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ORIGINAL RESEARCH

The Relationship Between Harsh Parenting and Smartphone Addiction Among Adolescents: Serial Mediating Role of Depression and Social Pain

Dawei Wang*, Mengmeng Zhou*, Yixin Hu

School of Psychology, Shandong Normal University, Jinan, People's Republic of China

*These authors contributed equally to this work

Correspondence: Yixin Hu, School of Psychology, Shandong Normal University, No. 88, East Wenhua Road, Jinan, Shandong Province, People's Republic of China, Email huyixin2005@163.com

Purpose: With the increasing prevalence of smart phones, adolescent smartphone addiction has garnered significant attention from researchers. Previous studies have revealed that smartphone addiction is associated with various internalization and externalization problems. Therefore, this present study aims to investigate the risk factors contributing to adolescent smartphone addiction.

Methods: Study 1 recruited a sample of 540, 690, and 470 Chinese students aged between 10–17 years for exploratory factor analysis, confirmatory factor analysis, and predictive validity analysis of the social pain scale. Study 2 utilized data from a sample of 718 Chinese students aged between 10–17 years to examine the measurement model used revised social pain scale, smartphone addiction scale, harsh parenting scale, and depression sub-scale.

Results: The present study revealed that (1)The Social Pain Scale had good applicability in Chinese adolescents; (2) There were significant, positive correlations among harsh parenting, smartphone addiction, depression and social pain; (3) Social pain and depression played a partially serial mediating role in the relationship between harsh parenting and smartphone addiction, and similarly the relationship between paternal harsh parenting and smartphone addiction, while a completely serial mediating role in the relationship between maternal harsh parenting and smartphone addiction.

Conclusion: This study provides a direct path (improving parenting style) and an indirect path (reducing social pain to reduce depression) regarding interventions for adolescents with smartphone addiction, and establishes a basis for improving the situation of adolescent smartphone addiction.

Keywords: harsh parenting, smartphone addiction, adolescents, multiple mediation model

Introduction

According to the latest survey report of the China Internet Network Information Center (CNNIC), adolescents account for a significant proportion of mobile internet users in China, reaching as high as 17.5%.[1] With the increasing popularity of smartphones, adolescents have developed a strong dependency on them, even bordering on addiction.[2] Consequently, researchers have devoted extensive attention to the issue of smartphone addiction among adolescents.[3] Smartphone addiction refers to the detrimental effects on social function and psychological and behavioral problems caused by excessive reliance and misuse of smartphones.[4,5] Given that adolescence is a period characterized by rapid psychological and behavioral changes,[6] adverse behavioral problems can exert far-reaching influences on this population. Moreover, smartphone addiction can lead to various negative outcomes for adolescents including deteriorating mental health[7] and declining academic performance.[8] Considering the widespread prevalence of smartphone addiction and its detrimental consequences, it becomes imperative to explore factors that may mitigate teenagers' susceptibility towards such addictive behaviors. Harsh parenting represent an important family-related factor that could significantly impact adolescents' propensity towards smartphone addiction; therefore, researchers should also pay attention to how emotional problems

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like depression and negative emotional cognition such as social pain resulting from harsh parenting contribute to adolescents' vulnerability towards smartphone addiction.

The Relationship Between Harsh Parenting and Smartphone Addiction

Family serves as the primary setting for individual socialization, with parents assuming the crucial role of initial and paramount agents in children's socialization process.[9] The adverse parenting style known as harsh parenting[10] has been extensively investigated due to its detrimental effects on the physical and mental development of children and adolescents.[11–13] Harsh parenting encompasses parents' severe behaviors, expressions of affection, and attitudes towards their offspring during the upbringing process.[14] It primarily involves disciplinary actions such as shouting, slapping, spanking, pushing or using objects to inflict harm[15–17] while also encompassing implicit forms of attack like psychological aggression and control.[18–20]

According to the general strain theory, a negative family environment, as a significant source of stress, exerts a profound influence on individual emotions and behaviors.[21] Children exposed to such an adverse family environment and enduring prolonged exposure to harsh treatment may experience heightened pressure. In response to the stress caused by harsh parenting, individuals may adopt maladaptive strategies in order to alleviate negative feelings.[15,22] Previous research has demonstrated that negative parenting styles can lead to internalization problems in adolescents,[23] increase their risk of smartphone dependence,[24,25] and contribute to problematic internet use among this population.[26,27] Moreover, longitudinal studies have revealed that good family functioning acts as a protective factor against problematic internet use among adolescents.[28] Furthermore, direct investigations have found that harsh parenting significantly predicts adolescents' smartphone addiction.[22,25,29] Accordingly, we proposed Hypothesis 1: Harsh parenting is positively correlated with smartphone addiction.

The Mediating Role of Social Pain

Social pain refers to a specific emotional response elicited when individuals encounter exclusion or disregard from society, or experience devaluation by the groups with whom they aspire to establish relationships.[30,31] Researchers have emphasized that children's development of the emotional processing system relies on emotional cues present in their immediate environment, and exposure to negative emotional signals may result in an attentional bias towards processing negative emotional stimuli within the environment.[32] Furthermore, studies have demonstrated that negative parenting styles can contribute to a biased processing of negative emotions in children.[33,34] Consequently, adolescents who have encountered harsh parenting are more prone to exhibiting negative emotional reactions and experiencing social pain subsequent to rejection by social groups or peers.

The temporal need-threat model[35–37] posits that individuals undergo three stages following social exclusion. In the reflexive stage, individuals experience pain, sadness, anger, and low satisfaction, which is manifested by a diminished sense of belonging, self-esteem, control, and existential meaning. During the reflective stage, individuals strive to alleviate social exclusion through prosocial or antisocial behaviors.[38] Finally, in the retrieval stage, individuals encounter intense feelings of alienation, depression, helplessness, and worthlessness. Previous research has demonstrated that social exclusion elicits negative emotional reactions such as anxiety, grief, sadness and anger[39] resulting in social pain. Individuals who experience social exclusion may develop negative emotions like loneliness during face-to-face interactions and turn to the online environment where they are more likely to rely on mobile phones and develop smartphone addiction.[40,41] In sum, we proposed the following hypothesis.

