The mediating effect of parental monitoring in the association between parent–child relationship harmony and smartphone addiction: findings from a nationwide youth survey in China

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Abstract

Background The increasing prevalence of smartphone addiction among youth has raised concerns. Previous research has indicated that poor parent–child relationship can lead to youth smartphone addiction. However, parent–child relationship harmony involves multiple parties and is difficult to intervene in due to family authority and other factors. Focusing on the pathways between parent–child relationships harmony and smartphone addiction is crucial for preventing smartphone addiction. This study was conducted to examine the role of parental monitoring as a mediator and the role of self-control as a moderator in the association between the parent–child relationship harmony and smartphone addiction among Chinese youth.

Methods The nationwide survey included 9,270 youth in the Chinese mainland. The data collected included individual characteristics, smartphone addiction status, parent–child relationship harmony, parental monitoring and self-control were collected. Sample weights were applied to ensure that the composition of our sample was consistent with the official statistics for each provincial-level administrative division on gender and school type. Structural equation modeling was used to analyze the mediating effect of parental monitoring and the moderating effect of self-control in the association between the parent–child relationship harmony and smartphone addiction.

Results Among the 10,000 weighted participants, 5,166 (51.7%) were male, and 3,608 (36.0%) were aged 16 to 18 years. Parental monitoring mediated 48.14% (95% CI: 40.24 to 56.03) of the association between the parent–child relationship harmony and smartphone addiction. The partial mediating effect of parental monitoring was differed across gender and age groups, and there was no significant heterogeneity. Moreover, self-control negatively moderated the indirect effects of parental monitoring on smartphone addiction ($\beta = -0.12$, 95% CI: -0.57 to -0.38), and the mediating effect of parental monitoring decreased as self-control increased.

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Conclusion Our study explored the association between parent–child relationship harmony and youth smartphone addiction, which appeared to be partially mediated by efficient parental monitoring. Self-control played a moderating role in the indirect pathway of the mediating effect.

Keywords Smartphone addiction, Parent–child relationship harmony, Parental monitoring, Self-control, Youth

Introduction

Recent developments in multifunctional smartphones and their subsequent global adoption have changed the communication landscape but have also raised concerns about addiction worldwide [1, 2]. The ages between 10 and 25 years are a critical period of youth development when young people face more challenges and temptations [3, 4]. Youths are most affected by and at risk from substance and behavioral addictions [5, 6]. The data suggest that among youths, smartphone addiction is more likely to lead to behavioral problems and psychological disorders, such as dry eye syndrome, sleep disorders and attention deficits [7–9].

To develop effective strategies for preventing smartphone addiction among youths, understanding the underlying mechanisms of smartphone addiction is important. Studies have shown that it is essential to focus on the influence of family factors on problem addiction among youths. Previous studies have also shown that a positive parent–child relationship serves as an important protective factor for emotional and behavioral problems in young people. It also acts as a safeguard against problematic smartphone use among youths [10, 11].

However, parent–child relationship harmony involves multiple parties and is difficult to intervene in due to family authority and other factors. Focusing on the pathways between parent–child relationships harmony and smartphone addiction is crucial for preventing smartphone addiction. At the individual level, not all youths with poor parent–child relationship is at increased risk for smartphone addiction. Some protective factors may play a role in preventing smartphone addiction. According to behavioral theory, children's behavior is influenced by the reward and punishment mechanisms in parental supervision. Therefore, effective parental monitoring involves setting clear rules and implementing reward and punishment measures can control adolescents' problematic behaviors [12, 13]. Theoretical and empirical researches have shown that positive parent–child relationship can help parents implement more effective and proactive supervision and reduce problems among youths [14, 15]. In addition, based on Control Theory, adolescents' ability of self-control can be strengthened through feedback mechanisms, which can reduce the negative impact of external factors, such as insufficient parental supervision [16]. In the study of youths smartphone addiction,

parent–child relationships, parental monitoring, and self-control may play important roles. The relationship between these variables and smartphone addiction exhibits complex characteristics. However, the possible effects of these mechanisms on smartphone addiction among youths are still unclear.

