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Parent–child relationship and Smartphone Use Disorder among Chinese adolescents: The mediating role of quality of life and the moderating role of educational level

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Highlights:

1. Adolescents who have better relationships with parents reported lower levels of Smartphone Use Disorder.
2. The effect of parent–child relationship on Smartphone Use Disorder was mediated by quality of life.
3. Adolescents who have better relationships with parents reported higher quality of life.
4. The effect of parent–child relationship on quality of life was weakened with increase in educational level.

Abstract: The present study explored the effect of parent–child relationship on Smartphone Use Disorder (SUD) and the mediating role of quality of life (QOL). In

addition, we explored the role of educational level from the developmental psychology perspective. Our results indicate that: (1) parent–child relationship could negatively predict SUD among adolescents; (2) QOL played a partial mediator role in the relationship between parent–child relationship and SUD; (3) As educational level increased from elementary school to middle school to high school, the effect of parent–child relationship on QOL weakened. This study showed that adolescents with good parent–child relationship had a higher QOL thus exhibiting a lower extent of SUD. Moreover, the link between parent–child relationship and SUD weakened as the educational level increased.

Key words: Parent–child relationship; Smartphone Use Disorder; Quality of life; Educational level; Adolescents.

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1. Introduction

With the popularity of smartphone among adolescents, Smartphone Use Disorder (SUD) is attracting increasing attention from researchers (Hong, Chiu, & Huang, 2012). In 2012, approximately 20% of Chinese adolescents reported SUD (He, Chen, Bao, & Lei, 2012). Researchers have addressed relevant issues such as SUD (Sha, Sariyska, Riedl, Lachmann, & Montag, 2019), mobile phone addiction (Hong et al., 2012), excessive smartphone use (Shen & Wang, 2019), problematic mobile phone use (Beranuy, Oberst, Carbonell, & Chamarro, 2009), and pathological smartphone use (Saidon, Musa, Harun, & Adam, 2016). Based on recent developments in ICD-11 using the term Gaming Disorder instead of Gaming Addiction and the prominent perspective of I-PACE model (Brand, Young, Laier, Wölfling, & Potenza, 2016; Brand et al., 2019; Pontes et al., 2019), researchers are more inclined to use the terms SUD and Internet Use Disorder (IUD) instead of Mobile Phone Addiction and Internet Addiction (Müller, Brand, Mies, Lachmann, Sariyska, & Montag, 2017; Sha et al., 2019). Therefore, we use the term SUD in this study to refer to excessive and uncontrollable behaviors related to smartphone use (Griffiths, 2017). Empirical study showed that SUD has detrimental consequences on individual psychological and physical health. Specifically, SUD was found associated with negative emotions, interpersonal problems, low educational achievement, and suicidal ideation (Chen, Yan, Tang, Yang, Xie, & He, 2016; Hakala, Rimpelä, Saarni, & Salminen, 2006; Kates, Huang, & Coryn, 2018; Tanja, Mandy, Juliane, Nico, Antje, & Wieland, 2019;

Wang et al., 2014; Yang, Chen, Huang, Lin, & Chang, 2017).

There are close relationships between IUD and SUD. Smartphones have become the most popular Network Terminal in recent years. For example, by February 2019, more than 98% of netizens in China were smartphone netizens (CNNIC, 2019). Therefore, SUD can be regarded as a new manifestation of IUD (Lin, Chang, Lee, Tseng, Kuo, & Chen, 2014; Liu, Yang, Lin, Yu, & Zhou, 2017). Generally, IUD can be categorized into generalized IUD and specific IUD (Chen, et al., 2019; Leung et al., 2019). Generalized IUD involves a general, multidimensional overuse of the Internet. In contrast, specific IUD involves a specific Internet-related activity such as Internet Gaming Disorder or Social Networking Disorder (Davis, 2001; Montag et al., 2015). The SUD discussed in the current study is a generalized IUD because it does not pertain to a specific activity like the case of Internet Gaming Disorder, Social Networking Disorder, or Cybersex Disorder (Baggio et al., 2018; Montag et al., 2015).

Numerous studies have confirmed the link between parent–child relationship and adolescents' behavior disorders, such as the positive association between (generalized) IUD and Internet Gaming Disorder (a form of specific IUD) (King & Delfabbro, 2016; Shek, Zhu, & Ma, 2018; Wang et al., 2018). However, little is known about the relationship between parent–child relationship and SUD. There are similarities and differences between IUD and SUD. For example, both IUD and SUD involve vulnerable personalities (Duke & Montag, 2017; Lachmann, Duke, Sariyska, & Montag, 2017; Lachmann, Duke, Sariyska, & Montag, 2019; Peterka-Bonetta,

Sindermann, Elhai, & Montag, 2019). Unlike IUD, SUD is usually associated with loss of control, social anxiety, and needs for physical contact (Lee, Chang, Lin, & Cheng, 2014).