Hypothesis 2: Social pain mediates the relation between harsh parenting and smartphone addiction.

The Mediating Role of Depression

Depression has emerged as a significant emotional challenge that poses threats to the emotional and social development of adolescents.[42] A recent study unveiled that the prevalence rate of depressive symptoms among Chinese adolescents was 35.27%,[43] while data from the 2011–2019 Youth Risk Behavior Survey in the United States indicated a detection rate of depressive symptoms at 31.2% (30.3% - 32.0%) in this age group.[44] Negative social events or experiences, such as abuse, neglect, and dysfunctional family relationships[45] are crucial risk factors for

depression.[46,47] Previous research has consistently demonstrated that negative parenting styles including authoritarianism, strictness, emotional abuse, and neglect significantly predict depressive symptoms among adolescents.[48–53] Children raised in harsh parenting environments and exposed to chronic stressors (characterized by maltreatment from their parents) are prone to experiencing adverse emotional reactions like anger, depression, and other mood disorders.[10,14,54,55]

The compensatory internet use theory posits that excessive internet usage serves as a maladaptive coping mechanism employed by individuals to alleviate negative emotions. When faced with stressful events, many individuals resort to the overuse of the internet (such as through smartphone addiction) as a means to release psychological pressure.[56–59] Consequently, individuals experiencing negative emotions (eg, depression) are more inclined to employ the internet (eg, smartphone addiction) in order to mitigate stress and alleviate negative emotions. Empirical studies have consistently demonstrated that depression constitutes a significant risk factor for smartphone addiction.[60] Building upon these findings, we propose the following hypothesis.

Hypothesis 3: Depression mediates the relation between harsh parenting and smartphone addiction.

The Serial Mediating Role of Social Pain and Depression

Social pain and depression may independently mediate the relationship between harsh parenting and smartphone addiction, but further investigation is needed to explore the possibility of a serial mediating role in this relationship. Harsh parenting often involves parents displaying unconcerned, emotional, and negative attitudes towards their children.[61,62] This can lead adolescents to feel excluded by their parents and families, resulting in social pain. Adolescents experiencing high levels of social pain believe they are being excluded by others, which contributes to increased negative affect such as depression.[36,63,64] Empirical studies have also identified social pain as a risk factor for depression.[65,66] As depression intensifies among adolescents, they may seek ways to compensate for their negative emotional experiences leading to smartphone addiction.[57–59] Relevant research has shown that high levels of depression in adolescents are an important factor contributing to smartphone addiction.[60] In summary, we hypothesize that harsh parenting can contribute to increased social pain which subsequently elevates levels of depression and ultimately leads to smartphone addiction. Accordingly, we proposed the following hypothesis.

Hypothesis 4: Social pain and depression play a serial mediating role in the relationship between harsh parenting and smartphone addiction.

The Present Research

The present research includes two studies. For Study 1, we revised the Social Pain Scale based on the Chinese context. For Study 2, we explored the relationship between harsh parenting and smartphone addiction, and further investigated the serial mediating role of social pain and depression in the relationship between harsh parenting and smartphone addiction to establish a basis for future research, as well as interventions for smartphone addiction among adolescents. Figure 1 presents the theoretical model.

Study 1: Revised Social Pain Scale

Since the Social Pain Scale was originally only offered in English and is currently only used with foreign adolescents, we revised the Social Pain Scale to a Chinese version through exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), and verified its applicability for Chinese adolescents.

Exploratory Factor Analysis of the Social Pain Scale

Participants

We selected 540 students via randomly cluster sampling from two primary and secondary schools in Zaozhuang, Shandong Province; 63 were in fourth grade, 54 were in fifth grade, 60 were in sixth grade, 136 were in seventh grade, 178 were in eighth grade, and 49 were in ninth grade. There were 300 boys and 240 girls, ranging in age from 8 to 17 years old, with a mean age of 13.01 and a standard deviation of 1.46.

