How different levels of mobile phone addiction relate to adolescent depressive symptoms: the mediating role of parent-adolescent relationships

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Abstract

The present study aims to examine and compare, in both mobile phone addicts (MPAs) and possible-MPAs, (1) the direct effect of mobile phone addiction (MPA) levels on adolescent depressive symptoms, and (2) the indirect effect of MPA levels on depressive symptoms as mediated by parent-adolescent relationships. We recruited 1766 Chinese adolescents (53.2% male; M_{age}= 13.30, SD = 2.00, *range* from 10 to 18 years) from Shenzhen Shuijing Primary School, Shenzhen Longcheng Middle School, and High School of Shenzhen Overseas Chinese Town in China. The participants completed a questionnaire survey that measured MPA levels, parent-adolescent relationships, and depressive symptoms. The results showed that (1) The direct effect of MPA on adolescent depressive symptoms was stronger than that of possible MPA; (2) the indirect effect of MPA on depressive symptoms through parent-adolescent relationships was stronger than that of possible MPA. This study expanded the interdependent relationship between Internet addiction and depression by illustrating the mediating mechanism of parent-adolescent relationships in the link between different levels of MPA and adolescent depressive symptoms, having made an important contribution to the development of family-based prevention and intervention strategies for adolescent depressive symptoms.

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Introduction

The number of mobile phone users in China reached 1028.74 million as of December 2021, around 13.3% among which are adolescents (aged 10–19 years) (CNNIC, 2022). Mobile phones play an essential role in adolescents' lives, and statistics from various countries demonstrated that more than 30% of adolescents have mobile phone addiction (MPA) (He et al., 2012). In the DSM-5, Gambling Disorder was identified as the first behavioral addiction, and Internet Gaming Disorder is potentially suitable for future inclusion (American Psychiatric Association, 2013). MPA may also be included in the manual as a behavioral addition if it is found to cause significant clinical impairment (Kuss et al., 2016). Accordingly, MPA may fall within the core definition of behavioral addiction by virtue of symptoms such as withdrawal, tolerance, and relapse (Billieux et al., 2015; Griffiths, 2005; Kuss et al., 2018). A series of negative impacts of MPA on adolescents' psychological and

behavioral development (i.e. depressive symptoms, anxiety, and suicide) have been identified (Billieux, 2012). Particularly, MPA was frequently reported to be closely associated with depressive symptoms (Ivanova et al., 2020; Jun, 2016; Yang et al., 2019). The study hence aimed to explore the relation of MPA levels to depressive symptoms for developing effective intervention and prevention programs.

Mobile phone addiction levels and adolescent depressive symptoms

Depressive symptoms, the core index of internalizing problems among adolescents, are characterized by depressed mood as well as lack of interest and pleasure (Cassano & Fava, 2002). There was a surge in evidence revealing the positive relation between MPA and depressive symptoms (Billieux, 2012; Yang et al., 2019). A 3-year longitudinal study found that MPA in 8th grade could positively predict adolescent depressive symptoms in 10th grade (Jun, 2016). The main elements of addictive behaviors such as tolerance, relapse, and withdrawal are common risk factors for depressive symptoms (Billieux et al., 2015). In particular, mobile phone usage tolerance, dependence, and obsession may further exacerbate depressive symptoms (Kumar, 2014; Luo et al., 2019). According to the interdependent relationship between Internet addiction and depression (Seki et al., 2019), Internet addiction and depressive symptoms could reciprocally enhance each other by following mechanisms. As the Internet offers useful tools for individuals to relieve daily stress, its excessive use may result in the deterioration of face-to-face interpersonal relationships and further stress, which worsen depressive symptoms. Therefore, higher levels of MPA threatens adolescents' social relationships (i.e. social isolation and social anxiety) by exacerbating offline social communication and interpersonal intimacy; the lack of positive social interaction leads to more depressive symptoms (Baker & Algorta, 2016; Cui & Tian, 2020; Hou et al., 2021; Zhang et al., 2018).