Therefore, a moderated mediation model was evaluated in this study. First, the link between parent–child relationship and SUD could be mediated by quality of life (QOL). Second, the indirect effect of parent–child relationship and SUD through QOL could be moderated by educational level.

1.1. Parent–child relationship and SUD

According to Bronfenbrenner's (2005) ecological systems theory, adolescents experience continuous, significant, and reciprocal interactions with their immediate environment such as parents, teachers, siblings, and peers. A stable family environment is an important protective factor for adolescents (Vanassche, Sodermans, Matthijs, & Swicegood, 2014). Also, the family system is vital in adolescent IUD (Wartberg, Kriston, Kammerl, Petersen, & Thomasius, 2015). The family is an important contextual factor for adolescents' growth and development (Lin & Tsai, 2016). Family can provide adolescents both emotional warmth and social support (Dobewall et al., 2018). Family factors could influence adolescents' psychological health, such as psychological well-being, self-esteem, and interpersonal relationships (Lin et al., 2016) as well as physical health, such as lack of physical exercise and obesity (Lin, Fung, Tsai, Strong, Hsieh, & Lin, 2019). As a crucial aspect of the family system, parent–child relationship closely associated with adolescents' IUD. The attachment theory states that secure attachments with parents provide warmth and

support to children (Bowlby, 1982; Chng, Li, Liao, & Khoo, 2015). Adolescents with insecure parent–child attachments are more vulnerable to IUD. Many studies showed that poorer parent–child relationship related to more use of the Internet, and in some cases led to IUD (Chen, Li, Bao, Yan, & Zhou, 2015; Jafar & Touraj, 2012).

Despite the evidence associating parent–child relationship with IUD, the relationship between parental factors and SUD is rarely studied. For example, child neglect, psychological abuse, parent–adolescent conflict and parenting style could contribute to SUD (Lian, You, Huang, & Yang, 2016; Shah, Chauhan, Gupta, & Sen, 2016; Sun, Liu, & Yu, 2019). Despite the differences between SUD and IUD, they are both technology disorders, characterized by the impulse to use technology devices (Jun, 2016). Thus, we expected that parent–child relationship would negatively be associated with SUD.

1.2. Mediating role of QOL

Previous studies suggested a link between parent–child relationship and IUD but few examined mediators or moderators in this link (Wang et al., 2018). Parent–child relationship could probably influences SUD through subjective QOL (Altafim, Mccoy, & Linhares, 2018; Chahine, 2014). Thus, we expected QOL could mediate the effect of parent–child relationship on SUD.

QOL means “*an individuals’ perception of their position in life in the context of the culture and value systems in which they live, and in relation to their goals, expectations, standards, and concerns*” (WHOQOL Group, 1995, p. 1405). QOL indicates individual satisfaction with different aspects of their lives (Costanza et al.,

2007). A high QOL is considered a symbol of successful development (Vandeleur, Walter, Armstrong, Robinson, Nixon, & Horne, 2018). Positive psychology focuses on the way people express and handle their emotions (Khazaei, Khazaei, & Ghanbari-H, 2017). According to the broaden-and-build theory, positive emotions can improve cognitive and emotional levels and promote positive behaviors (Fredrickson, 2001; Fredrickson, Mancuso, Branigan, & Tugade, 2000). Poor parent-child relationship, which involves reduced emotional warmth and supportive acceptance, can lower people's perception and assessment of QOL (Moreno, Janssen, Cox, Colby, & Jackson, 2017). To alleviate negative emotions, people with poor parent-child relationships would turn their attention elsewhere and, thus, they may exhibit problematic behaviors (Xuan et al., 2018). Therefore, QOL could be a vital mediator between poor parent-child relationship and problem behaviors.

First, it is reasonable to believe that poor parent-child relationships could impair QOL (Altafim et al., 2018; Chahine, 2014). Parent-child relationship can provide warmth and acceptance to adolescents (Papp, Cummings, & Goeke-Morey, 2005). Adolescents suffering poor parent-child relationship may lose this source of support, experience worse subjective well-being, and display low QOL (Steele & Mckinney, 2018; Tam, Kwok, Ling, & Li, 2018). Empirical studies have established the relationship between child abuse and child QOL (Chahine, 2014). Consistent with these views, we hypothesized that adolescents who experience poor parent-child relationship tend to report lower QOL.

Second, low QOL may be a contributing factor for SUD. A previous study has

shown as the association between low QOL and disordered behaviors such as gambling disorder and disordered impulse control (Chamberlain & Grant, 2019). Also, research has revealed the associations between low life satisfaction and high IUD and between low life satisfaction and high SUD (Lachmann et al., 2018; Pontes, Szabo, & Griffiths, 2015; Shahnaz & Karim, 2014). SUD is accompanied by impulsive and out-of-control behaviors related to the use of smartphones (Leung, 2008). Therefore, we expected that people with lower QOL would display a greater extent of SUD. Based on existing research summarized above, we predicted that parent–child relationship would influence the QOL, which would influence adolescents’ SUD. Based on these, we proposed hypothesis 1: **(H1)**: QOL would mediate the link between parent–child relationship and SUD.