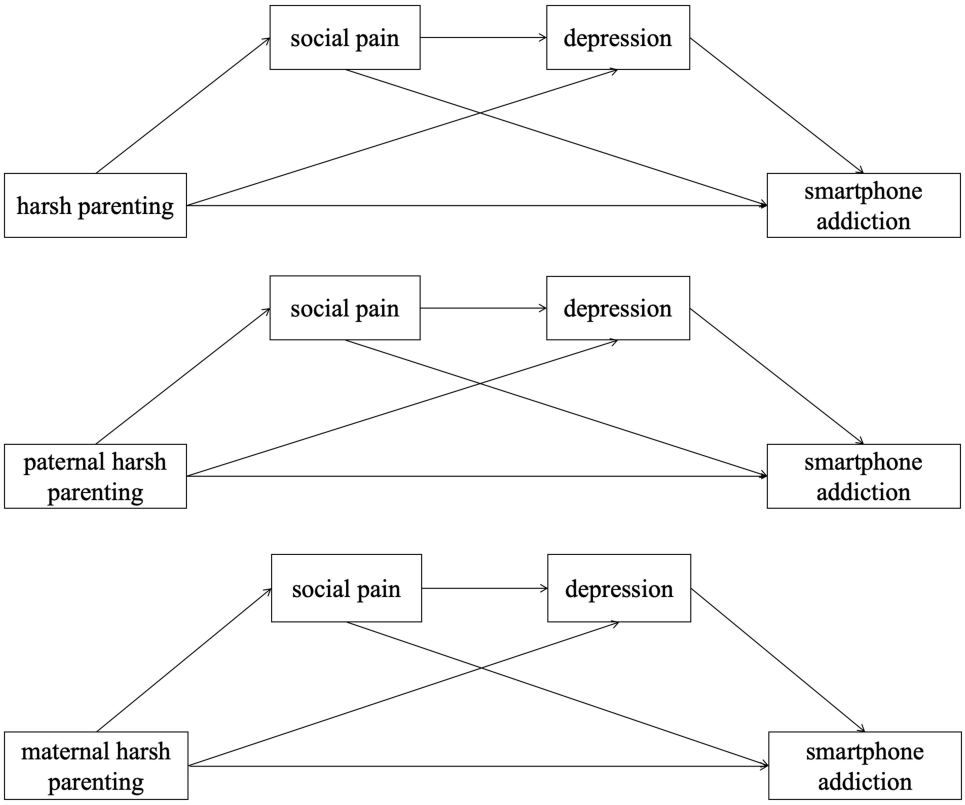

Figure 1 Structural equation modelling.

Measures

The Social Pain Scale is a self-reported measurement tool developed by Stangier, Schuller and Brahler,[67] originally grounded in foreign samples, to gauge social pain among adolescents. This scale consists of 10 items, such as "I get upset when someone turns me down". Participants rate each item from 1 (complete agreement) to 5 (complete disagreement). For this study, we used the Chinese version of the Social Pain Scale, and the coefficient α was 0.953.

We first translated the Social Pain Scale (encompassing psychology and evaluation) into Chinese. Next, with help from experts in English and psychology, we translated the Chinese version back into English, and then again into Chinese. We fully considered habits of expression and cultural differences. We produced the final translation after repeated deliberation and modification, with support from various experts.

Procedure

For this study, we used the Social Pain Scale to collect data through online measurement, and sampled the entire class. The head teacher sent a link to the survey to the students and provided them with guidance. After the students completed the questionnaire, data were auto-generated.

Statistical Analysis

SPSS17.0 was used to conduct exploratory factor analysis of the data.

Ethics Statements

The procedures we conducted on human subjects were approved by the ethical standards of the Academic Committee of Shandong Normal University, and conformed to the ethical standards set forth in the 1964 Declaration of Helsinki and its later amendments or similar ethical standards. The participants signed informed consent forms and were told they could withdraw from the research at any time.

Results

Bartlett's test showed that χ^2 was 6683.549 (df = 45, $p < 0.001$), and the Kaiser-Meyer-Olkin value was 0.944, indicating that these data were suitable for EFA. We also used maximum likelihood analysis with the oblimin rotation method.[68] We excluded items according to the following criteria: (1) the commonality of items was less than 0.3 or a factor only contained one or two items; (2) items had a loading less than 0.4 on the hypothesis factor or with an intersection on two or more factors, with a loading greater than 0.4; and (3) we used eigenvalues equal to 1 as cut-off lines for extracting factors.

We extracted one factor that explained 70.453% of the total variance. The scree test showed that the slope tended to be gentle after one factor was extracted. The results of EFA indicated that the factor loading ranged from 0.694 to 0.903 for all items (see Table 1).

Confirmatory Factor Analysis of the Social Pain Scale

Participants

We selected 691 students via randomly cluster sampling from two primary and secondary schools in Zaozhuang, Shandong Province. Among them, 81 were in fourth grade, 75 were in fifth grade, 63 were in sixth grade, 190 were in seventh grade, 214 were in eighth grade, and 68 were in ninth grade. There were 386 boys and 305 girls, aged 8 to 17, with an average age of 12.99 and a standard deviation of 1.49.

Measures

The Social Pain Scale was developed by Stangier, Schuller and Brahler[67] and revised via EFA. This scale consists of 10 items, such as "I get upset when someone turns me down". The participants rate each item from 1 (complete agreement) to 5 (complete disagreement). In this study, the coefficient α was 0.956.

Procedure

The same as EFA.

Statistical Analysis

SPSS17.0 was used for data description analysis and reliability analysis. M-plus 7.0 was used to analyze the structural validity of the single factor model obtained from the exploratory factor analysis. Mode 1 is a single factor model based on exploratory factor analysis. Model 2 is a two-dimensional model that packages 10 items into 2 factors, items 1–5 for factor 1, items 6–10 for factor 2.

Ethics Statements

The procedures we conducted on human subjects were approved by the ethical standards of the Academic Committee of Shandong Normal University, and conformed to the ethical standards set forth in the 1964 Declaration of Helsinki and its

Table 1 The Results of Exploratory Factor Analysis for the Social Pain Scale

Items	Factor
1. It hurts my feelings if somebody denies a request of mine.	0.694
2. I feel very humiliated when I am excluded from a group.	0.835
3. I feel insulted when being ignored at a party.	0.828
4. It hurts me when somebody ignores me.	0.850
5. When I feel rejected, I experience inner tension.	0.816
6. When an acquaintance does not respond to me when I say hello, I feel rejected.	0.829
7. When a friend distances himself/herself from me, I feel repulsed.	0.899
8. When I get the impression that a colleague withdraws from me, I feel rejected.	0.903
9. When somebody declines my request or suggestion, I feel snubbed.	0.870
10. If somebody cancels an appointment without a good reason, I feel repulsed.	0.851

Table 2 The Results of Confirmatory Factor Analysis

Model	χ^2/df	RMSEA	CI	CFI	TLI	SRMR
Two-factor model	7.93	0.100	0.089, 0.111	0.965	0.953	0.030
One-factor model	3.93	0.065	0.053, 0.077	0.986	0.960	0.020

later amendments or similar ethical standards. The participants signed informed consent forms and were told they could withdraw from the research at any time.

Results

As shown in Table 2, model 1 is a single factor model based on EFA. Model 2 is a two-dimensional model that packages 10 items into 2 factors: Items 1–5 for Factor 1 and Items 6–10 for Factor 2. Results showed that the single-factor model of the Social Pain Scale fit better than the two-factor model (χ^2/df = 3.93; CFI = 0.986; TLI = 0.960, RMSEA = 0.065, CI = [0.053, 0.077], RMSEA = 0.020).