Up to now, many studies have focused on the effect of MPA on depressive symptoms, but few studies explore and compare the impact of differentiated MPA levels (MPA, possible MPA, and non-MPA) on depressive symptoms (Lei & Yang, 2007). Possible MPAs, a potentially growing group of adolescents, may easily turn into MPAs when individuals engage in uncontrollable use of mobile phones. MPAs reported significantly longer daily use time (3.78 h) than possible MPAs (3.51 h) and a higher dependence on mobile phones such as using them for intermediary communication and phone calls (Lopez-Fernandez et al., 2014). Furthermore, MPAs experienced decreased social support (i.e., higher need of acceptance and closeness; Warzecha & Pawlak 2017) and vulnerable personality traits (i.e., lower

consciousness and agreeableness; Blachnio & Przepiorka 2016). Empirical evidences showed that individuals with a higher dependence on mobile phones tend to experience more depressive symptoms (Seo et al., 2016; Thomée et al., 2011). A preliminary study found that the direct effect of MPA on depressive symptoms in college students was stronger than that in possible MPAs (Chen et al., 2016). Specifically, with the increase of the Internet usage time, MPAs may experience more negative real-life relationship episodes and face an increase in social isolation, which makes them depressed (Dalbudak et al., 2013; Yoo et al., 2014). However, there is a gap in studies that would verify this finding in adolescents, a typical group of young mobile phone users, and further explore potential mechanisms linking MPA levels and depressive symptoms, which the present study aimed to achieve.

The mediating effect of parent-adolescent relationships

The interdependent relationship between Internet addiction and depression emphasizes the ways in which Internet addiction influences depressive symptoms through the mediating mechanism of interpersonal relationships (Seki et al., 2019). Individuals with Internet addiction may hence suffer from more negative relationships with significant others (broadly defined to include family, friends, and any individual who is important to them; Grasmick & Bursik Jr, 1990) and further develop more symptoms of depression. As one of the most important interpersonal relationships, parent-adolescent relationships play a significant role in determining adolescents' developmental outcomes (Anderson et al., 2010). Although previous studies have documented a negative association between MPA and parent-adolescent relationships (e.g., KHanshan & Tamnaeifar 2022; Musetti et al., 2022) and a negative association between parent-adolescent relationships and adolescent depressive symptoms (e.g., Hu & Ai 2016; Sheeber et al., 2007; Zhang et al., 2021), research has been rarely conducted until now to explore whether parent-adolescent relationships will mediate the effects of MPA levels on adolescent depressive symptoms. Combining the interdependent link between Internet addiction and depression and existing findings, parent-adolescent relationships are an important factor that could mediate the link between MPA levels and adolescent depressive symptoms.

First, there is evidence that MPA levels are an important risk factor for parent-adolescent relationships (Moawad & Ebrahem, 2016; Odendaal et al., 2006; Zhu & Li, 2017). With the advent of the Internet era, frequent and even excessive use of mobile phones has become a major feature of the digital native generation, especially adolescents (Prensky, 2001; Thompson, 2013; Zhang & Costa, 2018).

Through immersion in digital technology during childhood and adolescence, young individuals are more likely to suffer from MPA (Chambers et al., 2003; Jiang & Zhao, 2017). Specifically in the cultural context of China, parents show higher educational expectations for their children, and thus adolescents are required to focus on academic tasks rather than spending much time on mobile phones (Huo & Yuan, 2015; Ren & Edwards, 2015). However, adolescents with higher levels of MPA may use mobile phones in ways non-expected by parents (i.e., social networks, video games, and online shopping) rather than in expected ways (i.e., academic materials and online courses). Therefore, parents are increasingly trying to monitor adolescents' online activities and monitor their use of mobile phones. Specifically, strict parental supervision, reduced interaction, and increased conflict between parents and adolescents would contribute to the emergence of negative parent-adolescent relationships (Richards et al., 2010). MPA can hence contribute to parent-adolescent conflict patterns and enhance negative family relationship experience.