1.3. The moderating role of educational level

Although parent–child relationship might be related to SUD through QOL, this effect may vary according to individual factors. Based on Shaffer’s (2016) view, adolescents at different stages of development showed differences in physiological, cognitive, and social development. Generally speaking, adolescence can be divided into three different stages: preadolescence (about 9–12 years old), early adolescence (around 13–16 years old), and late adolescence or early adulthood (around 17–21 years old) (Turkstra, 2010). Correspondingly, adolescents have individual differences at three different educational levels: fifth and sixth grades of elementary school, middle school, and high school. One existing study (Jang & Ryu, 2016) observed differences regarding the link between parenting behavior and adolescents’

problematic mobile phone use in three different age groups (elementary school, middle school, and high school). In addition, from elementary school to middle school to high school, differences were observed regarding the prevalence of smartphone use and extent of smartphones dependence (Gao, Zheng, Zhao, Ying, & Lei, 2014). Specifically, as the educational level increased, the prevalence of smartphone use and the extent of smartphone dependence in adolescents also increased.

Moreover, as parent–child conflict increases, there is a higher risk of children’s problematic behavior (Davies, Martin, & Sturge-Apple, 2016). As children grow up, there are changes in the parent–child relationship. A meta-analysis study (Laursen, Coy, & Collins, 1998) showed that parent–child conflict first increases then decreases throughout adolescence. Specifically, during the transition to adulthood, there is a plausible decrease in mother–youth relationship because adolescents are more involved in personal relationships and activities outside the home (Castellani et al., 2014). In addition, from early to middle adolescence, the way both adolescents and parents resolve the parent–child conflict gradually changes to support a more horizontal relationship (Van Doorn, Branje, & Meeus, 2011). Thus, the effect of parent–child relationship on the children’s behavior problems depends on the children’s age (Kim, Schulz, Zimmermann, & Hahlweg, 2018; Knauer, Ozer, Dow, & Fernald, 2018; López-Pérez & Wilson, 2015; Steele et al., 2018; Stockdale, Coyne, & Padilla-Walker, 2018). We expect that educational level would moderate the effects of parent–child relationship on SUD via QOL.

Therefore, this study aimed to explore at which educational level the parent–

child relationship is more likely to inhibit or promote SUD effectively. Based on these, we proposed hypothesis 2: (**H2**): Educational level would moderate the mediation process (see Fig. 1). Specifically, the effect of parent–child relationship on QOL would be weakened with the increase in educational level.

1.4. This study

Based on above, the current study tested the following hypotheses: **H1**: QOL would mediate the link between parent–child relationship and SUD; **H2**: Educational level would moderate the mediation process (see Fig. 1). Specifically, the effect of parent–child relationship on QOL would be weakened by increased educational level. We expected that poorer parent–child relationships would be associated with lower QOL, which would then relate to higher extents of SUD. Also, our mediation process would be moderated by educational level.

[Figure 1 about here]

2. Method

2.1. Participants

Cluster sampling was used to select participants from three elementary, middle, and high schools in Shenzhen, China. Then, within each school, cluster sampling was used to randomly select several classes. Finally, 1769 students were recruited to participate in our study. Students understood the anonymity and confidentiality of the survey and voluntarily filled in questionnaires in the classroom for about 20 min. There are approximately 40–50 students in each class. Trained graduate students gave standardized instructions in front of the class. This study was approved by the Ethics

Committee of Shenzhen University. We obtained informed consent forms from the participants and their parents. After excluding two students reporting not having or using a smartphone, 1767 valid samples were obtained. 51.8% of the adolescents were males. The mean age of the participants was 13.33 (SD = 1.94, range = 10–18). There are 556 elementary school students (M = 11.43, SD = 1.06), 644 middle school students (M = 12.89, SD = 0.80), and 567 high school students (M = 15.67, SD = 0.83).

2.2. Measures

2.2.1. Parent–child relationship

The Parent–child Relationship Scale (Kerr & Stattin, 2000) was used to measure parent–child relationship. Sixteen items were measured on a four-point Likert scale (1 = never and 5 = always) with two subscales: (1) Father–child relationship (eight items, such as “how disappointed you are with your father?”); (2) Mother–child relationship (eight items, such as “how disappointed you are with your mother?”). The total score ranged between 16 and 64. A higher score represents a better parent–child relationship. The scale has been a valid measurement of parent–child relationship in Chinese adolescents (Hawk, 2017; Zhang, Yu, Xu, Wei, & Yan, 2015). Cronbach’s alpha for our study was satisfactory ($\alpha = 0.86$).