Outcomes of Social Pain

Participants

We selected 476 students via randomly cluster sampling from two primary and secondary schools in Zaozhuang, Shandong Province. Among them, 58 were in fourth grade, 38 were in fifth grade, 46 were in sixth grade, 122 were in seventh grade, 162 were in eighth grade, and 49 were in ninth grade. There were 257 boys and 219 girls, aged 10 to 17, with an average age of 13.14 and a standard deviation of 1.41.

Measures

Social Pain

The Social Pain Scale was developed by Stangier, Schuller and Brahler[67] and revised via EFA. This scale consists of 10 items, such as "I get upset when someone turns me down". Participants rate each item from 1 (complete agreement) to 5 (complete disagreement). In this study, the coefficient α was 0.955.

Meaning in Life

The Meaning in Life Scale was developed by Steger, Frazier and Frazier[69] and revised by Wang.[70] This scale consists of 10 items, such as "I am looking for something that makes my life feel meaningful". Participants rate each item from 1 (absolutely untrue) to 7 (absolutely true). In this study, the coefficient α was 0.854.

Anxiety

In this study, we measured individuals' anxiety status using the anxiety sub-scale of the Depression-Anxiety-Stress Scale (DASS-21) developed by Lovibond and Lovibond[71] and revised by Gong et al.[72] The anxiety sub-scale includes 7 items, such as "I" m worried about some occasions that may make me panic or make a fool of myself'. The scale is rated on a 4-point scale ranging from 0 (totally disagree) to 3 (totally agree). In this study, the coefficient α of the scale was 0.828.

Procedure

The same as EFA.

Statistical Analysis

SPSS17.0 was used for data description analysis, regression analysis and reliability analysis.

Ethics Statements

The procedures we conducted on human subjects were approved by the ethical standards of the Academic Committee of Shandong Normal University, and conformed to the ethical standards set forth in the 1964 Declaration of Helsinki and its

Table 3 Outcomes of Social Pain

Variables	Meaning in Life	Anxiety
Social pain	0.03***	0.072***

Notes: ***$p < 0.001$.

later amendments or similar ethical standards. The participants signed informed consent forms and were told they could withdraw from the research at any time.

Results

The results showed that social pain had a negative effect on meaning in life ($p < 0.001$) and a positive effect on anxiety ($p < 0.001$) (see Table 3).

Discussion

Our results indicated that the social pain scale had good applicability in Chinese adolescents, and the single-dimensional scale had good structural validity. The scale, with coefficient α, ranged from 0.953 to 0.956. In addition, the Social Pain Scale, revised for Chinese adolescents, had a positive correlation with anxiety and a negative correlation with meaning in life. The reliability, structural validity parameters, and predictive validity met statistical standards, indicating that the Social Pain Scale could be used with Chinese adolescents.

Study 2: The Relationship Between Harsh Parenting and Smartphone Addiction Among Adolescents: A Multi-Mediating Model Examination of Depression and Social Pain

In this study, we used a scale for harsh parenting, smartphone addiction, depression, and social pain to explore the relationship between overall harsh parenting, paternal harsh parenting, and maternal harsh parenting and smartphone addiction among adolescents, and further investigated the mediating role of depression and social pain in this relationship.

Methods

Participants

The sample size was determined a A prior using Monte Carlo power analysis for indirect effects (power = 0.80, α = 0.05).[73] We entered the effect sizes obtained by previous studies for the links between harsh parenting and smartphone addiction,[22] $r = 0.23$, harsh parenting and social pain, $r = 0.15$ (smallest effect), harsh parenting and depression,[55] $r = 0.39$, social pain and depression,[66] $r = 0.43$, social pain and smartphone addiction, $r = 0.15$ (smallest effect), depression and smartphone addition,[60] $r = 0.23$. The results indicated that 581 participants were needed to detect serial mediation. For this study, we selected 750 adolescents via randomly cluster sampling from three primary and secondary schools in Zaozhuang, Shandong Province. The effective data was 718, and the effective rate was 95.73%. Among them, 81 students were in fourth grade, 70 were in fifth grade, 71 were in sixth grade, 184 were in seventh grade, 238 were in eighth grade, and 74 were in ninth grade. There were 391 boys and 327 girls, with an average age of 13.09 and a standard deviation of 1.39. The reason for exclusion was a failed polygraph test.

Measures

Harsh Parenting

The harsh parenting scale developed by Wang[74] and consists of four items for fathers and mothers. Typical examples include "When I do something wrong, I get very angry and even yell" and "When I do something wrong, hit me with your hand or kick me with your foot". The 8-item scale is rated on a 5-point scale ranging from "1= never that way" to "5= always that way". In this study, the coefficient α was 0.885.

Smartphone Addiction

The Smartphone Addiction Scale was developed by Kwon, Kim, Cho and Yang[75] and revised by Wang et al.[76] The scale consists of 10 items, with typical examples such as "When my mobile phone is not around, I feel impatient and irritable". This scale adopted a 6-point score, with 1 representing strongly disagree and 6 representing strongly agree. In this study, the coefficient α was 0.920.

Social Pain

The Social Pain Scale was developed by Stangier, Schüller and Brähler[67] and revised in Study 1 to measure social pain in adolescents. The scale consists of 10 items, with typical examples such as "It hurts my feelings if somebody denies a request of mine" and "When an acquaintance does not respond to me when I say hello, I feel rejected". The scale uses 5-point scoring, with 1 representing complete agreement and 5 representing complete disagreement. In this study, the coefficient α was 0.956.