Existing studies suggest that communication barriers and family conflicts within parent–child relationship harmony may increase the risk of smartphone addiction among youths [17, 18]. Research also indicates that positive parental supervision and self-control can mitigate the adverse effects of smartphone addiction among youths [12, 19]. However, existing studies lack an understanding of the mechanisms underlying the associations between parental–child relationship harmony, parental monitoring and self-control and mobile phone addiction. Additionally, existing studies have several limitations, such as small sample sizes and a lack of representativeness. These limitations highlight an important evidence gap that needs to be addressed.

This study conducted a survey among youths aged between 11 and 25 in all 31 PLADs in the Chinese mainland. We aimed to investigate whether parental monitoring plays a mediating role in the association between parent–child relationship harmony and smartphone addiction and to assess the moderating role of self-control. Our findings can provide a deeper understanding of the underlying mechanisms of smartphone addiction and offer effective suggestions for society, families and schools to prevent mobile phone addiction among young people.

Methods

Survey design

We collected data through a two online survey. The online survey was administered by a survey company called KuRunData [20–22]. We stratified the sampling within each provincial-level administrative division (PLAD) by school type (junior high school, senior high school or college) to estimate the sample size by utilizing data from the Statistical Communiqué on the 2022 Economic and Statistical Bulletin on Education Development (Table S2), which includes data from China and the 31 PLADs. Based on statistical conventions, a sample size exceeding 30 is considered large and robust. Since the number of college students in Xizang is the smallest,

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its data were set as the benchmark. We set the sample size for college students in the Xizang stratum to 30. The sample sizes for the other strata were allocated based on the proportion of the number of college, high school, and middle school students in each PLAD to the number of college students in Xizang. The estimated sample sizes from each PLAD were aggregated, resulting in a total estimated sample size of 9,270.

In the first stage, we included all 31 PLADs in the Chinese mainland. The overall sample size goal was allocated to each PLAD based on the proportion of students in each PLAD relative to the national total. In the second stage, we applied stratified sampling within each type of school (junior high school, senior high school or college) in each PLAD. We allocated sample size goals to each stratum based on the proportion of students in each stratum relative to the total number in the corresponding PLAD.

A total of 12,642 adolescents accessed the e-questionnaire, and 10,388 completed it. Among the 10,388 respondents, 495 responses were identified as unqualified, and 623 responses were stored as backup data. Ultimately, 9,270 respondents were included in our analysis. The overall response rate was 73.3% (9,270/12,642). Detailed information regarding the survey design can be found in the Supplemental Methods.

To ensure that the composition of our sample aligned with official statistics for each PLAD on gender and school type [23–28], we assigned sample weights to each respondent. These weights were calculated by dividing the sample size goal by the actual number of respondents within each stratum.

Outcome variable: smartphone addiction status

Smartphone addiction status was the outcome variable in our analysis. In this study, the determination of smartphone addiction was based on the Smart Phone Dependence Scale (SAS-SV). It has 10 questions and adopts a 6-point scale, with 1 representing "strongly disagree" and 6 representing "strongly agree". The total score ranges from 0 to 60, with higher scores indicating a greater risk of SA. Scores of 32 or higher on the SAS-SV were considered indicative of SA among Chinese youths [29]. The Cronbach's α for this scale was 0.91 for South Korean adolescents [30]. The Cronbach's α for this scale was 0.92 in this study.

Independent variable: parent–child relationship harmony

Parent–child relationship harmony, as the independent variable, was measured by a single question. There are three levels of parent–child relationships, with 1 representing "not harmonious", 2 representing "generally harmonious" and 3 representing "harmonious".