2.2.2. QOL

The Subjective QOL Questionnaire (Cheng & Gao, 1998) was used to measure QOL. This study used 47 items to measure seven dimensions of QOL: (1) Anxiety experience (eight items, such as “feeling nervous when asking questions or taking

exams in class”); (2) depression experience (seven items, such as “feeling pessimistic and disappointed with the future”); (3) peer interaction (six items, such as “my friends are very friendly to me”); (4) school life (eight items, such as “it would be nice there’s no study”); (5) family life (seven items, such as “like spending time with parents”); (6) somatosensory (five items, such as “feeling difficulty breathing or fainting”); (7) self-awareness (six items, such as “most people like me”). Each item was measured on a four-point Likert scale (1 = never and 4 = always). The total score ranged from 47 to 188. A higher score represents a better QOL. This scale is a valid and reliable measurement of subjective QOL in Chinese adolescents (Lan, Zhang, Li, & Xu, 2004; Li et al., 2016; Wang, Xu, Li, Cao, & Hao, 2010; Zhou, Liu, & Song, 2009; Zhu et al., 2017). Cronbach’s alpha of this study was adequate ($\alpha = 0.79$). See details in Supplementary Table 1 for correlations on the subscales of the Subjective QOL Questionnaire.

2.2.3. SUD

The Mobile Phone Addiction Index (MPAI) (Leung, 2008) was used to measure SUD. Seventeen items were used to measure four dimensions: (1) Inability to control craving (seven items, such as “someone said that smartphones took up my time over much”); (2) anxiety and feeling lost (five items, such as “when a smartphone is not around for a while, I always worry about missing important information or smartphone calls”); (3) withdrawal and escape (three items, such as “when I feel isolated, I will use smartphone with others”); (4) productivity loss (two items, such as “the time spent on smartphone directly decreased to the efficiency of my work or

learning”). Each item was measured on a five-point Likert scale (1 = strongly disagree and 5 = strongly agree). The total score ranged between 17 and 85. A higher score represents higher extent of SUD. The scale has been a reliable and valid measurement of SUD in Chinese adolescents and college students (Gao, Li, Zhang, Gao, & Mei, 2017; Liu, Zhou, Niu, & Fan, 2017). Cronbach’s alpha of this study was good ($\alpha = 0.90$). See details in Supplementary Table 2 for correlations on the subscales of the MPAL.

2.3. Common method biases

Anonymous response and reverse coding of some items were carried out to avoid common method biases. Harman’s single-factor test was used to test the deviation in common biases. The results show that there were 15 factors with the original root greater than 1. The cumulative variance explained by the first factor was 19.46%, and the critical value was less than 40%. This indicated no severe common method biases in this study (Zhou & Long, 2004).

2.4. Statistical analyses

First, the SPSS data analysis package (version 24.0) was used to conduct descriptive statistics and correlation analysis. Second, regression analysis was carried out using Baron and Kenny’s (1986) four-step method and Bootstrapping method to evaluate the mediation effect. Finally, the moderator role of the educational level was evaluated using Hayes’s (2013) PROCESS macro. The bootstrapping procedure was used to estimate the indirect effect and confidence intervals (CI).

3. Results

3.1. Descriptive statistics and correlation analysis

As shown in Table 1, most participants used smartphones. 47.70% of the participants used smartphones less than 5 h a week; 26.80% of the participants used smartphones 5–10 h a week; 11.60% of the participants used smartphones 10–15 h a week; 6.10% of the participants used their smartphones for 15–20 h a week; 7.80% of the participants used smartphones for more than 20 h a week.

[Table 1 about here]

As shown in Table 2, parent–child relationship negatively related to SUD and positively related to QOL. QOL was negatively associated with SUD. As expected, parent–child relationship negatively related to SUD.

[Table 2 about here]

3.2. Testing for mediation

The mediation test was analyzed controlling for gender and age. As shown in Table 3, parent–child relationship negatively predicted SUD ($\beta = -0.27, P < 0.001$) and positively predicted QOL ($\beta = 0.54, P < 0.001$). When regressing SUD on both QOL and parent-child relationship, both QOL ($\beta = -0.22, P < 0.001$) and parent-child relationship ($\beta = -0.16, P < 0.001$) negatively predicted SUD. The results showed that QOL partially mediated the effects of parent–child relationship on SUD.

The indirect effect and CI were evaluated using Bootstrapping procedure (sample size = 5000). The indirect effect of parent–child relationship on SUD via QOL was $-0.1168, 95\% CI = [-0.14, -0.08]$. The 95% CI did not include zero, indicating that parent–child relationship had a significant indirect effect on SUD through QOL.

[Table 3 about here]

3.3. Testing for moderated mediation

As shown in Table 4, the only significant effect was the interaction effect of parent–child relationship and educational level on QOL ($\beta = -0.05, p < 0.001$). Specifically, the link between parent–child relationship and QOL weakened as the educational level increased. As shown in Fig. 2, the effect of parent–child relationship on QOL weakened from elementary school ($\beta = 0.54, p < 0.001$) to middle school ($\beta = 0.45, p < 0.001$) to high school ($\beta = 0.35, p < 0.001$). Besides, the indirect effect of parent–child relationship on SUD via the QOL also varied across educational level. As shown in Table 5, the conditional indirect effect weakened from elementary school ($\beta = -0.10, p < 0.001$) to middle school ($\beta = -0.09, p < 0.001$) to high school ($\beta = -0.08, p < 0.001$). 26% of the variance in SUD can be explained by this model.