Depression

In this study, we measured individuals' depression status using the depression subscale of the DASS-21, developed by Lovibond and Lovibond[71] and revised by Gong et al.[72] The depression sub-scale includes 7 items, such as "I do not seem to feel any pleasure or comfort at all". The scale is rated on a 4-point scale ranging from 0 (totally disagree) to 3 (totally agree). In this study, the coefficient α was 0.865.

Procedure

For this study, we used the Harsh parenting, Smartphone addiction, Social Pain and Depression scales to collect data through online measurement, and sampled the entire class. The head teacher sent a link to the survey to the students and provided them with guidance. After the students completed the questionnaire, data were auto-generated.

Statistical Analysis

In this analysis, SPSS17.0 was used for description analysis, correlation analysis and reliability analysis, and M-plus 7.0 was used for confirmatory factor analysis and model test.

Ethics Statements

The procedures we conducted on human subjects were approved by the ethical standards of the Academic Committee of Shandong Normal University, and conformed to the ethical standards set forth in the 1964 Declaration of Helsinki and its later amendments or similar ethical standards. The participants signed informed consent forms and were told they could withdraw from the research at any time.

Results

Common Method Bias Test

In this study, we used the Harman single factor method to estimate the effects of common method bias. The total variance of the six factors was 68.98%, and the explanatory rate of the first factor was 32.39%, indicating no significant common method bias in this study.[77]

Confirmatory Factor Analysis

The fitting data of the measurement model were acceptable ($\chi^2(546) = 1994.98$, $p < 0.001$, root mean square error of approximation (RMSEA) = 0.061, comparative fit index (CFI) = 0.922, Tucker-Lewis index (TLI) = 0.915, standardized root-mean-square residual (SRMSR) = 0.048). We further investigated the measurement models for several different factors and compared them with the four-factor model. As shown in Table 4, the four-factor model was more suitable for data fitting in this study than other models, indicating that the participants could clearly distinguish among different factors.

Correlation Analysis

Table 5 shows the mean, standard deviation, correlation coefficient, and significance of each factor. There were significant, positive correlations between smartphone addiction and harsh parenting, paternal harsh parenting, maternal harsh parenting,

Table 4 The Results of Confirmatory Factor Analysis

Model	χ^2	df	χ^2/df	RMSEA	CFI	TLI	SRMR
Four-factor model (X, Y, M1, M2)	1994.98	546	3.65	0.061	0.922	0.915	0.048
Three-factor model (M1, Y+X, M2)	5444.87	557	9.78	0.111	0.736	0.717	0.131
Two-factor model (M1+M2, Y+X)	7609.82	559	13.61	0.133	0.618	0.594	0.155
One-factor model (X+Y+M1+M2)	11,272.58	560	20.13	0.163	0.420	0.384	0.183

Notes: X=harsh parenting, y=smartphone addiction, m1=depression, m2=social pain.

depression and social pain ($r = 0.338$, $p < 0.01$; $r = 0.290$, $p < 0.01$; $r = 0.314$, $p < 0.01$; $r = 0.494$, $p < 0.01$; $r = 0.364$, $p < 0.01$). There was a significant, positive correlation between harsh parenting, paternal harsh parenting, maternal harsh parenting, and depression and social pain ($r = 0.479$, $p < 0.01$; $r = 0.375$, $p < 0.01$; $r = 0.477$, $p < 0.01$; $r = 0.242$, $p < 0.01$; $r = 0.203$, $p < 0.01$; $r = 0.229$, $p < 0.01$); depression was positively correlated with social pain ($r = 0.289$, $p < 0.01$).

Mediating Effects of Social Pain and Depression in the Relationship Between Harsh Parenting and Smartphone Addiction

The results showed that harsh parenting had significant, positive effects on social pain ($\beta = 0.134$, $p < 0.01$) and smartphone addiction ($\beta = 0.101$, $p < 0.05$). Social pain had significant, positive effects on smartphone addiction ($\beta = 0.230$, $p < 0.001$). The indirect effect of harsh parenting on smartphone addiction through social pain was 0.003, p <0.01, and the 95% CI was [0.010, 0.057]. Harsh parenting had significant, positive effects on depression ($\beta = 0.481$, $p < 0.001$) and smartphone addiction ($\beta = 0.101$, $p < 0.05$). Depression had significant, positive effects on smartphone addiction ($\beta = 0.377$, $p < 0.001$). The indirect effect of harsh parenting on smartphone addiction through depression was 0.181, p <0.001, and the 95% CI was [0.135, 0.234]. Social pain had a positive predictive effect on depression ($\beta = 0.226$, $p < 0.001$). The serial indirect effect of harsh parenting on smartphone addiction through social pain and depression was 0.212, p <0.001, and the 95% CI was [0.163, 0.268]. (see Figure 2 and Table 6)

The results showed that paternal harsh parenting had significant, positive effects on social pain ($\beta = 0.109$, $p < 0.05$) and smartphone addiction ($\beta = 0.095$, $p < 0.05$). Social pain had significant, positive effects on smartphone addiction ($\beta = 0.232$, $p < 0.001$). The indirect effect of paternal harsh parenting on smartphone addiction through social pain was 0.025, p <0.05, and the 95% CI was [0.004, 0.050]. Paternal harsh parenting had significant, positive effects on depression ($\beta = 0.380$, $p < 0.001$) and smartphone addiction ($\beta = 0.095$, $p < 0.05$). Depression had significant, positive effects on smartphone addiction ($\beta = 0.388$, $p < 0.001$). The indirect effect of paternal harsh parenting on smartphone addiction through depression was 0.147, p <0.001, and the 95% CI was [0.109, 0.196]. Social pain had a positive predictive effect on depression ($\beta = 0.249$, $p < 0.001$). The serial indirect effect of paternal harsh parenting on smartphone addiction through social pain and depression was 0.173, p <0.001, and the 95% CI was [0.130, 0.223]. (see Figure 3 and Table 7)

