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Addictive Behaviors 118 (2021) 106857

Contents lists available at ScienceDirect

Addictive Behaviors

journal homepage: www.elsevier.com/locate/addictbeh

Loneliness and problematic mobile phone use among adolescents during the COVID-19 pandemic: The roles of escape motivation and self-control

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ARTICLE INFO

Keywords:
COVID-19
Loneliness
Adolescent problematic mobile phone use
Escape motivation
Self-control

ABSTRACT

In this cross-sectional study, we explored the relationship between loneliness and problematic mobile phone use among Chinese adolescents during the COVID-19 pandemic, considering the effects of escape motivation and self-control. We recruited 1034 adolescents (mean age 15.76 ± 1.20 years) from China. The results showed that loneliness was positively associated with escape motivation and adolescent problematic mobile phone use. Furthermore, when controlling for gender, escape motivation mediated the relationship between loneliness and problematic mobile phone use, and self-control moderated the relationship between escape motivation and problematic mobile phone use. Specifically, as self-control increased, escape motivation was less likely to induce problematic mobile phone use. Thus, loneliness and escape motivation may be factors that increase the risk of problematic mobile phone use, and self-control should be considered in prevention and intervention strategies aimed at attenuating adolescent problematic mobile phone use.

1. Introduction

According to the China Internet Development Statistical Report, China had 940 million Internet users as of September 2020. Among them, mobile phone users accounted for 99.2%, and middle and high school students accounted for 14.8% (The 46th China Internet Development Statistical Report, 2020). The report indicated that personal life and mobile phone use are becoming more intertwined. Mobile phone overuse by adolescents is a problem not only in China, but globally. A report from App Annie showed that globally, teenage mobile phone users have high levels of engagement with mobile applications, and compared with older mobile phone users, teenagers open popular applications 60 times more often per person (Mobile Market Report, 2020). Excessive mobile phone use can severely affect adolescent mental health and well-being (Busch & McCarthy, 2021). Particularly during the COVID-19 pandemic, adolescent mobile phone use differs from that during normal school time. This increase in mobile phone use time may increase the risk of problematic mobile phone use (PMPU) among adolescents and affect their physical and mental health and academic performance (Arpaci & Kocadag Unver, 2020). Therefore, the mechanism of PMPU among adolescents during this period must be explored.

1.1. Loneliness and PMPU

As the COVID-19 outbreak has become a global public health crisis, an increasing number of people are being affected psychologically, and some reports have suggested that loneliness has increased during this pandemic (Killgore, Cloonan, Taylor, Lucas, & Dailey, 2020; Li & Wang, 2020). The Compensatory Internet Use theory (Kardefelt-Winther, 2014) suggests that when individuals have psychosocial problems in the real world, they may use virtual networks or mobile phones to escape negative feelings (i.e., loneliness). Loneliness is a psychological feeling in which one is unhappy because their perceived social status and expected social interactions do not match their actual levels (Kagan, 2009; Russell, 1996). Many cross-sectional studies have shown that loneliness is an important predictor of PMPU (Bian & Leung, 2015; Kim, LaRose, & Peng, 2009; Ma, Huang, & Ma, 2020). For example, a survey of 4509 middle school students in China revealed that loneliness and smartphone overuse were positively correlated (Zhen, Liu, Hong, & Zhou, 2019). A similar result was found among Chinese college students (Cui, Peng, Han, & Huang, 2015; Shen & Wang, 2019). A longitudinal study also showed that loneliness positively predicted levels of problematic smartphone use (Kim, 2019).

Theoretically, the Interaction of Person-Affect-Cognition-Execution

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https://doi.org/10.1016/j.addbeh.2021.106857
Received 26 October 2020; Received in revised form 30 January 2021; Accepted 30 January 2021
Available online 11 February 2021

(I-PACE) model for problematic and addictive behaviors explains this relationship (Brand et al., 2019; Brand, Young, Laier, Woelfling, & Potenza, 2016). I-PACE consists of two major processes: specific problematic behaviors (early stages) and specific addictive behaviors (later stages). In the early stages, a person's characteristics (e.g., personality, specific needs) may influence their internal responses (affect, cognitive responses and execution), and the person may decide to use the Internet for gratification, which in turn affects their appraisal and decision processes, leading to establishment and intensification of problematic behavioral outcomes. In the later stages, these associations between affective and cognitive responses, decisions to behave in specific ways, experiences of gratification and compensation and behavior-specific expectancies can become increasingly stronger, resulting in addictive behaviors. Loneliness is assumed to be a core characteristic during periods such as the COVID-19 pandemic (Killgore et al., 2020); thus, according to the I-PACE, loneliness can influence PMPU.