[Table 4 about here]

[Table 5 about here]

[Figure 2 about here]

4. Discussion

We examined the potential mechanism underlying the link between parent–child relationship and SUD in a large sample of Chinese adolescents. The results indicate that QOL had a mediating effect on the link between parent–child relationship and SUD. Besides, the mediating effect of QOL was moderated by educational level.

4.1. The mediating role of QOL

We found that QOL partially mediated the link between parent–child relationship and SUD among adolescents. These findings are consistent with previous studies, indicating that poor parent–child relationship was a risk factor for IUD and Internet Game Disorder (King et al., 2016; Lian et al., 2016; Shek et al., 2018; Wang & Qi, 2017) and revealing that QOL would affect subjective well-being (Meiselman, 2016). This study highlighted the critical role of QOL in this link.

On the one hand, we found that poor parent–child relationship enhanced the risk of SUD, and this effect was partially mediated by QOL. This result coincides with the broaden-and-build theory, with the opinion that individuals can better face acceptance and criticism and deal with their problems and situations by cultivating positive emotions (Datu & King, 2016; Fredrickson, 2001). Mauss, Tamir, Anderson, and Savino (2011) pointed out that individuals who reported more happiness and higher satisfaction of life were better at enduring stress and solving problems. Poor parent–child relationship, a significant negative stimulus for adolescents, could threaten and damage their QOL (Steele et al., 2018), thus creating more negative emotions. Consequently, they may use smartphones to escape from pain and troubles caused by their lower QOL, thus more likely to suffer from SUD.

On the other hand, QOL could effectively inhibit the adverse effect of poor parent–child relationship on SUD. QOL, an indicator of the immediate living conditions and personal goals to an individual, can characterize the individual's surrounding environments (Jennings, 2002). For example, school-age adolescents who were not victims of bullying have a higher QOL (Kadiroğlu, Hendekci, & Tosun,

2018). Useful supports and partnership can promote family QOL (Balcells-Balcells, Giné, Guàrdia-Olmos, Summers, & Mas, 2019). Thus, by improving peer relationship and promoting useful supports, it is possible to promote QOL. Except for the above mediation effects, every link in our mediation model deserves attention. First, the result that parent–child relationship positively influenced QOL is consistent with previous studies (Altafim et al., 2018; Chahine, 2014). Adolescents with poor parent–child relationship may feel exhausted and experience more negative emotions, leading to lower QOL. In contrast, a good relationship with parents was a protective factor for adolescents' psychological health outcomes (Lin, Latner, Fung, & Lin, 2018). The result regarding the link between QOL and SUD is also consistent with existing research, which showed that QOL would influence impulsive or compulsive behaviors (Chamberlain et al., 2019). Adolescents with lower QOL have a higher risk of SUD because the social support received from smartphones may help them escape from the pain in the real world. Another possible explanation is that the maladaptive-cognition aspect of QOL would increase the degree of SUD (Davis, 2001). Finally, besides QOL, the link between parent–child relationship and SUD could be mediated by other factors. Future studies could explore other mediators in the link between parent-child relationship and SUD.

4.2. The moderating role of educational level

With increasing educational level, the indirect effect of parent–child relationship on SUD via QOL is weaker among students from elementary school to middle school to high school. It is consistent with differentiation of the self (Kerr et al., 1988). This

theory proposed that people with high levels of differentiation of the self were inclined to maintain a balance between independence and emotional connections when interacting with others. They can maintain a clear sense of self when they mix with others, instead of meeting the expectations of others. Moreover, from the developmental perspective, people gradually gain complete self-identity throughout adolescence (Berzonsky, 1990; Beyers & Çok, 2008; Dahl, Allen, Wilbrecht, & Suleiman, 2018; Shaffer et al., 2016). Adolescence is a key stage in human development (Bart & Beatriz, 2018; Nandita, Zdena, Shirtcliff, & Pfeifer, 2018; Sawyer et al., 2012). At this stage, a lot of factors can affect the cognitive and behavioral development of adolescents (Steinberg & Morris, 2001). With age, students gradually move from family to society and progressively gain complete self-identity (Berzonsky, 1990; Beyers et al., 2008). Thus, the effect of external environmental factors on students is weakening. Therefore, the indirect effect of parent-child relationship on SUD via QOL becomes weaker as the educational level increases.

