles of parental mediation^{11,12}, basic psychological needs¹⁵, and FoMO¹⁸, few have integrated these variables into a coherent model. In order to reveal the unique advantages of parental mediation in adolescents' smartphone addiction and to provide targeted recommendations for reducing adolescents' smartphone addiction levels and promoting their physical and mental well-being.

Theoretical basis and hypothesis

The relationship between parental mediation and adolescents' smartphone addiction

Parental mediation refers to the measures actively taken by parents to harness the positive effects of media and avoid its negative impacts on children and adolescents; these measures include all strategies of control, supervision, and explanation of the media and content accessed by minors¹⁹.

In the field of digital media, researchers have identified three principal types of parental mediation: (a) active mediation, which involves discussions about media content; (b) restrictive mediation, which includes limiting children's media usage and setting rules for duration and content; and (c) parental monitoring, which involves parents monitoring their children's media use and content by, for example, checking emails and website visits²⁰. Parental mediation theory²¹ emphasizes parents' efforts to mitigate the media's potential impact on children. Parental mediation strategies enable children to benefit from the opportunities offered by digital technologies and protect them from online risks and threats²². Social cognitive theory emphasizes the interaction between the environment, individual characteristics and behavior. Parental mediation, as an important environmental variable, has a significant impact on adolescents' smartphone use^{11–13}. Active mediation can promote positive communication and discussions between parents and adolescents regarding smartphone use, which helps in building the parent-child relationship¹¹. Adolescents with good relationships with their parents are more likely to disclose more information during communication, actively discussing their thoughts, feelings, and activities. Through active mediation by parents, adolescents develop a more objective and rational attitude toward smartphone use, thereby learning to control excessive use and adopting healthy ways to engage with their phones¹¹. Therefore, active mediation is an effective strategy for parents to intervene in adolescent smartphone addiction^{11,13}. However, during adolescence, individuals desire autonomy, and restrictive mediation and parental monitoring may lead to negative consequences¹². For example, excessive restriction and monitoring of adolescents' smartphone use may provoke rebellious emotions, damage the parent-child relationship, make adolescents feel that their parents do not trust them, and increase the likelihood of excessive smartphone use.

As such, we hypothesize:

H1a Active mediation will be negatively associated with the smartphone addiction.

H1b Restrictive mediation and parental monitoring will be positively associated with the smartphone addiction.

The mediating role of basic psychological needs

Basic psychological need is an important intrinsic motivator of individual behavior²³. According to the theory of basic psychological needs, parents' positive parenting styles can meet their children's basic psychological needs; consequently, parents of teenagers earn the trust of their children and help them engage in healthy behaviors¹⁴. On the contrary, negative parenting styles can neither meet the basic needs of teenagers nor give them enough understanding and warmth; therefore, teenagers do not feel that they are accepted in reality and thus seek psychological satisfaction through the Internet. Previous studies have shown that positive parenting styles, such as autonomous support and emotional warmth, encourage individuals to feel encouraged and accepted²⁴, contribute to the satisfaction of their basic psychological needs²³, enhance academic performance and well-being²⁵, and reduce externalizing behavioral problems. For example, parents use psychological control to require their children to listen to the opinions of their elders and conform to their wishes; this measure conflicts with the psychological needs of adolescents for independent development²⁶ and leads to a lack of individual psychological needs, resulting in problematic behaviors.

Regarding the impact of parental mediation on adolescents' smartphone addiction, parents employing active mediation strategies communicate with their children about smartphone use and discuss its pros and cons with a gentle attitude. These practices, which are akin to positive parenting, are likely to help adolescents feel better understood and supported. By contrast, parents who use restrictive or monitoring strategies often adopt a harsh tone and attitude, which may cause adolescents to resist parental measures²⁷, leading to deteriorated parent-child relationships and communication difficulties²⁸. Their adoption of such strategies resembles negative parenting styles and can impair the satisfaction of children's basic psychological needs. However, researchers have yet to examine the relationship between different types of parental mediation and the adolescents' basic psychological

needs. Could parental mediation, as a parenting behavior related to adolescents' media use, also affect individual basic psychological needs satisfaction? On the basis of the preceding analysis, this study hypothesizes that parental mediation affects the satisfaction of adolescents' basic psychological needs. Specifically, active mediation is likely to foster the fulfillment of basic psychological needs, whereas restrictive mediation and parental monitoring are likely to impede it.

Meanwhile, the lack of psychological needs in real life is an important predictor of mobile phone addiction, and a large number of studies have shown that such deficiency will make individuals turn to the Internet for alternative satisfaction¹⁵. For example, they will play online games to meet their competence needs, use social media to fulfill their interpersonal needs, and browse the Internet aimlessly to satisfy their autonomy needs. Particularly in the digital era, various applications available on smartphones can easily meet basic psychological needs, and this compensatory psychology may promote excessive smartphone use, leading to addiction^{4,29}.

Self-determination theory suggests that basic psychological needs mediate the association between the social environment and individual behavior³⁰. Empirical studies have shown that psychological need satisfaction mediates the association between positive environments (e.g., parental support, positive parenting, and teacher support) and positive developmental outcomes (e.g., high well-being, high self-esteem, proactive behavior, and higher academic achievement)³¹. Meanwhile, basic psychological needs also play a mediating role between adverse environments (e.g., adversity, high stress, and controlling parenting) and negative developmental outcomes (e.g., psychological distress, depression, anxiety, and behavioral problems). However, at present, few studies have directly explored the mediating role of basic psychological needs in parental mediation and adolescents' smartphone addiction.