Mediating variable: parental monitoring

Parental monitoring was the mediating variable in our analysis. We used a Chinese version of the parental monitoring scale to measure parental monitoring. It consists of 5 questions and uses a 3-point scale. When the score is higher, the parental supervision of their children is more stringent [31]. The scale's Cronbach's α was 0.82 for American high school students [31]. The Cronbach's α for this scale was 0.75 in this study.

Moderating variable: self-control

Self-control was the moderating variable in our analysis. Self-control was measured by the volitional control subquestionnaire of the Early Youth Temperament Questionnaire-Revised (EATQ-R). The questionnaire consists of 15 questions and uses a 5-point scale. Higher scores on this measure indicate stronger self-control [32]. The scale's Cronbach's α was 0.81 in Australia [33]. The Cronbach's α for these scales in this study was 0.84. It has good reliability and validity in young people [33].

Covariates

Data on gender, age, residence, school type and family economic situation were obtained for the survey participants. School type was divided into junior high school, senior high school and college. Residence was categorized as urban or rural. Family economic situation was classified as lower-middle, middle or upper-middle. Gender, age, residence, school type, and family economic status, reflecting basic demographic and socioeconomic characteristics, were controlled as covariates in our analysis. If the distribution of these variables is imbalanced, it may lead to confounding bias.

Data analysis

We summarized the sample characteristics, including gender, age, residence, school type, grade and other factors potentially associated with smartphone addiction in both the full sample and by subgroups of smartphone addiction. We present the proportions of smartphone addiction for male and female youths by PLAD in a statistical map.

Structural Equation Modeling (SEM) is applicable to analyses with latent variables, effectively accounting for measurement error while offering enhanced precision in estimating mediating and moderating effects [34]. Our research included the latent variables, such as parental monitoring, smartphone addiction and self-control. So in our research, mediation and moderated mediation models were used to analyze the mediating and moderating effects of parental monitoring and self-control in the association between parental–child relationship

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and smartphone addiction among youths by SEM [34]. We constructed a model to assess the mediating effect of parental monitoring in the association between the parent–child relationship and smartphone addiction. In addition, the relationships between parent–child relationships harmony, parental monitoring, and smartphone addiction might vary across different genders and age groups [35–37]. To account for the heterogeneity related to age and gender, we conducted subgroup analyses based on gender (male, female) and age group (11–15, 16–18, 19–22, and 23–25 years). We chose the age thresholds of 15, 18, and 22, as these ages correspond to key transition points among Chinese youths: moving from middle school to high school at 15, from adolescence to adulthood upon entering university at 18, and graduating from university at 22. The mediating effect sizes of each subgroup factor are presented as standardized coefficients with standardized 95% confidence intervals (CIs) in a forest plot.

Furthermore, we constructed a moderated mediation SEM to analyze whether self-control moderated the mediating effects of parental monitoring on smartphone addiction status. Interactions between the mediating effects of parental monitoring and subgroup factors or moderating factors on the risk of smartphone addiction were examined using standardized coefficients with 95% CIs in the model. According to a simple slope analysis, the levels of the moderator variable were set to the corresponding values (mean-SD, mean, mean + SD), and the effect of the moderator variable of self-control on the mediating effect of parental monitoring in the association between the parent–child relationship harmony and smartphone addiction was measured [38]. The bias-corrected CIs of the proportions of mediation effects were all calculated with 1,000 bootstrapping resamples. Gender, age, residence, school type and family economic situation were adjusted in all moderation and moderated mediation models. The specific variables in the model are detailed in Table S1.

Statistical significance was defined as two-tailed *P* values < 0.05. The 95% CI of the direct and mediating effects did not contain 0, indicating that the effect was significant. We used Stata 18.0 and Mplus 8.3 for all statistical analyses.

Ethics approval
The study was reviewed and approved by the Ethics Committee of Capital Medical University (Z2023SY111). Our study adhered to the principles delineated in the Declaration of Helsinki. In accordance with the committee's requirements, electronic informed consent was obtained from all adult participants, juvenile participants and juvenile participants' guardians.