In all, the findings of this study have great significance. From the perspective of parent-child relationship, we explored the effect of parent-child relationship on adolescents' SUD and its underlying mechanism based on attachment theory. In particular, we firstly used the attachment theory to examine the effect of parent-child relationship on adolescents' SUD. Second, based on the perspective of positive psychology, we explored the potential mechanism in the association between parent-child relationship and SUD. Also, from the perspective of developmental

psychology, we tested that educational level moderated the indirect effect of parent-child relationship on SUD. Specifically, relatively good parent-child relationship is associated with relatively high QOL in adolescents, which is associated with relatively low risks for SUD. Moreover, the effect of parent-child relationship on QOL and SUD in adolescents is moderated by educational level of the adolescent.

5. Conclusions

Altogether, this study expanded the previous studies by testing a moderated mediation model to elucidate the potential mechanism between parent-child relationship and SUD among adolescents. In all, a functional parent-child relationship could improve QOL, which partially, in turn, reduced the risk of SUD. Moreover, the current study tested the buffering effect of educational level on the link between poor parent-child relationship and SUD, which can guide intervention and prevention efforts.

Nevertheless, this study has several limitations. First, the sample representativeness cannot be reached out to the Western population. Second, there might be more mediators in the link between parent-child relationship and SUD other than QOL. The current study focused on the QOL as a mediator. In the future, we need more exploration to enrich our understanding of the mechanism through which parent-child relationship could influence SUD. Third, in the Western population, previous studies showed that adolescents with poor parent-child relationship were more prone to disorder behaviors (Felitti et al., 1998; Thege, Horwood, Slater, Tan, Hodgins, & Wild, 2017). In the Asian population, previous studies showed that poor parent-child relationship would increase the risk of adolescent SUD (Kim & Chun,

2018; Li, & Hao, 2019). Since our research only studied the Chinese adolescent population, whether the findings can be extended to more cross-cultural populations is subject to future verification. In the future, we need to explore the difference and similarities regarding the link between parent-child relationship and SUD across different cultures. Also, the cross-sectional design cannot decide causality. Additionally, this study used self-reports to capture SUD. This may be biased due to social desirability or recall bias. Lastly, only the SUD inventory was used to capture IUD. Because there are other types of IUD, it is difficult to know whether the study results can be generalized to other types of generalized IUD or technology addictions.

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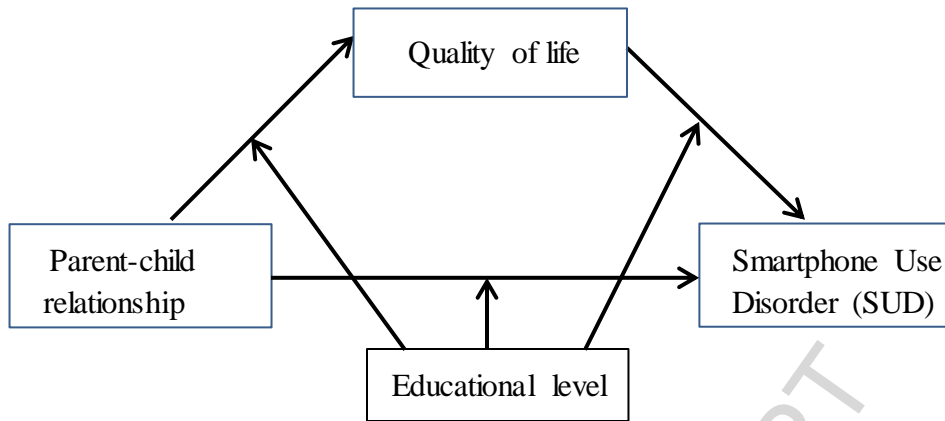


Fig. 1.Conceptual model.