In summary, this study proposes that basic psychological needs, as an intrinsic motivator, may mediate the relationship between parental mediation and adolescents' smartphone addiction. Therefore, we hypothesize the following:

H2a Active mediation may promote the satisfaction of adolescents' basic psychological needs and in turn reduce adolescents' smartphone addiction.

H2b Restrictive mediation and parental monitoring may obstruct the satisfaction of adolescents' basic psychological needs and in turn increase adolescents' smartphone addiction.

The mediating role of fear of missing out

Fear, especially the fear of missing out (FoMO), may be a significant cause of smartphone addiction^{32,33}. Research indicates that FoMO is an important reason for social media use^{34,35}, with individuals high in FoMO being more sensitive to interpersonal solicitations and support from social networks¹⁸. They may constantly pay attention to social media, constantly browse social networking sites, and worry about skipping any new developments; therefore, they are more likely to use social media frequently and become addicted to social networks³³. The portability and accessibility of smartphones, as the primary devices for Internet use, facilitate individuals' pursuit of online social interactions, making FoMO a likely positive predictor of adolescent smartphone addiction.

Positive parenting, such as parent–child communication, is a potent way to prevent adolescents' FoMO¹⁶. The more parents communicate with their children, the lower the FoMO of adolescents. By contrast, negative parenting behaviors, such as psychological control, are major contributors to adolescents' FoMO¹⁷. Several studies have shown that negative parenting styles, such as parental control and lack of support, are significant predictors of misplaced fear among families^{36,37}. Parents' adoption of methods such as restriction and monitoring leads to a lack of warmth in the family and strained parent–child relationships³⁸. This environment increases adolescents' desire to use social media as they become aware of the numerous events or activities that they are not a part of during their online media usage. They also tend to believe that others have a better experience than themselves, and this upward comparison mentality can cause adolescents to focus on others' activities on social media, leading to persistent FoMO¹⁷. As parental mediation is a unique form of parenting behavior, the relationship between parenting styles and FoMO provides a basis for the connection between parental mediation and FoMO.

Based on previous research, this study proposes that FoMO acts as a mediating variable between parental mediation and adolescents' smartphone addiction. Hence, we hypothesize that:

H3a Active mediation may reduce adolescents' FoMO, which in turn may reduce adolescents' smartphone addiction.

H3b Restrictive mediation and parental monitoring may increase FoMO in adolescents, which in turn leads to a greater propensity for smartphone addiction.

Chain mediation of basic psychological needs and fear of missing out

Although both basic psychological needs and FoMO may mediate the association between parental mediation and adolescents' smartphone addiction, they may have some correlation. First, frustration with an individual's basic psychological needs in real life can lead to psychological discomfort and the experience of FoMO. According to self-determination theory, the satisfaction of one's basic psychological needs is a prerequisite for effective self-regulation and mental health²³. When these needs are not met, individuals may develop FoMO and manifest a close and continuous focus on the actions of others³⁹. Empirical studies have found that thwarted psychological needs are the primary cause of FoMO, with low belonging and interpersonal needs being positively correlated with FoMO^{40,41}. By contrast, when autonomy and competence needs are satisfied, individuals can effectively use their social resources to reduce FoMO⁴², suggesting that higher satisfaction of basic psychological needs can decrease FoMO. Second, the factors associated with FoMO may not only act independently but also interact in a

complex manner. For instance, situational factors could indirectly affect FoMO through mediating psychological factors⁴³. Research has further revealed that FoMO may mediate the relationship between psychological needs and Internet or social media addiction^{34,44,45}. Thus, we hypothesize that:

H4 Basic psychological needs and FoMO act as a chained mediator between parental mediation and smart-phone addiction.

In this study we tentatively constructed a chained mediation model to make an exploration (Fig. 1).

Methods

Participants and procedure

We selected three middle schools from Wuhan, Yichang, and Xiaogan in China. For each school, we drew two classes from the 7th and 8th grades, resulting in a set of 6,000 participants. After eliminating invalid samples (those that had consistent or obviously false answers or provided incomplete answers for key variables), we identified 5,841 valid participants, yielding an effective response rate of 97.35%. The sample comprised 2,772 boys (47.46%) and 3,069 girls (52.54%), and their ages ranged from 11.5 to 15.3 years ($M = 13.35$, $SD = 1.29$).

We conducted the study with the informed consent of the school administrators, class teachers, and students. We administered the online questionnaire survey with facilitation by class teachers and using computer information technology during class. A doctoral or master's student in psychology led the survey, describing to the participants the purpose of the survey, specifying the methods for answering the items, emphasizing the participants' voluntary participation, and guaranteeing the participants' anonymity. The participants independently completed the survey within the allocated time (approximately 20 min). After the survey, the administrator collected and organized the questionnaire. In the treatment of human participants, this study complies with the American Psychological Association ethical standards and the 1964 Helsinki declaration and its later amendments or comparable ethical standards, and was approved by the medical ethics committee at China Three Gorges University.