Results
Sample characteristics
In the unweighted sample, the largest proportions of students were from Henan (8.1%), Shanxi (7.8%) and Shandong (7.0%) (Table S4). There were few differences in the sample characteristics between the unweighted (Table S3) and weighted (Table 1) groups. The weighted sample of 10,000 students included approximately equal proportions of males (51.7%) and females (48.3%). The median age of students was 16 years (IQR: 14–20). The majority of students were approximately 16–18 years old (36.0%), resided in urban areas (75.4%), attended college (36.8%) and were in middle-level economic situations (54.0%). A total of 71.7% (95% CI: 70.9% to 72.6%) of the youths in the weighted sample reported having a smartphone addiction.

Mediation analyses
After controlling for gender, age, residence, school type and family economic situation, the mediation analysis revealed that parental monitoring mediated the association between the parent–child relationship harmony and youth smartphone addiction. The results revealed that the total effect between the parent–child relationship harmony and smartphone addiction was −0.42 (95% CI: −0.47 to −0.37), and the mediating effect of parental monitoring was −0.20 (95% CI: −0.23 to −0.17). Thus, parental monitoring mediated 48.14% (95% CI: 40.24 to 56.03) of the association between the parent–child relationship harmony and smartphone addiction (Fig. 1, Table S5, Table S6).

The results are presented as standardized coefficients with 95% confidence intervals. The model's fit indices were CFI: 0.939, RMSEA: 0.049, and SRMR: 0.026, which demonstrate a good fit [39]. Maximum likelihood estimation was used to estimate the model standardized coefficients and 95% confidence intervals. Latent variables are represented by ovals, while observed variables are represented by rectangles. Arrows indicate the directional paths between variables, with coefficients representing the strength and direction of the relationship. Gender, age, residence, school type and family economic situation were the control variables in the model.

No significant heterogeneity was observed when subgrouping by gender was performed in the SEM of the mediation effect analysis. The mediating effect of parental monitoring explained 42.3% of the total effect in males (95% CI: 31.7% to 52.9%) and 55.3% (95% CI: 42.8% to 67.7%) in females (Fig. 2, Table S6).

Moreover, in the subgroup analysis by age group, parental monitoring explained 52.0% of the association between parent–child relationship harmony and mobile

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Table 1 Sample characteristics by smartphone addiction status, weighted

Variable	Full sample (*n* = 10,000)	Smartphone addiction (*n* = 7,175)	Non smartphone addiction (*n* = 2,825)
Male, n (%)	5,166 (51.7)	3,710 (51.7)	1,456 (51.6)
Age (years), median (IQR)	16 (14, 20)	16 (14, 20)	16 (14, 20)
Age group (years), n (%)			
11–15	4,161 (31.5)	3,008(41.9)	1,154(40.8)
16–18	3,604 (36.0)	1,851(25.8)	746 (26.4)
19–22	2,381 (23.8)	1,708 (23.8)	674 (23.8)
23–25	860 (8.6)	609 (8.5)	252 (8.9)
Urban residence, n (%)	7,538 (75.4)	5,352 (74.6)	2,186 (77.4)
Educational attainment, n (%)			
Junior high school	3,549 (35.5)	2,554 (35.6)	995 (35.2)
Senior high school	2,770 (27.7)	1,996 (27.8)	774 (27.4)
College	3,680 (36.8)	2,624 (36.6)	1,056 (37.4)
Family economic situation, n (%)			
Lower-middle	1359 (13.6)	1073 (15.0)	287 (10.1)
Middle	5,399 (54.0)	3,928 (54.7)	1,471 (52.1)
Upper-middle	3242 (32.4)	2174 (30.3)	1068 (37.8)