Second, parent-adolescent relationships, specifically the quality of connections between parents and adolescents, are negatively related to depressive symptoms (Garcia et al., 2008; Kim et al., 2015; Lin & Tsai, 2016). For instance, parents may opt to handle conflict with adolescents by reducing the frequency of communication, exerting higher psychological and behavioral control, or conveying predominantly negative emotions (Withers et al., 2016). Resultingly, negative parent-adolescent relationships are perceived by adolescents with less emotional warmth as they are accompanied by less social support from parents, which may further put adolescents at higher risks of developing depressive symptoms. In sum, adolescents with higher levels of MPA are more likely to experience poor quality of parent-adolescent relationships, which further increases the risk of depressive symptoms. Therefore, based on the interdependent relationship between Internet addiction and depression, we proposed following hypotheses:

Hypothesis 1 *MPA has a stronger direct effect than possible MPA on the depressive symptoms of adolescents.*

Hypothesis 2 *MPA has a stronger indirect effect than possible MPA, via parent-adolescent relationships, on adolescent depressive symptoms.*

The present study

Therefore, based on the interdependent relationship between Internet addiction and depression (Seki et al., 2019), the present study aims to examine and compare, between MPAs

and possible MPAs, (1) the direct effect of MPA levels on depressive symptoms, and (2) the mediating effect of parent-adolescent relationships in this link (see the mediation model in Fig. 1).

Method

Participants and Procedures

By convenience sampling, a total of 1769 students were recruited from Shenzhen Shuijing Primary School, Shenzhen Longcheng Middle School, and High School of Shenzhen Overseas Chinese Town in China. Prior to providing the questionnaires, two postgraduate students explained the purpose and nature of this study, the participants' rights, and privacy precautions, and collected informed consents from parents and students. Participants completed questionnaires in their classrooms voluntarily and anonymously; completion of each questionnaire took approximately 20 min. The present study was approved by the Ethics Committee of Shenzhen University.

After excluding three responses with invalid answers, we finally obtained 1766 valid questionnaires (53.2% male; M_{age} = 13.30, SD = 2.00, *range* from 10 to 18 years). Our sample is comprised of 556 elementary school students of the fifth and sixth grades (M_{age} = 11.43, SD = 1.06, *range* from 10 to 14 years), 642 middle school students (M_{age} = 12.89, SD = 0.80, *range* from 11 to 16 years), and 568 high school students (M_{age} = 15.67, SD = 0.83, *range* from 14 to 18 years) who completed the survey.

Measures

Mobile Phone Addiction levels

We measured MPA levels using the Mobile Phone Addiction Index (MPAI; Leung 2008). This scale includes four dimensions: (1) inability to control craving (consisting of seven items, such as "I spend a lot of money on mobile phone usage such as excessive phone bills, games, and membership recharge."); (2) anxiety and feeling lost (including five items, such as "If I do not have my mobile phone, I will feel restless."); (3) withdrawal and escape (appearing in the survey three items, such as "When I was down, I used to use my mobile phone to make myself feel better."); (4) productivity loss (represented by two items, such as "The time spent on mobile phones has directly reduced my learning efficiency."). Each item was measured by a five-point Likert scale (1 = *not at all*, 2 = *rarely*, 3 = *occasionally*, 4 = *often*, and 5 = *always*). The total score of MPAI ranged from 17 to 85. According to cut-off values of the total score
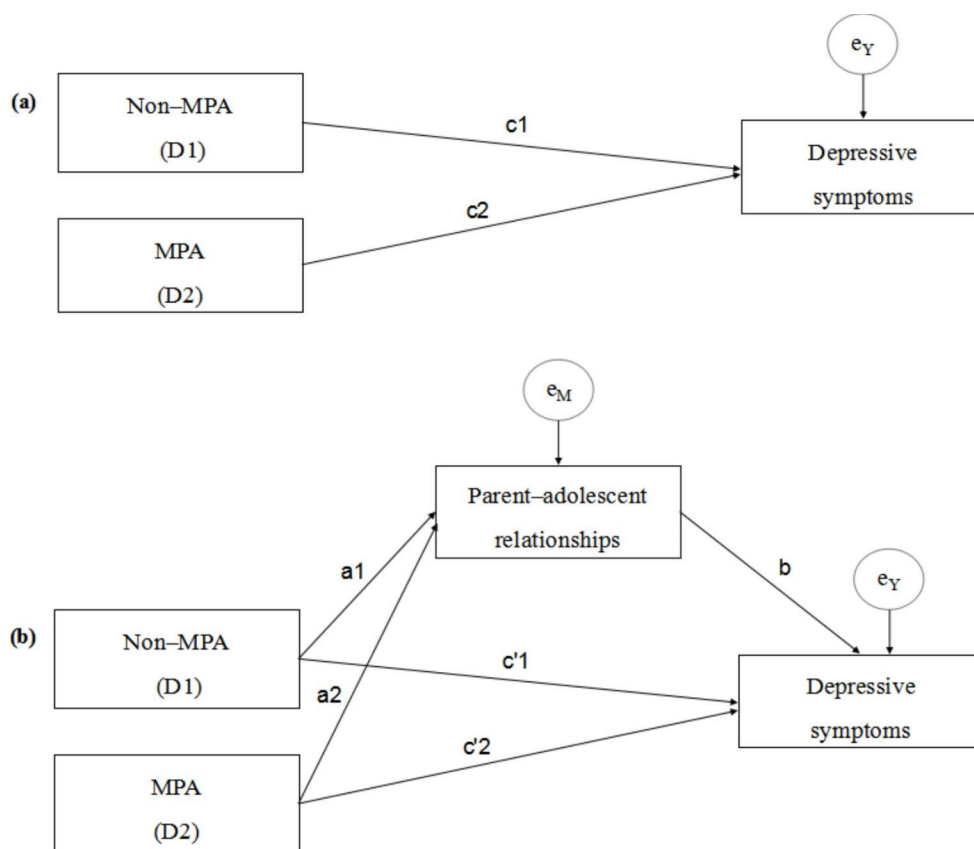
Fig. 1 The mediation model