Measures

Smartphone addiction

In this study, we employed the Smartphone Addiction Scale developed by Hong et al.⁴⁶. This scale was adapted from Young's Internet Addiction Scale⁴⁷ to assess the degree of smartphone addiction. It includes 11 items across three dimensions: time management and related problems, academic problems and their impacts, and reality substitution. Sample items include "When using my phone, I always want to use it for a little longer," "My academic performance and focus on studies are affected by my phone use," and "Before doing anything, I always check my phone for missed calls or unread messages." The items are rated using a 6-point Likert-type scale, with anchors ranging from 1 (never) to 6 (always). Higher scores indicate more severe smartphone addiction. In this study, the Smartphone Addiction Scale had a Cronbach's alpha coefficient of 0.89.

Parental mediation

The revised Parental Mediation in Smartphone Use Questionnaire (Adolescent Version)⁴⁸ comprises 20 items that categorize parental mediation into three types: active mediation, restrictive mediation, and parental monitoring.

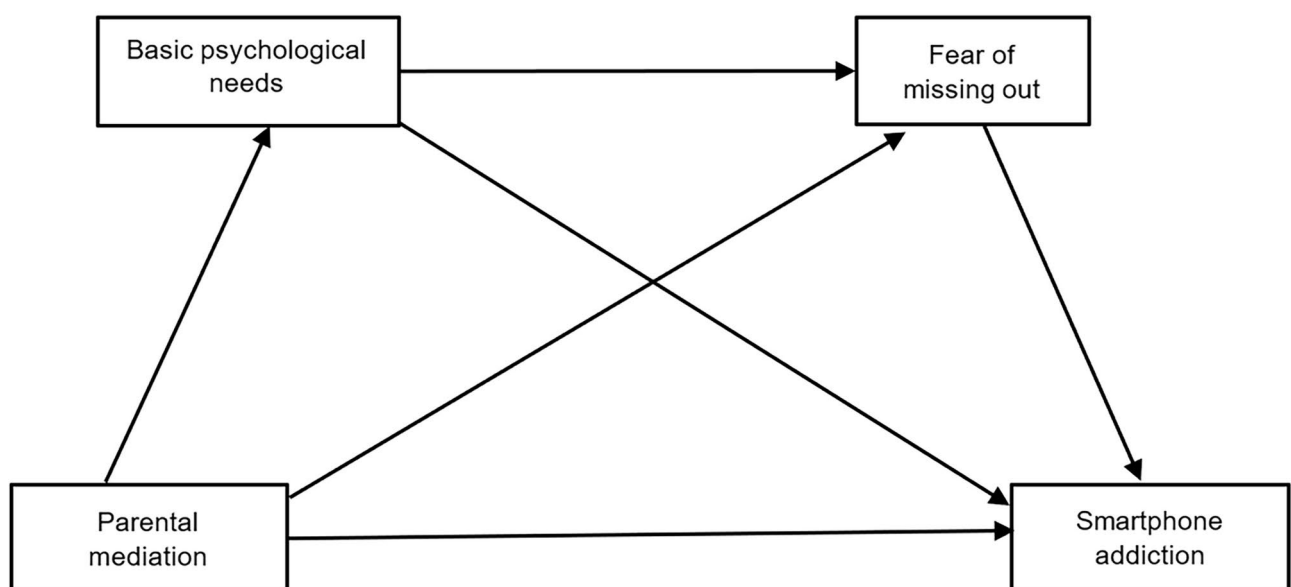


Fig. 1. Diagram of the hypothesized model. Parental mediation includes active mediation, restrictive mediation, and parental monitoring.

monitoring. The questionnaire uses a five-point Likert-type scale, with 1 indicating “never” and 5 indicating “always.” Higher scores on each dimension indicate greater parental mediation. In this study, this q

Basic psychological needs

nal needs. Sample items include “I usually feel free to express my ideas and opinions,” “Most of the time, I feel a sense of accomplishment from what I do,” and “I feel that people I interact with regularly are friendly.” All items are rated on a five-point Likert-type scale, with 1 indicating “never” and 5 indicating “always.” Higher scores indicate a greater degree of satisfaction of basic psychological needs. In this study, the scale had a Cronbach’s alpha coefficient of 0.91.

Fear of missing out

We used the Fear of Error Scale developed by Przybylski et al.³⁹ and adapted by Ma and Liu⁵⁰. For this study, we the context of FoMO to smartphone usage. A sample item is “When I am on vacation, I continuously and closely monitor my friends’ activities through my phone (e.g., WeChat Moments, QQ Space).” This scale consists of 10 items that are rated on a five-point Likert-type scale, with higher scores indicating higher FoMO levels. In this study, the scale had a Cronbach’s alpha coefficient of 0.82.

Results

SPSS (version 25) was used for descriptive statistical analysis of the data, Model 6 of the PROCESS micro (version 4.1) for SPSS was employed for mediation analysis³¹. Hypothetical models were tested by estimating 95% confidence intervals (CIs) for mediation effects using 5000 bootstrap samples. The results we reported were that with controls (sex and age).

Correlation analysis of variables

Descriptive statistics and correlations of key variables are presented in Table 1. The results showed significant positive correlations between active mediation and basic psychological needs and significant negative correlations between active mediation and both FoMO and smartphone addiction. They also revealed active mediation to be negatively associated with restrictive mediation and parental monitoring. Meanwhile, we noted that restrictive mediation had a positive association with parental monitoring and smartphone addiction and a negative association with basic psychological needs. As for the correlation between restrictive mediation and FoMO, it did not show statistical significance. Parental monitoring showed a positive association with smartphone addiction and a negative association with basic psychological needs. As for the correlation between parental monitoring and FoMO, it did not show statistical significance. Basic psychological needs exhibited a negative association with both FoMO and smartphone addiction. Meanwhile, FoMO showed a positive association with smartphone addiction.