The presented results were derived from a weighted sample, n (%), frequency with percentage, IQR, interquartile range. The percentage in parenthetical represents the distribution of variables in the full sample and different levels of smartphone addiction
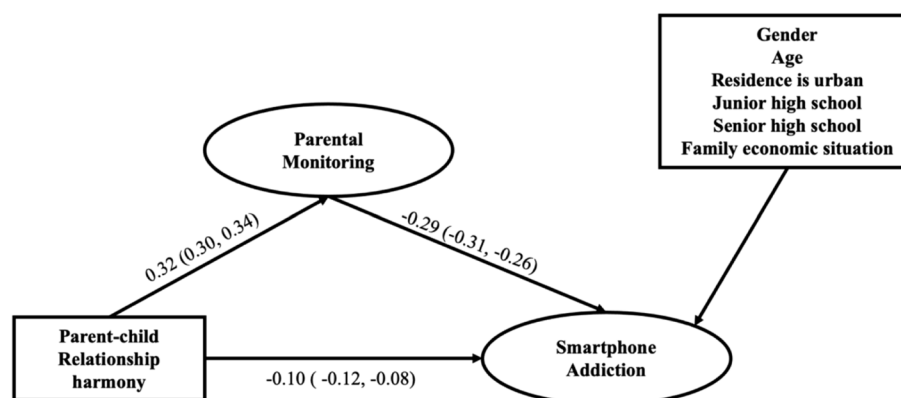
Fig. 1 Mediation analyses of parental monitoring, weighted

phone addiction at ages 11 to 15 years (95% CI: 39.5% to 64.5%), 47.7% at ages 16 to 18 years (95% CI: 35.0% to 60.4%), and 40.8% at ages 19 to 22 years (95% CI: 24.4% to 57.2%) (Fig. 2, Table S8). At 23 to 25 age group, the parent–child relationship harmony had no significant direct effect on smartphone addiction (direct effect: −0.11, 95%CI: −0.32 to 0.11), and parental supervision fully mediated the association between parent–child relationship harmony and smartphone addiction (Table S7).

The presented results were derived from a weighted SEM. Subgroup analysis of the mediating role was performed based on Model 1. The bias-corrected CIs of the proportions of mediation effects were calculated with

1,000 bootstrapping resamples. Age, residence, school type and family economic situation were the control variables in the sex subgroup model. Gender, residence and family economic situation were the control variables in the age subgroup model

Moderated mediation analyses

After controlling for gender, age, residence, school type and family economic situation, we inserted self-control as a moderator variable into the model. We found that the partial mediating effect of parental monitoring decreased as self-control increased. The results showed that self-control negatively moderated the indirect effect between
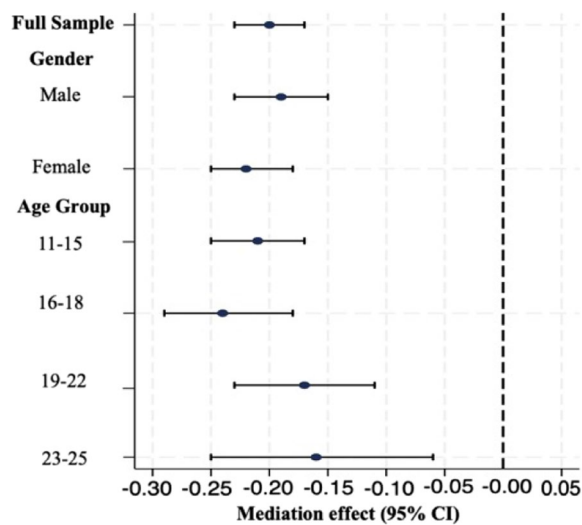
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Fig. 2 Subgroup analyses of parental monitoring in the association between parent–child relationship harmony and smartphone addiction, weighted

parental monitoring and smartphone addiction (self-control × parental monitoring standardized β = −0.48, 95% CI: −0.57 to −0.38) (Fig. 3, Table S9). The moderated mediation analyses of the bias-corrected percentile bootstrap indicated that the association between parent–child relationship harmony and smartphone addiction by parental monitoring was more prominent for youths with a low level of self-control (mean-SD) (mediation effect/total effect = 0.78, 95% CI: 0.62 to 0.93) than for those

with a medium level of self-control (mean) (mediation effect/total effect = 0.65, 95% CI: 0.44 to 0.86) or a high level of self-control (mean + SD) (mediation effect/total effect = 0.21, 95% CI: 0.11 to 0.53).