The results showed that maternal harsh parenting had significant, positive effects on social pain ($\beta = 0.118$, $p < 0.05$). Social pain had significant, positive effects on smartphone addiction ($\beta = 0.234$, $p < 0.001$). The indirect effect of maternal harsh parenting on smartphone addiction through social pain was 0.028, p <0.05, and the 95% CI was [0.007, 0.052]. Maternal harsh parenting had significant, positive effects on depression ($\beta = 0.477$, $p < 0.001$). Depression had significant, positive effects on smartphone addiction ($\beta = 0.389$, $p < 0.001$). The indirect effect of maternal harsh parenting on smartphone addiction through depression was 0.185, p <0.001, and the 95% CI was [0.137, 0.240]. Social pain had a positive predictive effect on depression ($\beta = 0.234$, $p < 0.001$). The serial indirect effect of maternal harsh parenting on smartphone addiction through social pain and depression was 0.213, p <0.001, and the 95% CI was [0.162, 0.271]. (see Figure 4 and Table 8)

General Discussion

Theoretical Implications

We divided the present research into two studies. For Study 1, we revised the Social Pain Scale to measure its applicability in Chinese adolescents. For Study 2, we used the revised Social Pain Scale, explored the relationship

Table 5 Means, Standard Deviations, Alpha Reliability, and Personal Correlations Among the Study Variables (N=718)

Variables	*M*	*SD*	1	2	3	4	5	6	7	7 (1)	7 (2)	8	9
1 Gender	1.46	0.50											
2 Age	13.09	1.39	0.111**										
3 Grade	3.91	1.50	0.097**	0.889**									
4 Only child	1.85	0.36	0.122**	0.001	−0.016								
5 Parents away	3.38	1.14	0.023	0.112**	0.161**	0.033							
6 Family background	1.79	0.90	−0.043	0.322**	0.464**	−0.138**	0.178**						
7 Harsh parenting	1.65	0.74	−0.071	−0.051	−0.069	0.018	−0.122**	0.068					
7 (1) Paternal harsh parenting	1.63	0.79	−0.094*	−0.049	−0.066	−0.003	−0.092*	0.041	0.884**				
7 (2) Maternal harsh parenting	1.68	0.86	−0.035	−0.043	−0.057	0.033	−0.125**	0.078*	0.904**	0.599**			
8 Smartphone addiction	2.54	1.22	0.006	0.076*	0.043	−0.027	−0.144**	−0.066	0.338**	0.290**	0.314**		
9 Depression	0.41	0.53	0.066	0.138**	0.119**	0.040	−0.140**	0.007	0.479**	0.375**	0.477**	0.494**	
10 Social pain	2.74	1.13	0.051	0.048	0.016	−0.008	−0.050	−0.018	0.242**	0.203**	0.229**	0.364**	0.289**

Notes: *$p < 0.05$, **$p < 0.01$.

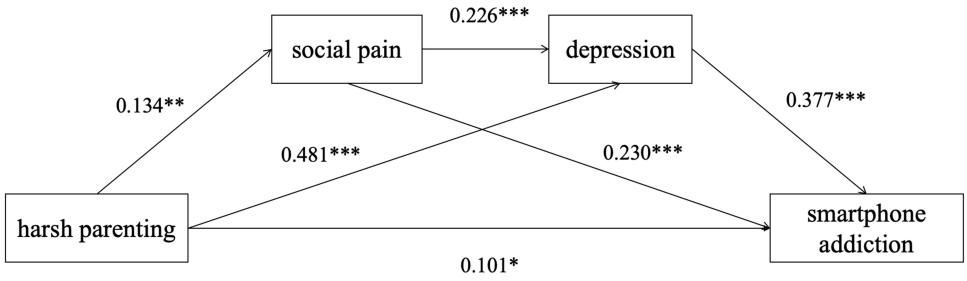

Figure 2 Path coefficient of the serial mediating model.
Notes: *p < 0.05, **p < 0.01, ***p < 0.001.

between harsh parenting and adolescent smartphone addiction, and further examined the mediating role of depression and social pain in the relationship between them.

We conducted two separate studies in our current research. In Study 1, we made revisions to the Social Pain Scale in order to assess its applicability among Chinese adolescents. In Study 2, we utilized the revised Social Pain Scale to investigate the association between harsh parenting and adolescent smartphone addiction, while also examining the serial mediating roles of depression and social pain in this relationship.

Applicability of Chinese Version of the Social Pain Scale

In Study 1, we verified the effectiveness of the Social Pain Scale in Chinese adolescents. The 10-item social pain scale had good applicability in Chinese adolescents and was suitable for measuring the level of social pain among Chinese adolescents. The outcomes of EFA and CFA indicated that the reliability and structural validity of the single-dimensional Social Pain Scale was good, and the factor loading of items and the parameters of the model test fit statistical standards. In addition, the content of the Social Pain Scale was in line with the social pain situation of adolescents against the background of Chinese culture, thus supporting the application of the Social Pain Scale in Chinese adolescents.

In Study 1, we validated the efficacy of the Social Pain Scale in Chinese adolescents. The 10-item social pain scale demonstrated excellent applicability among Chinese adolescents and proved suitable for assessing levels of social pain in this population. Results from exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) indicated strong reliability and structural validity of the single-dimensional Social Pain Scale, with factor loading of items and model fit parameters meeting statistical standards. Furthermore, the content of the Social Pain Scale aligned well with the social pain experiences prevalent among Chinese adolescents, thus supporting its utility in this population.