Testing the mediation model

We analyzed the mediating effects of basic psychological needs and FoMO on the different types of parental mediation and adolescents’ smartphone addiction.

First, we examined the chained mediating role of basic psychological needs and FoMO in the impact of active mediation on adolescents’ smartphone addiction. As shown in Table 2; Fig. 2, active mediation showed a negative association with smartphone addiction ($B = -0.12, p < 0.001$) and positively predicted basic psychological needs ($B = 0.26, p < 0.001$), but it did not predict FoMO. Basic psychological needs significantly negatively predicted smartphone addiction ($B = -0.24, p < 0.001$) while FoMO significantly positively predicted smartphone addiction ($B = 0.09, p < 0.001$). Basic psychological needs significantly negatively predicted FoMO ($B = -0.55, p < 0.001$). We found the direct effect of active mediation on smartphone addiction to be -0.12 (B (95% CI) = $[-0.16; -0.08], p < 0.001$), accounting for 65% of the total effect. We also noted the total indirect effect of basic psychological needs and FoMO on active mediation and smartphone addiction to be -0.07 (B (95% CI) = $[-0.09; -0.06]$), accounting for 35% of the total effect (Table 3). As for the mediating effect of basic psychological needs, we found it to be -0.06 (B (95% CI) = $[-0.08; -0.05]$), accounting for 30% of the total effect. The result indicated a significant mediating effect of basic psychological needs on active mediation and smartphone addiction. Meanwhile, we determined the chained mediating effect of basic psychological needs and FoMO to be -0.01 (B (95% CI) = $[-0.02; -0.01]$), accounting for 5% of the total effect. There was a significant chained mediating effect of basic psychological needs and FoMO on active mediation and smartphone addiction. However, FoMO did not mediate the relationship between active mediation and smartphone addiction.

Variables	M ± SD	1	2	3	4	5	6
1. Active mediation	4.25 ± 0.87	-					
2. Restrictive mediation	2.49 ± 0.95	0.11**	-				
3. Parental monitoring	2.69 ± 0.41	0.07**	0.24**	-			
4. Basic psychological needs	3.54 ± 0.52	0.38**	-0.12**	-0.11**	-		
5. Fear of missing out	2.53 ± 0.88	-0.10**	-0.01	0.04	-0.28**	-	
6. Smartphone addiction	2.98 ± 0.88	-0.19**	0.13**	0.17**	-0.30**	0.24**	-

Table 1. Descriptive statistics and correlation analysis ($n = 5,841$). M mean value; SD standard deviation; ** $p < 0.01$.

Predictors	Outcome: Basic psychological needs		Outcome: Fear of missing out		Outcome: Smartphone addiction	
	B	t	B	t	B	t
Active mediation	0.26	19.06***	0.08	0.28	-0.12	-5.94***
Basic psychological needs			-0.55	-13.85***	-0.24	-8.04***
Fear of missing out					0.09	6.19***
R ²	0.14		0.09		0.10	
F	363.27		109.64		83.44	

Table 2. Mediating effect of basic psychological needs and fear of missing out in active mediation-smartphone addiction association. *** $p < 0.001$.

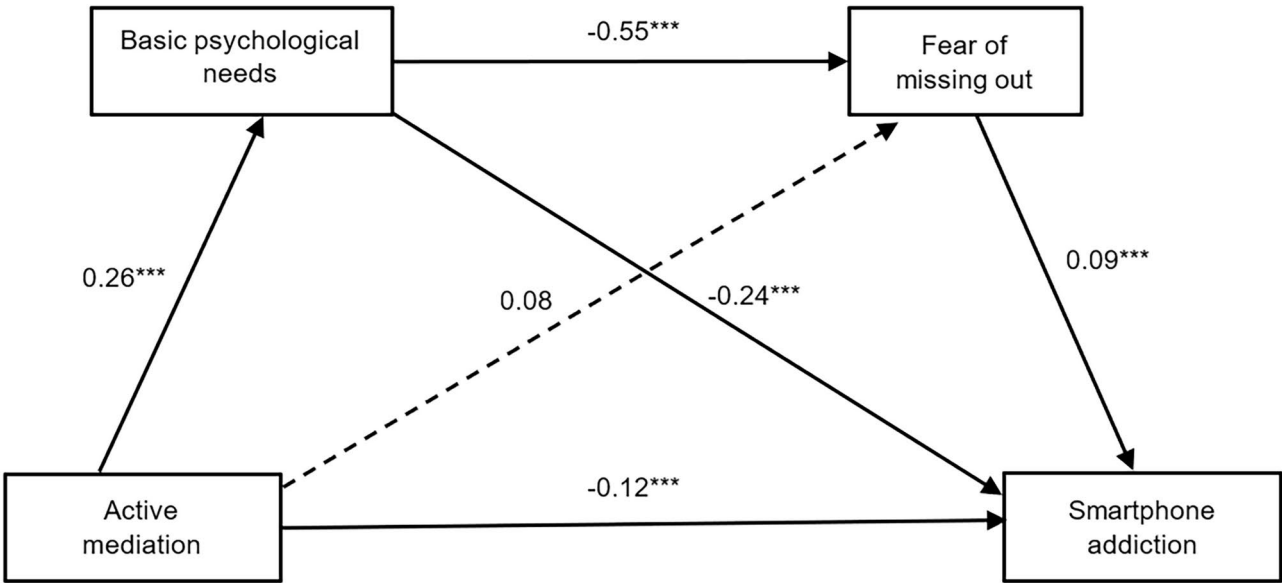


Fig. 2. A chain mediating model diagram of active mediation and smartphone addiction. *** $p < 0.001$.