of MPA (Chen et al., 2016; Young, 1998), participants with MPAI < 34 were classified as "non-MPAs", those with MPAI between 34 and 59.5 were typed as "possible MPAs", and those with MPAI > 59.5 were counted as "MPAs". This scale has been widely used in the measurement of MPA among adolescents (Gao et al., 2020). The Cronbach's α coefficient for this scale was 0.90 in this study.

Depressive symptoms

We measured depressive symptoms using a subscale from the Subjective Quality of Life Questionnaire (Cheng et al., 1998), which included 7 items (e.g., "I feel like a loser."). All of the items were scored on a 4-point Likert scale ranging from 1 = *never* to 4 = *always*, with higher scores indicating a greater degree of depressive symptoms manifestation. The total scores ranged from 4 to 28. This scale has been widely used for studies in adolescents (Lan et al., 2004). The index of CFA suggested a good fit: $x^2/df = 5.88$, $RMSEA = 0.061$, $CFI = 0.979$, $TLI = 0.966$, $SRMR = 0.023$. The Cronbach's α coefficient for this scale was 0.84 in this study.

Parent-adolescent relationships

We measured parent-adolescent relationships with the Parent-Child Relationships Scale compiled by Kerr & Stattin (2000), which was previously applied in studies involving adolescent populations (Zhang et al., 2015). We assessed the same construct separately for father and mother (eight items such as "Do you want your father/mother to change?"). All items were scored on a 4-point Likert scale, from 1 = *never* to 4 = *always*. After aggregating the scores of items related to the father and the ones for the mother, the total scores ranged from 16 to 64, with higher scores indicating higher quality of the parent-adolescent relationships. The Cronbach's α coefficient for this scale was 0.86 in this study.

Common method biases

The results of Harman's single-factor test showed that there were 8 factors with the original root exceeding 1. The first factor could explain 22.87% of the cumulative variance, and the critical value was less than 40%, indicating that severe common method biases do not exist in this study (Zhou & Long, 2004).

Table 1 Descriptive statistics

	Non-MPAs (N=560)	Possible-MPAs (N=1006)	MPAs (N=200)	Total (N=1766)	χ2 or F	df	p
Age (M±SD)	12.28±1.68	13.66±1.99	14.34±1.75	13.30±2.00	123.79***	2	<0.001
Gender n, %							
Male	279 (49.8%)	563 (56.0%)	98 (49.0%)	940 (53.2%)	7.07*	2	0.029
Female	281 (50.2%)	443 (45.0%)	102 (51.0%)	826 (46.8%)			
Do you have siblings? N, %							
Only children	205 (36.6%)	319 (31.7%)	69 (34.5%)	593 (33.6%)	3.95	2	0.138
Children with siblings	355 (63.4%)	687 (68.3%)	131 (65.5%)	1173 (66.4%)			
Grade N, %							
Elementary school students	280 (50.0%)	258 (5.6%)	18 (9.0%)	556 (31.5%)	212.69***	4	<0.001
Middle school students	210 (37.5%)	355 (35.3%)	77 (38.5%)	642 (36.4%)			
High school students	70 (12.5%)	393 (39.1%)	105 (52.5%)	568 (32.2%)			