The Relationship Between Harsh Parenting and Smartphone Addiction

The present study found a significant, positive association between harsh parenting and smartphone addiction, therefore confirming Hypothesis 1. This finding is consistent with previous studies.[22,25,29] Furthermore, we conducted an additional analysis by distinguishing paternal and maternal harsh parenting styles, which also demonstrated a positive relationship between both parental styles and smartphone addiction. The family environment is a crucial setting for adolescent socialization, where the parenting style plays a decisive role in their development.[21] Extensive research has focused on harsh parenting and has indicated that adolescents exposed to prolonged abusive behavior, abusive emotions,

Table 6 Specific Indirect Effects and 95% CI for the Multiple Mediation Model-Harsh Parenting

Model Pathways	Indirect Effects	LLCI	ULCI
x→m1→y	0.181	0.010	0.057
x→m2→y	0.031	0.135	0.234
x→m1→m2→y	0.212	0.163	0.268

Notes: x = harsh parenting, y = smartphone addiction, m1 = social pain, m2 = depression, bootstrap = 5000.

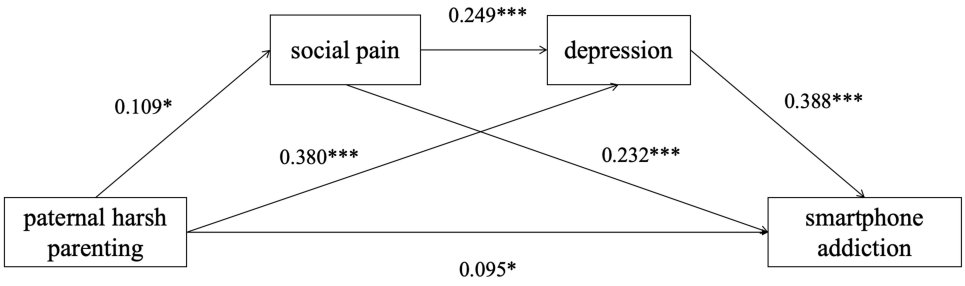

Figure 3 Path coefficient of serial mediating model.
Notes: *$p < 0.05$, ***$p < 0.001$.

and abusive attitudes from their parents may have internalization problems,[16,78] negative emotional experiences,[25,79] ultimately leading them to cope with these adverse feelings through maladaptive means, resulting in smartphone addiction.

The Mediating Role of Social Pain

We found that harsh parenting and paternal and maternal harsh parenting increased adolescents' social pain, leading to smartphone addiction. This confirmed Hypotheses 2. Harsh parenting, as a kind of negative family parenting style, can intensify adolescents' negative emotional reactions after experiencing peer or group social rejection.[80] Consequently, they are more likely to seek solace in their smartphones as a means to alleviate these adverse reactions.[40,41] In addition, peer attachment and parent-child attachment play an important role in adolescent development,[81–83] and experiencing exclusion from social groups may heighten feelings of loneliness among adolescents,[35–37] thereby contributing to smartphone addiction.[40,41]

The Mediating Role of Depression

The results showed that harsh parenting, both paternal and maternal harsh parenting, was associated with an elevated level of depression among adolescents, thereby confirming Hypotheses 3. Previous research showed that harsh parenting experiences, such as criticism and punishment by parents, are closely related to adolescent depression.[84] In line with compensatory internet use theory, individuals experiencing depression tend to engage in excessive internet use (smartphone addiction) as a means to alleviate their depressive symptoms.[56–59] Problematic internet use (eg, smartphone addiction) can be seen as an escape response to negative life events.[85] When adolescents faced with negative emotional reactions such as depression, they might adopt maladaptive coping strategies in order to release psychological stress and relieve negative emotions by excessively relying on mobile phones.

The Serial Mediating Effects of Depression and Social Pain

Finally, we also examined the serial mediating effect of social pain and depression on the relationship between harsh parenting and smartphone addiction, which supported Hypothesis 4. The I-PACE model[86,87] points out that subjective perceived situational stresses, such as negative family environment, may trigger individuals' affective experience and cognitive responses, subsequently leading to excessive Internet use. The relationship between perceived situational stress

Table 7 Specific Indirect Effects and 95% CI for the Multiple Mediation Model-Paternal Harsh Parenting

Model Pathways	Indirect Effects	LLCI	ULCI
x→m1→y	0.025	0.007	0.052
x→m2→y	0.147	0.137	0.240
x→m1→m2→y	0.173	0.163	0.268

Notes: x =paternal harsh parenting, y = smartphone addiction, m1 = social pain, m2 = depression, bootstrap = 5000.

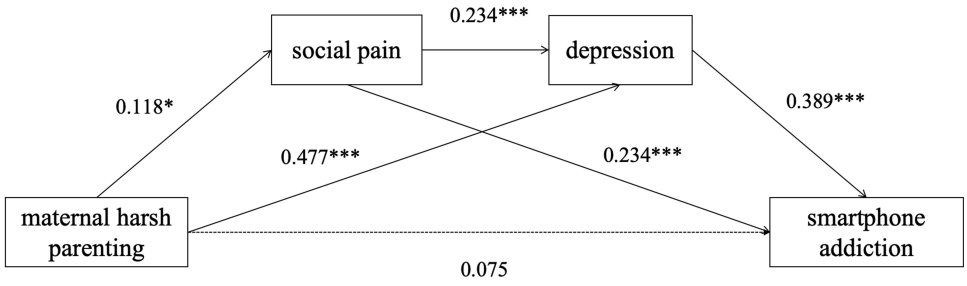

Figure 4 Path coefficient of the serial mediating model.
Notes: *$p < 0.05$, ***$p < 0.001$.

and Internet-use related disorders may be mediated by affective responses and cognitive responses. According to the I-PACE model, harsh parenting, a negative family environment, as a situational stressful factor, has a negative impact on individual emotions and behaviors,[11–13] including social pain (a form of negative affective experience), which further exacerbates adolescent depression.[65,66] When experiencing depression, adolescents attempt to alleviate their negative emotional state through excessive use of smartphone.[40,41]

The present study further found that social pain and depression completely mediated the relationship between maternal harsh parenting and smartphone addiction, and partially mediated the relationship between paternal harsh parenting and smartphone addiction. This finding may be attributed to the greater influence of maternal parenting on children and adolescents' emotions within the family, as well as its important role in fostering adolescents' emotional development and related abilities.[88–90] Conversely, fathers tends to have a stronger impact on adolescents' behavior perception and evaluation within the family.[91] In this study, social pain referred to an adverse emotional response experienced by adolescents due to social rejection, whereas depression represented a negative emotion. Therefore, both social pain and depression played a complete serial mediating role in the relationship between paternal harsh parenting and smartphone addiction, played a partially serial mediating role in the relationship between paternal harsh parenting and smartphone addiction.