Effect type	Effect	Bootstrap SE	% of total effect	Bootstrap 95% CI	
				Lower limit	Upper limit
Total indirect effect	-0.07	0.01	35%	-0.09	-0.06
Indirect effect 1	-0.06	0.01	30%	-0.08	-0.05
Indirect effect 2	-0.01	0.00	5%	-0.02	-0.01
Indirect effect 3	0.00	0.00		-0.01	0.01

Table 3. Bootstrap analysis of mediation effects. Indirect effect 1: active mediation → basic psychological needs → smartphone addiction; indirect effect 2: active mediation → basic psychological needs → fear of missing out → smartphone addiction; indirect effect 3: active mediation → fear of missing out → smartphone addiction.

Second, we examined the chained mediating effect of basic psychological needs and FoMO on the impact of restrictive mediation on adolescents’ smartphone addiction. As shown in Table 4; Fig. 3, restrictive mediation significantly positively predicted smartphone addiction ($B = 0.10$, $p < 0.001$) and negatively predicted basic psychological needs ($B = -0.06$, $p < 0.001$) but did not significantly predict FoMO. Basic psychological needs significantly negatively predicted smartphone addiction ($B = -0.40$, $p < 0.001$) while FoMO significantly positively predicted smartphone addiction ($B = 0.18$, $p < 0.001$). Moreover, basic psychological needs significantly negatively predicted FoMO ($B = -0.48$, $p < 0.001$). As for the direct effect of restriction mediation on smartphone addiction, we determined it to be 0.10 (B (95% CI) = [0.06; 0.14], $p < 0.001$), accounting for 75% of the total effect. We also found the total indirect effect of basic psychological needs and FoMO in restriction mediation on smartphone addiction to be 0.03, which accounted for 25% of the total effect (Table 5). We then noted the mediating effect of basic psychological needs to be 0.02 (B (95% CI) = [0.01; 0.04]), accounting for 16.67% of

Predictors	Outcome: Basic psychological needs		Outcome: Fear of missing out		Outcome: Smartphone addiction	
	B	t	B	t	B	t
Restrictive mediation	-0.06	-5.20***	-0.03	-1.53	0.10	4.99***
Basic psychological needs			-0.48	-12.91***	-0.40	-10.36***
Fear of missing out					0.18	7.89***
R ²	0.01		0.08		0.12	
F	27.05		83.28		91.18	

Table 4. Mediating effect of basic psychological needs and fear of missing out in restrictive mediation-smartphone addiction association. *** $p < 0.001$.

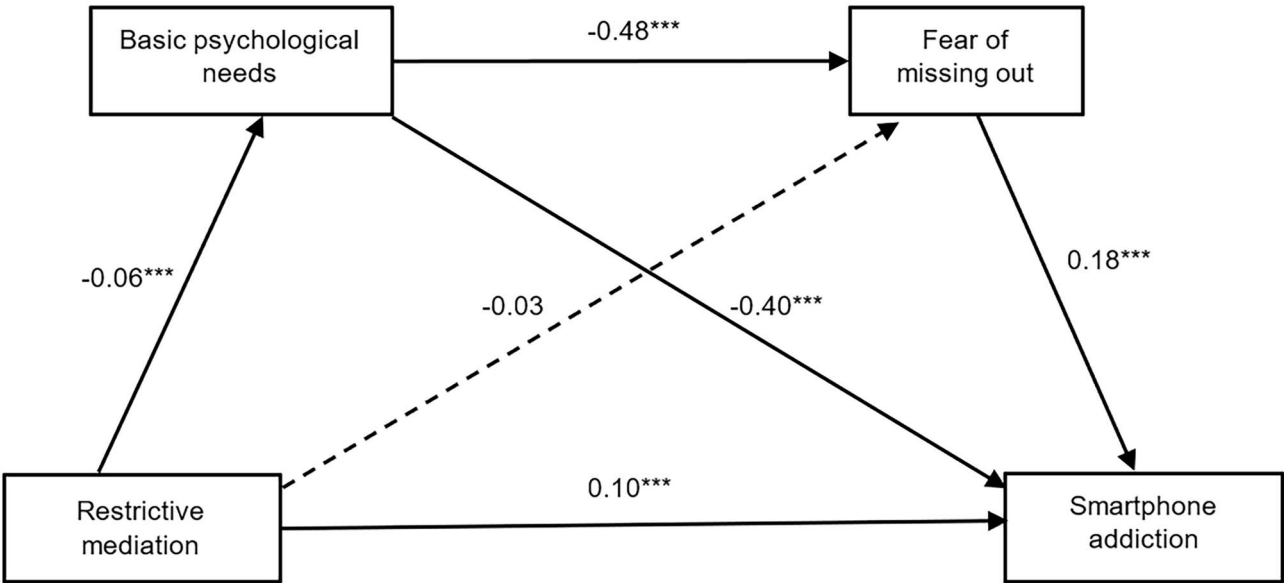


Fig. 3. A chain mediating model diagram of restrictive mediation and smartphone addiction. *** $p < 0.001$.