Note. $N=1766$. $M±SD=$ mean ± standard deviations. $^*p<.05,$ $^{**}p<.01,$ $^{***}p<.001$

Statistical analyses

First, SPSS (version 24.0) was applied to carry out descriptive statistics, correlation analysis, and the one-way ANOVA test. Second, according to Hayes and Preacher's (2014) procedure, we examined the mediation models for MPA levels as the multicategorical independent variable by model 4 of Hayes's (2013) PROCESS macro. In addition, we utilized gender and age as control variables in this study.

The specific steps of the mediation analysis included four procedures. (1) Based on the classification standard of MPA level proposed by Chen et al., (2016), MPA gravity was divided into three levels: non-MPA, possible MPA, and MPA. (2) In the mediation model (Fig. 1), we choose possible MPA as the reference level. By dummy coding, D1 and D2 respectively refer to non-MPA and MPA. When the participants were found non-MPAs, D1=1, D2=0; when the participants were found MPAs, D1=0, D2=1. (3) SPSS output the relative total effect (c1, c2), relative direct effect (c'1, c'2), and relative indirect effect (a1*b, a2*b).

Results

Descriptive statistics and correlation analysis

The results in Table 1 show that the proportions of non-MPAs, possible MPAs, and MPAs constitute 31.71%,

Table 2 Correlation analysis

Variables	M	SD	1	2	3
1 Mobile phone addiction levels	2.44	0.84	-		
2 Parent-adolescent relationships	3.03	0.51	-0.31***	-	
3 Depressive symptoms	1.72	0.62	0.34***	-0.39***	-

Note. $N=1766$. $M±SD=$ mean ± standard deviations. $^*p<.05,$ $^{**}p<.01,$ $^{***}p<.001$

56.96%, and 11.33% respectively. There were identified 560 non-MPAs (49.8% male; $M_{age}=12.28$, $SD=1.68$), 1006 possible MPAs (56.0% male; $M_{age}=13.66$, $SD=1.99$), and 200 MPAs (49.0% male; $M_{age}=14.34$, $SD=1.75$).

Correlation results are shown in Table 2. MPA levels were negatively associated with parent-adolescent relationships ($\beta = -0.31$, $p<.001$), and positively associated with depressive symptoms ($\beta=0.34$, $p<.001$). Parent-adolescent relationships were negatively associated with depressive symptoms ($\beta = -0.39$, $p<.001$).

Mobile phone addiction levels and adolescent depressive symptoms

As seen from the results of the one-way ANOVA test and further post-hoc test using the Least Significance Difference (LSD) (Table 3), MPAs exhibit more severe depressive symptoms than possible MPAs and non-MPAs. In turn, possible MPAs reported more severe depressive symptoms than non-MPAs.

Table 3 Differences in parent-adolescent relationships and depressive symptoms among Non-MPAs, Possible-MPAs, and MPAs

Variables	Non-MPAs (N=560)	Possible-MPAs (N=1006)	MPAs (N=200)	F	Mean difference between Possible-MPAs and Non-MPAs	Mean difference between MPAs and Possible-MPAs	Mean difference between MPAs and Non-MPAs
Parent-adolescent relationships (M±SD)	3.20±0.51	2.99±0.48	2.71±0.53	79.14***	0.20***	0.29***	0.49***
Depressive symptoms (M±SD)	1.48±0.53	1.79±0.60	2.06±0.67	83.67***	0.31***	0.27***	0.58***

Note. $N=1766$. $M±SD=$ mean ± standard deviations. $^*p<.05,$ $^{**}p<.01,$ $^{***}p<.001$

Table 4 Relative total effect, direct effect, and indirect effect (Reference level: Possible-MPA)