Discussion

Our study explores whether parental monitoring partially mediates the association between the parent–child relationship harmony and smartphone addiction. Using data from a nationally representative survey among youths in China, we found that parental monitoring mediates the negative associations between parental-child relationship harmony and smartphone addiction and that self-control functions as a moderator of the mediating association between parental monitoring and smartphone addiction. Our findings make a significant theoretical contribution by advancing our understanding of the associations among parental-child relationship harmony, parental monitoring and smartphone addiction. Moreover, the moderated mediation model provides insight into developing self-control for smartphone addiction among young people.

Parent–child relationship harmony can be directly associated with youth smartphone addiction, and we found that this direct association is partially mediated by parental monitoring. A good parent–child relationship contributes to effective supervision and promotes the healthy development of youths [19]. According to the results of previous biological mechanism studies [41, 42], the prefrontal cortex is the region of the brain responsible
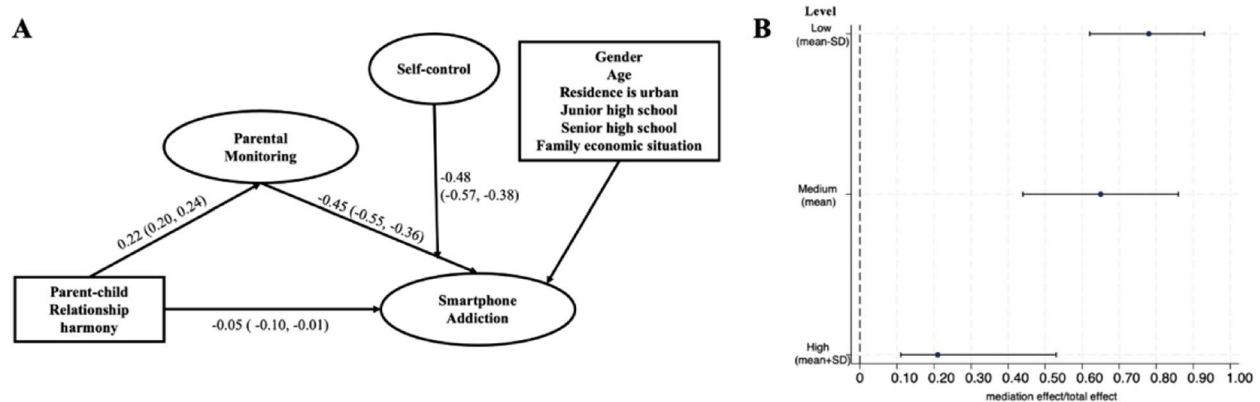

Fig. 3 Mediating effect of parental monitoring moderated by self-control, weighted. **A** The results are presented as standardized coefficients with 95% confidence intervals. Maximum likelihood estimation was used to estimate the model standardized coefficients and 95% confidence intervals. Compared with Model 1, the loglikelihoods of Model 2 increased 1790.607 (Model 1: −385404.427, Model 2: −383613.820) (χ^2 = 1790.607, $P < 0.05$). Model 2 demonstrated a good fit [40]. The latent variables are represented by ovals, and the observed variables are represented by rectangles. Arrows indicate the directional paths between the variables, with coefficients representing the strength and direction of the relationship. Gender, age, residence, school type and family economic situation were the control variables in the model. **B** The moderated mediation analysis was based on Model 2. The presented results were derived from a weighted simple slope analysis. Self-control was set to three values: mean-SD, mean, mean + SD. The bias-corrected CIs of the proportions of mediation effects were all calculated with 1,000 bootstrapping resamples. Gender, age, residence, school type and family economic situation were the control variables