Effect type	Effect	Bootstrap SE	% of total effect	Bootstrap 95% CI	
				Lower limit	Upper limit
Total indirect effect	0.03	0.01	25%	0.01	0.04
Indirect effect 1	0.02	0.01	16.67%	0.01	0.04
Indirect effect 2	0.01	0.00	8.33%	0.00	0.01
Indirect effect 3	-0.01	0.00		-0.01	0.01

Table 5. Bootstrap analysis of mediation effects. Indirect effect 1: restrictive mediation → basic psychological needs → smartphone addiction; indirect effect 2: restrictive mediation → basic psychological needs → fear of missing out → smartphone addiction; indirect effect 3: restrictive mediation → fear of missing out → smartphone addiction.

the total effect. There was a significant mediating effect of basic psychological needs on the relationship between restriction mediation and smartphone addiction. Basic psychological needs and FoMO showed a chained mediating effect equal to 0.01 (B (95% CI) = [0.00; 0.01]), which accounted for 8.33% of the total effect. The result indicated a significant chained mediating effect of basic psychological needs and FoMO on the relationship between restriction mediation and smartphone addiction. However, FoMO did not mediate the relationship between restriction mediation and smartphone addiction.

Finally, we examined the mediating effect of basic psychological needs and FoMO on the impact of parental monitoring on adolescents’ smartphone addiction. As shown in Table 6; Fig. 4, parental monitoring significantly positively predicted smartphone addiction ($B = 0.29$, $p < 0.001$) and negatively predicted basic psychological needs ($B = -0.13$, $p < 0.001$), but it did not significantly predict FoMO. Basic psychological needs significantly negatively predicted smartphone addiction ($B = -0.39$, $p < 0.001$) while FoMO significantly positively predicted

Predictors	Outcome: Basic psychological needs		Outcome: Fear of missing out		Outcome: Smartphone addiction	
	B	t	B	t	B	t
Parental monitoring	−0.13	−4.67***	0.02	0.38	0.29	6.44***
Basic psychological needs			−0.47	−12.70***	−0.39	−10.41***
Fear of missing out					0.17	7.69***
R ²	0.01		0.08		0.13	
F	21.75		82.09		97.40	

Table 6. Mediating effect of basic psychological needs and fear of missing out in parental monitoring–smartphone addiction association. *** $p < 0.001$.

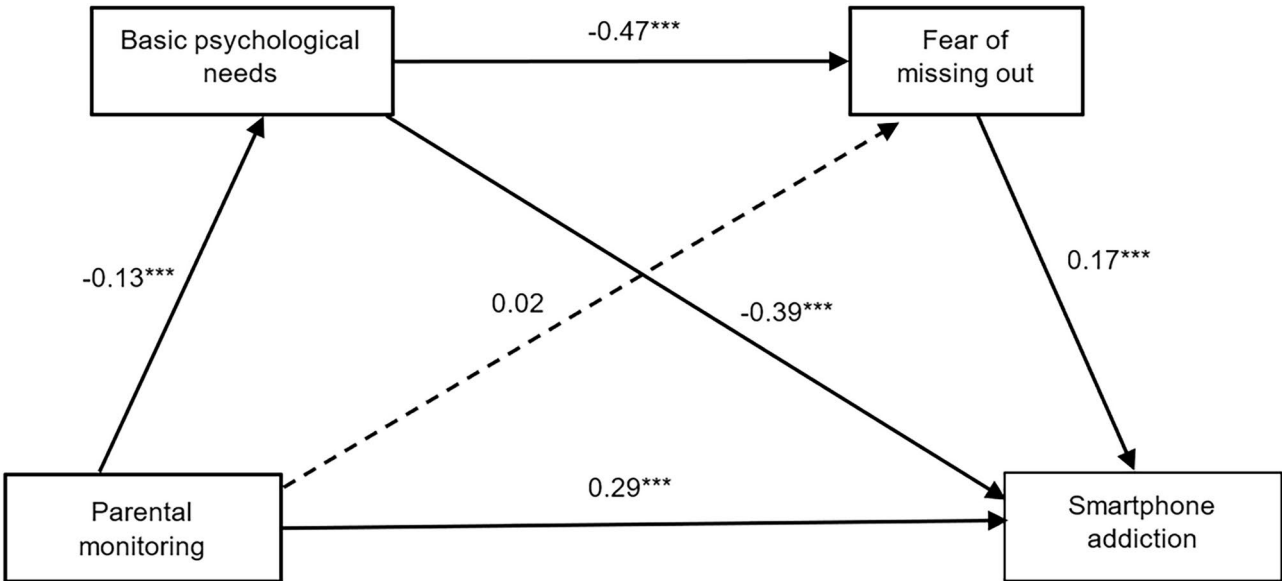


Fig. 4. A chain mediating model diagram of parental monitoring and smartphone addiction. *** $p < 0.001$.