	Relative effect size	Coeff.	SE	LLCI	ULCI
D1(Non-MPA)	Relative total effect	-0.31***	0.03	-0.37	-0.25
	Relative direct effect	-0.23***	0.03	-0.29	-0.17
	Relative indirect effect	-0.08*	0.01	-0.11	-0.06
D2(MPA)	Relative total effect	0.27***	0.05	0.18	0.36
	Relative direct effect	0.16***	0.05	0.07	0.25
	Relative indirect effect	0.11*	0.02	0.08	0.15

Note. *SE* = standard error, *LLCI* = lower limit of the 95% confidence interval, *ULCI* = upper limit of the 95% confidence interval

The mediating effect of parent-adolescent relationships

As shown in Table 4; Fig. 2, taking possible-MPA as the reference level, the relative total effect, relative direct effect, and relative indirect effect of MPA on depressive symptoms are all significant ($c2 = 0.27^{***}$, $c'2 = 0.16^{***}$, $a2*b = 0.11$ with *95% CI* = [0.08, 0.15], $a2*b/c2 = 40.74\%$). Compared to possible MPAs, actual MPAs are more likely to report negative parent-adolescent relationships, forcing them to experience more depressive symptoms. Similarly, the relative total effect, relative direct effect, and relative indirect effect of non-MPA on depressive symptoms are all significant ($c1 = -0.31^{***}$, $c'1 = -0.23^{***}$, $a1*b = -0.08$ with *95% CI* = [-0.11, -0.06], $a1*b/c1 = 25.81\%$). Compared to possible-MPAs, adolescent non-MPAs are less inclined to experience negative parent-adolescent relationships, which in turn alleviate depressive symptoms.

Discussion

In this study, we constructed a mediation model to test the mediating role of parent-adolescent relationships linking MPA levels and adolescent depressive symptoms. First, we found that the direct effect of MPA on depressive symptoms is stronger than that of possible MPA. Second, the mediating effect of parent-adolescent relationships between MPA and depressive symptoms was stronger than the link between possible MPA and depression levels. These findings advance our understanding of how different levels of MPA are associated with adolescent depressive symptoms.

Mobile phone addiction levels and adolescent depressive symptoms

The first finding indicated that MPA levels had significant impacts on adolescent depressive symptoms among MPAs and possible MPAs. This finding provides empirical support for the positive association between technology addiction and internalizing problems, which has attracted the attention of many educators, clinicians, and social workers (Lee et al., 2016; Yen et al., 2009; Young & Rogers, 1998). Consistent with the interdependent relationship between Internet addiction and depression (Seki et al., 2019), individuals' depressive emotions can be influenced by the Internet addiction. Therefore, MPA, a subtype of the Internet addiction, may also exert important effects on adolescents' degree of depressive symptoms. Our study found that MPA levels are
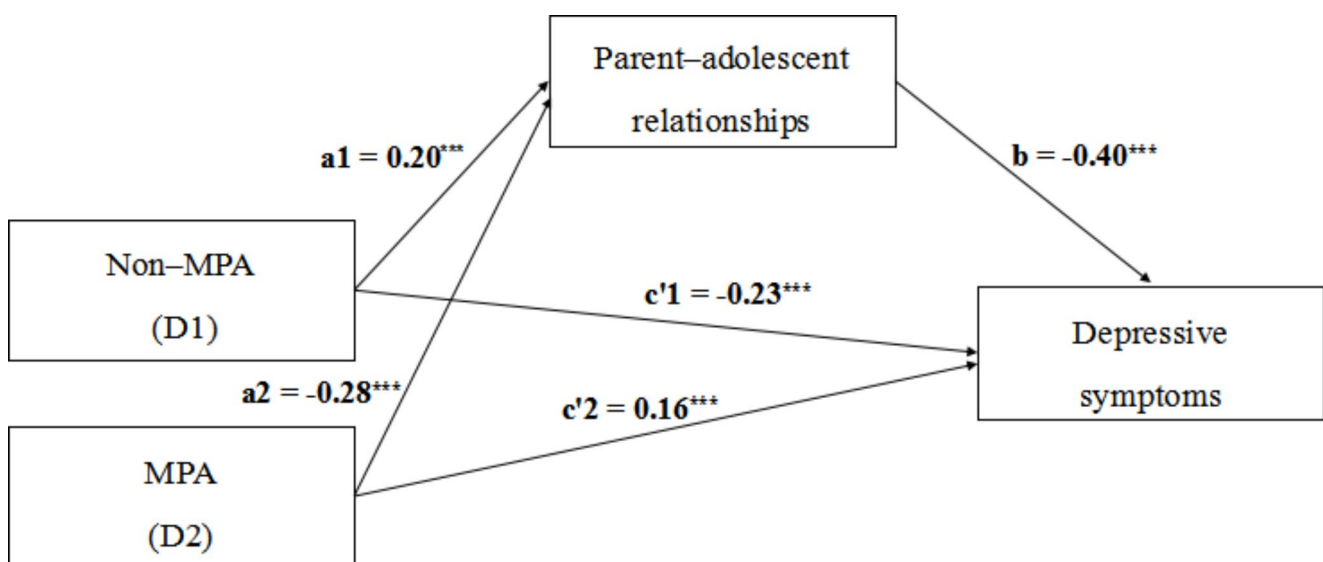
Fig. 2 Relative total effect, relative direct effect, and relative indirect effect