Practical Implication

First, we investigated the relationship between harsh parenting and smartphone addiction among adolescents, and found that harsh parenting could increase smartphone addiction among adolescents. It is important to note that authoritarian and rigid parenting styles exert detrimental effects on adolescent development. Furthermore, a nurturing family environment serves as a protective factor against problematic internet use.[28] Consequently, adopting an effective parenting style and fostering a warm familial atmosphere hold significant practical implications for promoting healthy adolescent development and mitigating internalizing and externalizing problems. The family environment and parental treatment have enduring impacts on adolescents; thus, we strongly encourage parents to embrace positive parenting approaches while cultivating a supportive family setting in order to mitigate negative behaviors such as smartphone addiction among teenagers.

Table 8 Specific Indirect Effects and 95% CI for the Multiple Mediation Model-Maternal Harsh Parenting

Model Pathways	Indirect Effects	LLCI	ULCI
x→m1→y	0.028	0.007	0.052
x→m2→y	0.185	0.137	0.240
x→m1→m2→y	0.213	0.162	0.271

Notes: x = maternal harsh parenting, y = smartphone addiction, m1 = social pain, m2 = depression, bootstrap = 5000.

Secondly, we have revealed the mediating role of social pain in the relationship between harsh parenting and adolescent smartphone addiction; specifically, harsh parenting may engender smartphone addiction by amplifying social pain subsequent to teenagers encountering social rejection from their peers. Consequently, students who undergo harsh parenting can alleviate their social pain by accurately perceiving social exclusion within the group, thereby diminishing smartphone addiction. It is recommended that educational institutions establish activities centered around team cooperation, foster harmonious relationships among students, and mitigate instances of social exclusion. Additionally, schools should implement courses focused on emotion management and related skills to ameliorate negative emotional responses and alleviate social pain following experiences of social exclusion in order to prevent the development of smartphone addiction.

Thirdly, we have further demonstrated the mediating role of depression in the association between harsh parenting and adolescent smartphone addiction. Specifically, it is suggested that harsh parenting may impact adolescent smartphone addiction by elevating levels of depression among adolescents. Consequently, schools and society should allocate greater attention to students who experience harsh parenting and promptly address their depressive symptoms to prevent an exacerbation of depression as well as a more severe manifestation of smartphone addiction. Moreover, educational institutions should incorporate mental health education courses into their curriculum to enhance teenagers' psychological well-being, mitigate the influence of depression on students' smartphone addiction, and proactively combat smartphone addiction.

Finally, we have identified the serial mediating role of social pain and depression in the relationship between harsh parenting and adolescent smartphone addiction. Harsh parenting may elevate adolescent depression by amplifying social pain, which subsequently contributes to smartphone addiction. Therefore, educational institutions should prioritize addressing the experience of social pain among adolescents exposed to harsh parenting as a means to mitigate the detrimental impact of this parenting style on depression and excessive smartphone usage through social pain. Schools can implement psychological counseling interventions aimed at alleviating social pain and mitigating its adverse effects on adolescent emotional well-being and behaviors.

Limitation and Future Prospects

Although our results have some theoretical and practical implications, we still faced some limitations.

Firstly, our study was a cross-sectional study and might not be able to explore the dynamic effects of harsh parenting on adolescents depression, social pain, and smartphone addiction. Therefore, it is imperative to employ longitudinal data to examine the long-term impact of harsh parenting on future smartphone addiction, and further investigate the mediating role of depression and social pain in the relationship between harsh parenting and smartphone addiction.

Secondly, in this study, the measurement of harsh parenting was solely based on children's perspective, which may not objectively reflect the actual situation. Therefore, future research should incorporate parental perspectives to provide a more comprehensive assessment of harsh parenting.

Thirdly, our findings indicate that depression and social pain partially mediate the association between overall harsh parenting and paternal harsh parenting on adolescent smartphone addiction, suggesting the existence of additional mechanisms underlying this relationship. Therefore, future research should further investigate other factors that mediate the effects of overall harsh parenting and paternal harsh parenting on adolescent smartphone addiction to enhance our understanding of these findings.

Finally, the mediating mechanisms we selected were depression and social pain, both of which constituted negative factors. By mitigating the levels of depression and social pain, we could potentially reduce the incidence of smartphone addiction among adolescents. However, it is important to note that depression and social pain persist in students and continue to exert an influence on smartphone addiction. Therefore, future studies should explore positive mediating mechanisms or protective factors in order to provide more constructive approaches for preventing or alleviating adolescent smartphone addiction.

Conclusions

(1) The Social Pain Scale had good applicability in Chinese adolescents.

(2) There were significant, positive correlations among harsh parenting and smartphone addiction, depression and social pain.

(3) Social pain and depression partially mediated the relationship between harsh parenting / paternal harsh parenting and smartphone addiction, while completely mediated the relationship between maternal harsh parenting and smartphone addiction.

Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics

The procedures we conducted on human subjects were approved by the ethical standards of the Academic Committee of Shandong Normal University, and conformed to the ethical standards set forth in the 1964 Declaration of Helsinki and its later amendments or similar ethical standards. The participants signed informed consent forms and were told they could withdraw from the research at any time.

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This manuscript has not been published previously and that it is not under consideration for publication elsewhere.

Disclosure

The authors report no conflicts of interest in this work.

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