Effect type	Effect	Bootstrap SE	% of total effect	Bootstrap 95% CI	
				Lower limit	Upper limit
Total indirect effect	0.07	0.02	19.44%	0.03	0.10
Indirect effect 1	0.05	0.01	13.89%	0.02	0.08
Indirect effect 2	0.02	0.00	5.55%	0.01	0.02
Indirect effect 3	0.00	0.00		−0.01	0.02

Table 7. Bootstrap analysis of mediation effects. Indirect effect 1: parental monitoring → basic psychological needs → smartphone addiction; indirect effect 2: parental monitoring → basic psychological needs → fear of missing out → smartphone addiction; indirect effect 3: parental monitoring → fear of missing out → smartphone addiction.

smartphone addiction ($B = 0.17, p < 0.001$). Basic psychological needs significantly negatively predicted FoMO ($B = -0.47, p < 0.001$). Meanwhile, parental monitoring showed a direct effect on smartphone addiction equal to 0.29 (B (95% CI) = [0.20; 0.38], $p < 0.001$), which accounted for 80.56% of the total effect. Basic psychological needs and FoMO exhibited a total indirect effect on the impact of parental monitoring on smartphone addiction equal to 0.07 (B (95% CI) = [0.03; 0.10]), which accounted for 19.44% of the total effect (Table 7). We determined the mediating effect of basic psychological needs to be 0.05 (B (95% CI) = [0.02; 0.08]), accounting for 13.89% of the total effect. There was a significant mediating effect of basic psychological needs on parental monitoring and smartphone addiction. Meanwhile, we found the indirect effect of basic psychological needs and FoMO on the impact of parental monitoring on smartphone addiction to be 0.02 (B (95% CI) = [0.01; 0.02]), accounting for 5.55% of the total effect. The result indicated a significant chained mediating effect of basic psychological needs

and FoMO on the relationship between parental monitoring and smartphone addiction. However, FoMO did not mediate the relationship between parental monitoring and smartphone addiction.

Discussion

The results of our study support Hypothesis 1 (H1a, H1b). This study found that active mediation had a significantly negative association with adolescents' smartphone addiction; these results are consistent with previous research findings¹¹. Active mediation, as a form of parent-child communication about media use, emphasizes dialogue and exchange. Such active dialogue-based mediation helps improve adolescents' critical thinking skills⁵², thereby protecting them from the negative influence of media content⁵³. In addition, effective communication between parents and their children indicates improved family functionality. The better the family functions, the more parents value their children's education and provide higher-quality educational resources and a rich living environment to meet their children's psychological needs⁵⁴, consequently reducing the likelihood of smartphone addiction among children.

This study also found that restrictive mediation positively predicted adolescents' tendencies toward smartphone addiction; this result is consistent with the findings of previous studies. Research has suggested that parents' limiting of adolescents' media content usage can trigger a rebellious mindset among adolescents, thereby creating a "forbidden fruit effect," in which excessive restrictions make restricted media content more appealing²⁷. Relative to active mediation, restrictive mediation is ineffective and may lead to outcomes contrary to parental intentions. For adolescents who desire independence and challenge parental authority, the negative consequences of restrictive mediation can be severe⁵⁵. For example, the more parents restrict content such as sexual videos, the more likely are girls to engage in sexual activities⁵⁶. Restricting adolescents from watching TV ads can increase materialistic tendencies⁵⁷, and strict restrictive mediation may increase hostility in children, leading to higher aggression²⁷.

In the current study, we found parental monitoring to be positively associated with adolescents' tendencies toward seeking a strong sense of autonomy over smartphone addiction; these results contradict previous findings. Previous studies have posited that parental monitoring could restrain adolescents' smartphone usage, enhance time management and academic investment, and thus reduce phone addiction⁵⁸. However, according to psychological reactance theory, adolescents with a strong sense of autonomy often view smartphone use as personal. Parental monitoring can thus make them feel psychologically controlled and can trigger rebellious emotions. When adolescents feel overly monitored beyond their tolerance, they may either become depressed, feel incapable of managing their own affairs, or deliberately defy their parents' wishes, leading to problematic behaviors⁵⁹. Additionally, adolescents tend to disclose less information to their parents and engage in more secretive behaviors to meet their needs for self-regulation and autonomy⁶⁰. These factors can lead to excessive smartphone use, resulting in smartphone addiction.

Consistent with Hypothesis 2 (H2a, H2b), the results of this study indicated that the basic psychological needs mediated the association between parental mediation and adolescents' smartphone addiction. Specifically, active mediation can reduce smartphone addiction by satisfying individuals' basic psychological needs, whereas restrictive mediation and parental monitoring can hinder the satisfaction of these needs, consequently leading to addiction. Hence, open and communicative mediation strategies help parents establish active relationships with their children and allow adolescents to feel trusted by their parents and believe in their ability to manage their personal affairs, including smartphone use. Such mediation methods can fulfill adolescents' need for autonomy, competence, and relatedness. When adolescents' basic psychological needs are effectively met through interactions with their parents, they are likely to develop positively without the need to resort to the Internet to compensate for unmet basic needs. In this way, their tendency toward smartphone addiction is reduced. Conversely, when parents employ restrictive strategies or monitoring to intervene in their children's smartphone use, they can damage their relationship with their children and make them reluctant to share their feelings⁶¹. These measures can thus lead to a lack of understanding, respect, and care for adolescents; undermine their basic psychological needs internally; prompt them to seek understanding and support online; and thus increase their use of smartphones and other electronic devices. These conditions may ultimately lead to addiction.