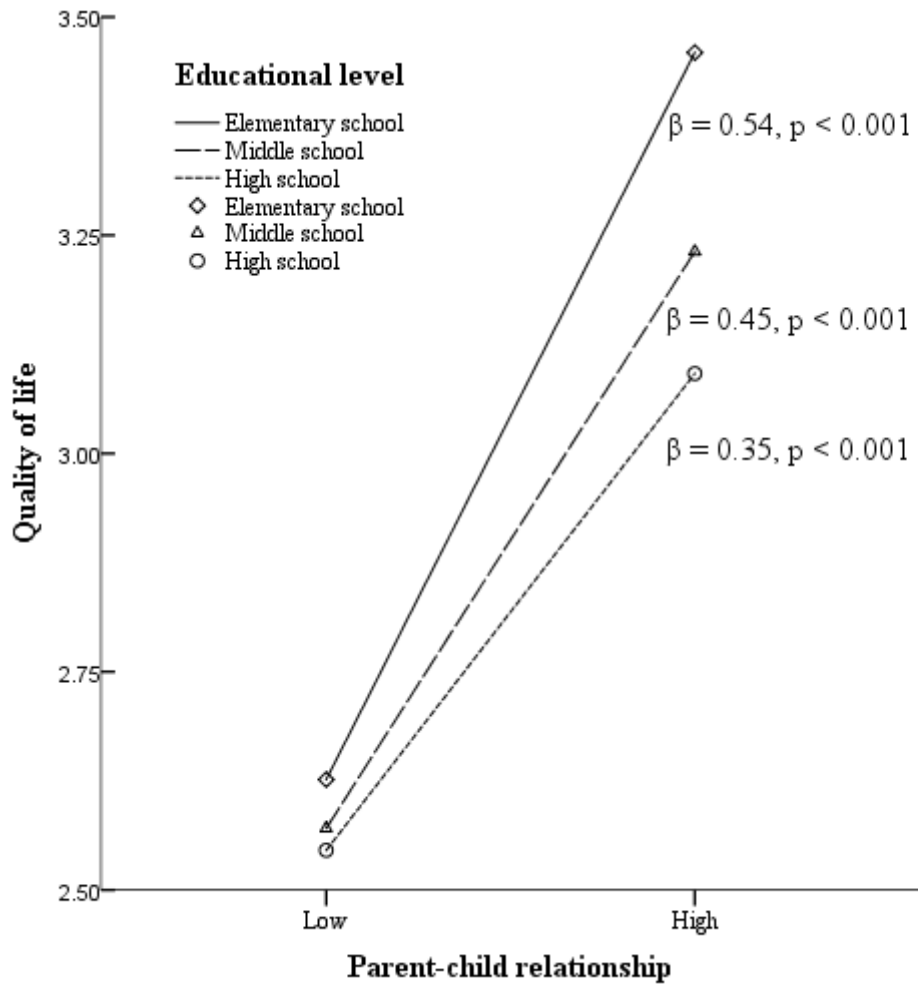


Fig.2. The interaction between parent-child relationship and educational level on quality of life.

Table 1 Descriptive statistics

	Elementary school (n=556)	Middle school (n=644)	High school (n=567)	Total (n=1767)	χ^2 or F	d f	p
Age M SD	11.43 1.06	12.89 0.80	15.67 0.83	13.3 3	325 8.9	2	0.001
Gender							
Male n,%	288 51.80%	345	306	939	0.6	2	0.001

				53.60%	54.00	53.1	1	7
					%	0%		3
Female n,%	268	48.20%	299	46.40%	261	828		9
					46.00	46.9		
					%	0%		
Usage time of smartphone per week								
<5 hours n,%	384	69.10%	279	43.30%	180	843		
					31.70	47.7		
					%	0%		
5-10 hours n,%	129	23.20%	159	24.70%	186	474		
					32.80	26.8		
					%	0%		
10-15 hours n,%	22	4.00%	87	13.50%	96	205	210	0.
					16.90	11.6	.34*	0
					%	0%	**	0
						108		0
15-20 hours n,%	14	2.50%	41	6.40%	53	6.10		
					9.30%	%		
>20 hours n,%	7	1.30%	78	12.10%	52	137		
					9.20%	7.80		
					%	%		
Usage time of smartphone per week in different activities M SD								
Social networking	2.16	5.89	3.25	5.12	3.40	2.96	10.34*	0.
					3.73	5.02	**	0
							2	0
								0.
Gaming	2.08	6.69	2.43	4.47	1.85	2.13	2.0	1
					3.56	5.05	3	2
								3
								1
								0.
Entertainment	3.25	9.67	5.03	10.30	4.45	4.28	6.4	0
					4.75	8.70	4**	2
								0
								2
								0.
Learning	2.78	8.92	2.58	7.50	2.07	2.48	1.4	2
					4.59	7.23	4	2
								3
								7

Note. $N = 1767$. $M =$ mean. $SD =$ standard deviations. ** $p < 0.01$, *** $p < 0.001$.

Table 2 Correlations between variables.

Variables	M	SD	1	2	3	4
1.Age	13.33	1.94	1			
2.Parent-child relationship	3.03	0.52	-0.10 ^{***}	1		
3.Smartphone Use Disorder (SUD)	2.44	0.84	0.39 ^{***}	-0.31 ^{***}	1	
4.Quality of life	2.95	0.44	-0.26 ^{***}	0.56 ^{***}	-0.39 ^{***}	1

Table 3 Mediation analysis.

Outcome variable	Prediction variable	<i>R</i>	<i>R</i> ²	<i>F</i>	β	<i>LLCI</i>	<i>ULCI</i>	<i>t</i>	
SUD	Gender	0.48	0.23	171.04 ^{***}	0	-0.09	0.08	-0.12	
	Age				0.36	0.32	0.4	17.13 ^{***}	
	Parent-child relationship					-0.27	-0.32	-0.23	-13.01 ^{***}
	Parent-child relationship					0.54	0.5	0.58	28.25 ^{***}
Quality of life	Gender	0.6	0.36	330.39 ^{***}	0.02	-0.03	0.12	1.19	
	Age				-0.21	-0.25	-0.17	-10.87 ^{***}	
	Parent-child relationship					0.54	0.5	0.58	28.25 ^{***}
	Parent-child relationship					-0.16	-0.21	-0.11	-6.31 ^{***}
SUD	Gender	0.51	0.26	150.98 ^{***}	0	-0.08	0.09	0.12	
	Age				0.32	0.27	0.36	14.81 ^{***}	
	Parent-child relationship					-0.16	-0.21	-0.11	-6.31 ^{***}
	Quality of life					-0.22	-0.27	-0.17	-8.40 ^{***}

Note. $N = 1767$. *LLCI* = lower limit of the 95% confidence interval, *ULCI* = upper limit of the 95% confidence interval. *** $p < 0.001$.