positively associated with adolescent depressive symptoms, providing new evidence for the interconnection between MPA and depression. More importantly, this positive association between MPA levels and depressive symptoms is supported by the Interaction of Person-Affect-Cognition-Execution (I-PACE) model (Brand et al., 2019), which asserts that the interactions between predisposing variables (i.e., depression), affective and cognitive responses, and executive functions are closely related to the development and maintenance of Internet-based addictive behaviors (e.g., MPA). This theoretical framework effectively integrates our research finding regarding the positive MPA-depression link that was also consistently supported in previous studies, which have revealed the positive bidirectional relationship between MPA and depressive symptoms (e.g., Jun 2016; Morita et al., 2021). In short, adolescents with higher levels of MPA are more likely to suffer more severe symptoms of depression, which in turn ensnares them into even more serious MPA than before (Chen et al., 2021).

Furthermore, the found effect of MPA on adolescent depressive symptoms is stronger than that of possible-MPA, which supports **Hypothesis1**. This finding extends prior research in the following three ways. First, both MPA and possible MPA exert significant effects on adolescent depressive symptoms development. This finding is consistent with existing studies that reveal the positive association between the levels of technology addiction and adolescents' psychological disorders (Jasso-Medrano & López-Rosales, 2018; Robertson et al., 2018; Yoo et al., 2014). Second, we further extended the link between MPA levels and depressive symptoms from college students to adolescents and provided more empirical support for the link between technology addiction levels and internalizing problems. Third, an understanding that possible MPAs are more likely to experience depressive symptoms than non-MPAs allows to create and launch more effective prevention and intervention strategies for possible MPAs.

The mediating effect of parent-adolescent relationships

The second finding allows to establish that parent-adolescent relationships mediated the associations between MPA levels and depressive symptoms among MPAs and possible MPAs. Parent-adolescent relationships thus constitute a vital mediating mechanism linking MPA levels and depressive symptoms among adolescents. This observation is consistent with previous studies on technology addiction (Chen et al., 2016; He, 2019; Liu et al., 2017), which revealed that interpersonal relationships play an important mediating role in the association between technology addiction and psychological disorders. As the Internet tools provide

convenient and diverse functions for adolescents, compulsive use of that technologies may interfere with their regular daily life and academic performance, damage their relationships with relatives, and further trigger psychological disorders (Kamibeppu & Sugiura, 2005; Yen et al., 2009).

This mediating role of parent-adolescent relationships in the link between MPA levels and depressive symptoms was supported by the interdependent relationship between Internet addiction and depression Seki et al., (2019) put forward, which suggests that the Internet addiction exerts significant impacts on individuals' depressive symptoms through the mediating mechanism of interpersonal relationships. Accordingly, adolescents who use mobile phones more frequently or uncontrollably tend to lack the time to interact with parents and receive stricter supervision from parents, and then experience more conflicts with parents (van den Eijnden et al., 2010; Yeh et al., 2008). Thus, when the parent-adolescent relationships are negative and cannot provide adolescents with effective social support and emotional warmth, they will display a higher risk of developing depressive symptoms (Liu et al., 2011).