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for performing higher cognitive functions. Studies have shown that a good parent–child relationship and effective parental supervision can promote the healthy development of the prefrontal cortex. Healthy development of the prefrontal cortex helps adolescents better process impulses, set long-term goals and suppress the tendency to engage in problematic sexual behavior. Effective parental monitoring can reduce the frequency and duration of teenagers' use of smartphones and guide the formation of correct smartphone addiction prevention concepts and use strategies when teenagers' self-control ability is not fully mature [43, 44]. We propose that by building a good parent–child relationship, providing a healthy family relationship and giving attention to effective supervision by parents, the occurrence of mobile phone addiction can be reduced. In the subgroup analysis by age group, we found that in the 11–15, 16–18, and 19–22 age groups, the proportion of the mediating effect of parental supervision between parent–child relationship harmony and smartphone addiction decreases with age. Counterintuitively, in the 23–25 age group, parental supervision acts as a complete mediator. This may be because, after turning 23 and entering a more independent phase of life, the impact of parent–child relationship harmony on smartphone addiction decreases. At this stage, the influence of parents on smartphone addiction largely depends on their willingness and strength of supervision [45]. Importantly, the sample size for the 23–25 age group in our study is small, and this finding might be a statistical anomaly. Therefore, further research on this age group is needed with larger samples.

Our results also show that self-control moderates the impact of parental monitoring on smartphone addiction. During adolescence, when self-control is extremely low, young people usually rely on their parents to adjudicate conflicts concerning immediate gratification. Self-control is about aligning thoughts, feelings and actions with lasting valuable goals in the face of temporarily more enticing alternatives. In the face of modern media devices and the internet, self-control can help teenagers use internet devices correctly and control the time and frequency of their use. Youths with a better level of self-control were shown to be less likely to overuse smartphones than those with a lower level of self-control while facing less parental supervision. This contributes to advantageous physical and mental health [46]. Young people with strong self-control can increase their willpower in the face of temptation in relatively poor internal and external environments.

Based on these findings, we propose the following recommendations to enhance youth smartphone addiction control measures. First, the government should actively advocate family-friendly policies to create good family relationship for young people. Youth smartphone addiction problems are a hallmark of poor parent–child relationship. By improving family policy, young people can maintain the harmony and stability of family relationship and establish positive parent–child relationship. Successful policies include family-friendly policies in Sweden. By implementing measures such as parental leave and flexible working hours, parents are given the opportunity to spend more time with their children and to balance work and family responsibilities with greater flexibility, thus better meeting the needs of their families.

Second, within the family environment, parents are generally the media gatekeepers of their children's smartphone use. The time spent between parents and young people should be increased, and efforts should be made to improve the quality of parent–child relationship [47]. Young people who establish warm, loving, intimate and caring relationship with their parents have lower levels of problem addiction. In China, communities, and schools in cities such as Beijing, Shanghai, and other provinces have organized various parent–child activities under the "Big Hand in Hand" program, such as parent–child sports events, volunteer activities, and reading clubs. Through joint participation and learning between parents and children, the "Big Hand in Hand" program helps strengthen parent–child relationships, enhances parental involvement in children's lives, and promotes parental supervision. Moreover, to implement effective parental monitoring to reduce the risk of smartphone addiction, parents can perform monitoring in four ways: (1) covering with their children, (2) limiting time, (3) limiting the type of content, and (4) actively discussing the meaning and impact of media content with their children (active mediation) [48]. Parental monitoring exerts a more pronounced mediating effect on smartphone addiction among younger adolescents. Considering smartphone addiction poses a greater threat to younger adolescents [49], when implementing effective parental monitoring strategies, particular attention should be directed towards younger adolescent populations. Encouraging parents to spend more time with younger adolescents is expected to yield positive outcomes in preventing smartphone addiction among youths. Compared to younger adolescents, the mediating role of parental monitoring is weaker for older adolescents. Further research is needed to explore the underlying behavioral and sociological mechanisms of smartphone addiction in older adolescents and to implement targeted interventions.