Table 4 Coefficients for the moderated mediation model.

	<i>Coeff.</i>	<i>SE</i>	<i>LLCI</i>	<i>ULCI</i>
Quality of life				

Constant	3.30 ^{***}	0.09	3.13	3.46
Gender	0.02	0.02	-0.02	0.05
Age	-0.02	0.01	-0.03	0
Parent-child relationship	0.32 ^{***}	0.02	0.28	0.36
Educational level	-0.08 ^{***}	0.02	-0.13	-0.04
Parent-child relationship × Educational level	-0.05 ^{***}	0.01	-0.07	-0.03
$R^2=0.37$				
$F=210.36^{***}$				
SUD				
Constant	1.79 ^{***}	0.43	0.95	2.64
Gender	0	0.03	-0.06	0.07
Age	0.10 ^{***}	0.02	0.07	0.14
Parent-child relationship	-0.21 ^{***}	0.06	-0.32	-0.1
Quality of life	-0.31 [*]	0.13	-0.56	-0.06
Educational level	0.22	0.19	-0.15	0.59
Parent-child relationship × Educational level	0.04	0.03	-0.01	0.09
Quality of life × Educational level	-0.04	0.06	-0.16	0.08
$R^2=0.26$				
$F=87.55^{***}$				

Table 5 Conditional indirect effect of parent-child relationship on SUD via quality of life at different educational level.

Educational level	β	Boot SE	Boot LLCI	Boot ULCI
Elementary school (1.00)	-0.1	0.02	-0.14	-0.06
Middle school (2.00)	-0.09	0.01	-0.11	-0.07
High school (3.00)	-0.08	0.01	-0.1	-0.05

Highlights

1. Adolescents who have better relationships with parents reported lower levels of Smartphone Use Disorder.
2. The effect of parent–child relationship on Smartphone Use Disorder was mediated by quality of life.
3. Adolescents who have better relationships with parents reported higher quality of life.
4. The effect of parent–child relationship on quality of life was weakened with increase in educational level.

Conflict of Interest

All authors have no conflicts of interest.

ACCEPTED MANUSCRIPT

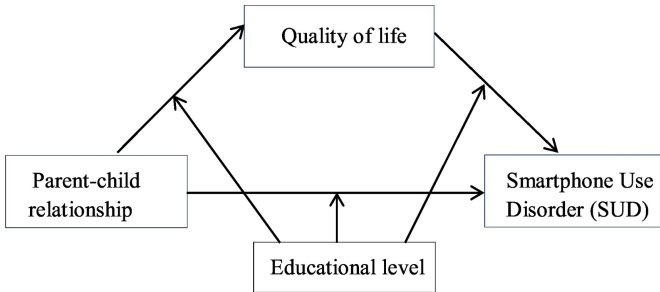


Figure 1

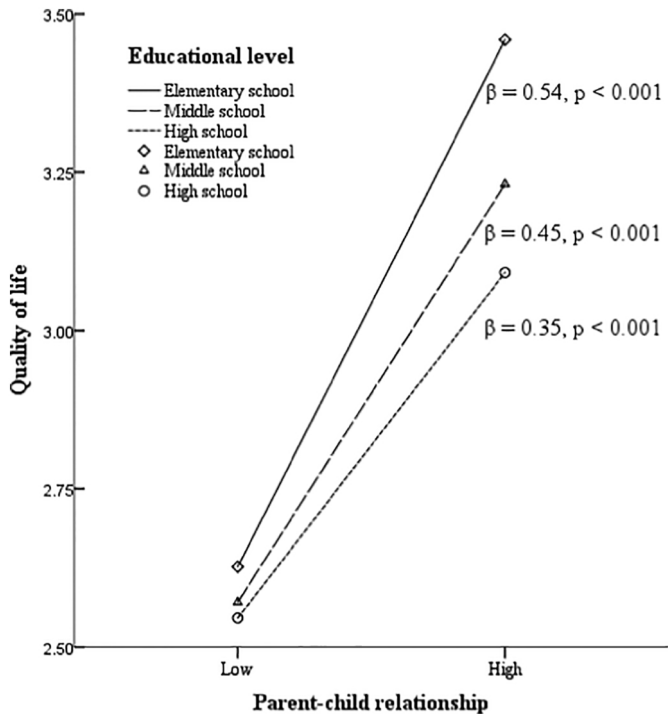


Figure 2