The results are not consistent with Hypothesis 3 (H3a, H3b), FoMO did not mediate the association between parental mediation and adolescents' smartphone addiction. This result differs from previous research findings. Previous studies have indicated that parenting styles can influence adolescents' FoMO¹⁷; for example, active communication between parents and children can reduce adolescents' FoMO while negative parenting styles, such as psychological control, are major factors causing FoMO in adolescents. However, in our study, we found that neither active nor negative forms of parental mediation affected adolescents' FoMO. In the era of mobile Internet, the use of social media has become a trend⁶², and adolescents are accustomed to being "always online" as part of cultural norms⁶³. To some extent, they rely on social media to communicate with their family and peers, access information, and regulate their emotions⁶⁴. Therefore, regardless of how their parents mediate their phone use, this mediation does not affect their FoMO.

Consistent with Hypothesis 4, the basic psychological needs and FoMO served as a chained mediator between parental mediation and adolescents' smartphone addiction. Active mediation satisfies adolescents' basic psychological needs, thereby reducing FoMO and smartphone addiction. Conversely, restrictive mediation and parental monitoring hinder the satisfaction of basic psychological needs, thereby increasing FoMO and leading to phone addiction. Thus, active parental mediation can promote the satisfaction of adolescents' basic psychological needs. Such satisfaction influences adolescents' smartphone addiction behavior through its effect on their FoMO. However, we should note that although the chained mediating effect in our study accounted for a smaller proportion of the total effect, it still holds value. First, a small effect size indicates an influence, albeit with varying magnitudes. Many factors influence psychological phenomena, and all possible influencing factors that align with social science theories must be identified. Even a small effect size can validate theoretical

hypotheses, and its significance in theoretical research cannot be denied⁶⁵. Second, small effect sizes have significant practical implications⁶⁶. Any system can experience significant chain reactions or even collapse from initially small changes, as exemplified by the butterfly effect. In practice, attention should be paid to small effects and their direct or indirect outcomes to prevent minor issues from escalating into major problems. Therefore, our findings may encourage parents to use active mediation to meet adolescents' psychological needs, further reducing their FoMO and preventing smartphone addiction. Conversely, when parents restrict adolescents' use of social media, such as limiting their use of QQ or WeChat for extended chats with their peers, and when adolescents cannot autonomously access social media, they experience higher levels of anxiety. Individuals with high FoMO are concerned about missing out on activities or important information on social networks and thus continuously follow and keep up with the latest information or updates (e.g., constantly checking QQ Space or WeChat Moments); this behavior leads to increased social media usage^{44,67}. As individuals with high FoMO desire to use smartphones to meet their psychological needs, they are prone to developing tendencies toward phone addiction.

Strengths and limitations

Theoretically, this study integrated both motivational and emotional aspects to analyze the chained mediating role of basic psychological needs and FoMO, thereby further clarifying the mechanism of parental mediation. It also revealed in greater depth the interactions between different types of parental mediation, basic psychological needs, and FoMO. Accordingly, this study enhances our understanding of the pathways through which parental mediation influences adolescents' smartphone addiction. Practically, parents should be keenly aware of the common strategies for guiding their children's phone use and, through appropriate learning, improve their level of active mediation to better prevent adolescents' phone addiction. Encouraging parents to communicate more with adolescents about phone use and employ active mediation strategies can satisfy children's basic needs, thereby reducing smartphone addiction tendencies. If parents do not communicate with their children or if they use monitoring and restrictive methods to mediate their children's phone use, children are more likely to seek fun and warmth on the Internet. In summary, this study contributes to the theoretical model in which the family environment (parental mediation) influences adolescents' smartphone addiction through motivational factors (basic psychological needs) and emotional factors (FoMO). In this way, the study enriches the theories related to parental mediation and provides important evidence for the prevention and mediation of adolescents' smartphone addiction.

However, the study has the following limitations. First, it employed a cross-sectional design, which could not be used to examine the causal relationship between parental mediation and adolescents' smartphone addiction. Future research should use a longitudinal design to investigate the psychological mechanisms through which parental mediation influences adolescents' smartphone addiction. Second, this study only focused on family and individual factors while peers also play an essential role in adolescents' smartphone addiction. Future research should explore the impact of other interpersonal factors on smartphone addiction among adolescents. Third, the sample of the present study included only middle school students and excluded high school students. In China, high school students are often under a boarding system in which schools strictly control students' smartphone usage and have uniform schedules. Therefore, the results of this study cannot be generalized to the Chinese high school student population.

Conclusion

In our research, we thoroughly investigated the correlation between parental mediation and smartphone addiction, with a specific focus on the mediating roles of basic psychological needs and FoMO. Our findings indicate that basic psychological needs can act as a mediator between parental and smartphone addiction. Moreover, basic psychological needs and FoMO collectively influence the relationship between parental mediation and smartphone addiction through chain mediation. These findings are crucial for developing educational strategies to prevent and address adolescents' smartphone addiction in school and family environments.

Data availability

The datasets analysed during the current study are available from the corresponding author on reasonable request.

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Author contributions

Y.C. and Q.G. wrote the original manuscript; Y.C. and Q.G. and Y.X., J.L., C.N. collected and analyzed the data; Y.C. and Q.G. revised the manuscript. All authors reviewed the final manuscript.

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Declarations

Competing interests

The authors declare no competing interests.

Additional information

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