Finally, at the educational level, schools should take the initiative to cultivate the self-control ability of teenagers. For some people, relying on mobile phones has become a habitual and spontaneous behavior. Individuals need to use cognitive inhibition, that is, self-control, to reduce

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their use of mobile phones [50]. Therefore, teachers can instruct teenagers to develop proper goal setting and planning strategies in the face of physical and psychological temptations [16], for example, using a mobile phone no more than 4 times a day for no more than 20 min each time. Over time, the effortful application of these skills may give way to effortless, automatic habits. The Mindfulness in Schools Project in the United States has been implemented in schools to increase students' self-control abilities. By offering relevant courses and training, these programs help students effectively manage negative emotions and external temptations, enabling them to navigate challenging situations with greater self-control ability [51]. Successful examples of school-based self-control enhancement can serve as excellent models for implementing these recommendations.

Our findings have several strengths. First, our study involved 9,270 participants, including all 31 PLADs in the Chinese mainland. We also assigned sample weights to each respondent to ensure that the composition of our sample aligned with official statistics for each PLAD on gender and school type. These methods render our findings more credible and applicable. Second, our novel study explores the mediating effect of parental monitoring and the moderating effect of self-control in the association between the parent–child relationship and smartphone addiction. This study fills the gap in the understanding of the underlying mechanisms of mobile phone addiction in youth. Accordingly, this study provides theoretical suggestions for the effective prevention of youth smartphone addiction in governmental, familial and educational contexts.

Our study has several limitations. First, the study was a cross-sectional survey, making it difficult to establish causality. Future longitudinal or experimental studies are needed to validate the causal mechanisms suggested by our analysis. Second, the study used self-reported methods to collect data, which can be subjective. Therefore, there may be self-reported bias. Third, our study revealed that parental monitoring only partially mediated the association between the parent–child relationship and smartphone addiction. This finding suggests that other factors, such as individual tendencies and sociocultural influences, which were not collected in our study, may also play a role in mediating this association [52, 53]. Finally, this study was based on an online survey, which can effectively focus on the potential population at risk of smartphone addiction, thereby achieving the objectives of our study. However, this may result in an overestimation of the proportion of smartphone addiction [54], because individuals who were unable to use the internet were not able to participate in the research. We recommend that future research include community-based surveys to obtain a more accurate estimate of the prevalence of smartphone addiction. For future research, we recommend implementing longitudinal or experimental studies to confirm the causal relationships among mobile phone addiction, mediation variables and moderating variables and developing deeper into other potential mediating factors to elucidate their mechanisms.

Conclusion

Parental monitoring mediated the association between the parent–child relationship and smartphone addiction among youths. Moreover, the strength of parental monitoring mediation was moderated by self-control, and the mediating effect decreased as self-control increased. For young people, especially those who have poor parent–child relationship, it may be important to design interventions for the government, schools and families that include strengthening parental monitoring and improving self-control to reduce smartphone addiction.

Abbreviations

PLAD   Provincial-level administrative division
SAS-SV   Smart Phone Dependence Scale
EATQ-R   Early Youth Temperament Questionnaire-Revised
SEM   Structural equation model
CI   Confidence interval

Supplementary Information

The online version contains supplementary material available at https://doi. org/10.1186/s12889-025-22366-3.

Supplementary Material 1.

Declarations

Ethics approval and consent to participate
The study was reviewed and approved by the Ethics Committee of Capital Medical University (Z2023SY111). Our study adhered to the principles delineated in the Declaration of Helsinki. In accordance with the committee's requirements, electronic informed consent was obtained from all adult participants, juvenile participants and juvenile participants' guardians.

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