Moreover, MPA has a stronger indirect effect than possible MPA on depressive symptoms via parent-adolescent relationships, which supports **Hypothesis2**. This finding confirms that adolescents with higher levels of MPA are inclined to experience poor parent-adolescent relationships, which in turn results in more severe depressive symptoms. Our finding is in line with existing studies, which revealed that higher levels of technology addiction are closely related to the development of depressive symptoms (Dowling & Quirk, 2009; Jang et al., 2008; Kormas et al., 2011). For example, Jang et al., (2008) found that Internet addicts reported more depressive symptoms than possible Internet addicts and non-Internet addicts. Another study also documented that MPAs were more likely to engage in poor interpersonal relationships than possible MPAs, which aggravates depressive symptoms (Chen et al., 2016). Therefore, the finding that MPA exerts a stronger impact on depressive symptoms development in adolescents than possible MPA identified is consistent with the previous research on other age groups.

In conclusion, the above findings suggested that both MPAs and possible MPAs may experience depressive symptoms resulting from the effects of excessive mobile phone use. As possible MPAs can be easily converted into MPAs, educators and consultants should pay enough attention to possible MPAs' behaviors when developing prevention and intervention programs. In addition, these findings further extend the interdependent relationship between Internet addiction and depression (Seki et al., 2019) and show that parent-adolescent relationships can be an important factor

that connects MPA at different levels of intensity with adolescent depressive symptoms.

Contributions and limitations

Our research makes several important contributions to research on MPA and depression in adolescents specifically as well as to exploration of the mediating role of interpersonal problems in how different levels of MPA contribute to depression. First, the present study examined whether previous findings could be generalized from college students to adolescents; this contribution may provide stronger evidence for the link between MPA levels and depressive symptoms among different age groups. Second, this study extended the interdependent relationship between Internet addiction and depression (Seki et al., 2019) by examining the mediating role of parent-adolescent relationships. Chen et al., (2016) preliminarily examined the mediating role of interpersonal problems in general in the link between MPA levels and depressive symptoms. This framework of study inspired researchers to investigate the roles of specific categories of interpersonal problems (i.e., parent-adolescent relationships, peer relationships, and teacher-student relationships). Our research is the first to explore the mediating role of parent-adolescent relationships in this link, revealing that higher levels of MPA damage parent-adolescent relationships, which in turn leads to higher degree of adolescent depressive symptoms.

In addition, our findings have significant implications for the development of effective prevention and intervention programs for depressive symptoms. First, considering the classified variation of the MPA levels, parents and educators should not only pay attention to the primary group of MPAs, but also identify the large group of possible MPAs to prevent them from developing actual MPA. Second, with an aim of positively regulating mobile phone use, parents and school managers could appropriately guide students to utilize mobile phones for learning and broadening horizons instead of indulging in games and social networks. Third, regarding efforts to build harmonious parent-adolescent relationships, frequent communications and positive interactions between parents and children could provide adolescents with more social support and emotional warmth, thereby alleviating depressive symptoms.

Our study yet includes several limitations that should be addressed in further researches on the topic. First, although we established the mediation models following sound theoretical foundations and empirical evidence, the cross-sectional design made it difficult to clarify the causal relationships between variables. Thus, more longitudinal studies should be conducted to further test the validity of

models examined in this research. Second, previous studies have revealed the mediating roles of interpersonal relationships such as peer relationships (Chen et al., 2016; Xie et al., 2019) and the moderating role of mindfulness (Yang et al., 2019) in the link between MPA and psychological problems. Therefore, future research could further examine alternative models (i.e., peer relationships, teacher-student relationships, and mindfulness) to better clarify the link between MPA levels and adolescent depressive symptoms. Third, since our research sample only included adolescents, future studies could work to generalize or adjust our findings to other age groups. Finally, as previous research has revealed gender differences in physical and mental development, we may try to explore whether gender differences exist in our research models in future research.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

Ethics approval: Ethics approval was obtained from the ethics committee of Shenzhen University. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Consent to participate: Informed consent was obtained from all individual participants included in the study.

Consent to publish: The authors affirm that human research participants provided informed consent regarding publishing their data.

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