Previous studies have focused mainly on the direct relationship between loneliness and PMPU in college students, but the underlying mechanisms (e.g., how loneliness is associated with PMPU) and the relationship between loneliness and PMPU in adolescents have rarely been studied. During the COVID-19 pandemic, because of disease control measures such as social distancing and quarantine (Li & Wang, 2020; Tull et al., 2020), middle and high school students have had to reduce their outdoor activities and in-person communication with their classmates; therefore, whether and how the resulting loneliness increases the risk of PMPU requires further study.

1.2. Escape motivation as a potential mediator

How does loneliness affect individual PMPU? Burglass (1985) stated that the main motivations of addictive behavior (e.g., PMPU) are to reduce pain, anxiety, and other negative emotions (e.g., loneliness), in other words, to escape. The stimulation hypothesis (Kerkhof, Finkenauer, & Muusses, 2011) states that mobile phone users rely on instant messaging applications to establish online social relationships with others, which can increase social channels, improve friendship quality, and reduce negative feelings such as loneliness. Therefore, the loneliness of staying at home during the COVID-19 pandemic (Killgore et al., 2020) may induce adolescents to escape from reality and use mobile phones for entertainment to reduce the psychological experience of loneliness. Individuals suffering from frustrations in the real world often have an internal drive to escape reality; hence, the motivation to use mobile phones is called escape motivation (Kim, 2017). These theories and concepts suggest that escape motivation may be a product of loneliness. Previous studies support this association. For example, loneliness, caused by unsatisfying interpersonal relationships, could activate adolescent escape motivation (Zhen et al., 2019). Shen and Wang (2019) found a positive association between loneliness and escape motivation among college students. Furthermore, reduced interaction with others in the real world and offline can increase people's loneliness and thus increase their evasive tendencies (Morahan-Martin & Schumacher, 2000).

Regarding the association between escape motivation and PMPU, according to the I-PACE, motivation as an internal trigger can influence problematic and addictive behaviors (Brand et al., 2019). Escapism-oriented motivation can be a powerful predictor of problematic use of video game live-streaming services (Chen & Chang, 2019) and Internet gaming disorder (Kircaburun et al., 2020). Such effects may also occur with PMPU (Kim, 2017; Park & Lee, 2012). For example, studies on Chinese college students have shown that escape motivation is positively correlated with excessive use of social networks and PMPU (Liu & Yu, 2011; Shen & Ran, 2018; Wang, Jackson, Wang, & Gaskin, 2015). Researchers have found similar results regarding escape motivation and mobile phone overuse among South Korean (Park, 2003) and British (Young, Kuss, Griffiths, & Howard, 2017) college students. However, because these studies focused on adult college students, it is unclear whether the results can be generalized to 12- to 19-year-old adolescents. Additionally, some studies have concluded that escape motivation mediates the associations between people's characteristics and problematic behaviors, such as trait emotional intelligence, Internet gaming disorder (Kircaburun et al., 2020), social anxiety, and smartphone overuse (Shen & Ran, 2018). Therefore, escape motivation may mediate the association between loneliness and PMPU during the COVID-19 pandemic.

1.3. Self-control as a potential moderator

Although escape motivation significantly affects PMPU, not all adolescents are equally affected by escape motivation induced by loneliness. Studies have shown that general inhibitory control moderates the relationship between craving and behavior (Ma, Huang, & Ma, 2020; Markowitz, Hancock, Bailenson, & Reeves, 2019). According to the I-PACE (Brand et al., 2019), in the process of problematic behaviors (e.g., PMPU), the associations between craving (e.g., escape motivation) and diminished inhibitory control (e.g., self-control) contribute to developing habitual behaviors. This model suggests that users' self-control may moderate the association between escape motivation and PMPU.

Self-control is the ability of an individual to consciously control their inner impulses and resist external temptations (Li & Huang, 2012). According to the dual-mode of self-control model, the complete self-control model includes an impulse system and a self-control system (Hofmann, Friese, & Strack, 2009). In the face of temptation, the impulse system may produce a positive approach to temptation, while the self-control system can reject temptation through thoughtful consideration and standards. Therefore, different levels of self-control influence problematic behavior to different degrees. Previous studies showed that highly self-controlled individuals were more effective than impulsive individuals in regulating their problematic behaviors (Gao, Liu, Gao, & Li, 2020) and reducing the occurrence of PMPU (Duckworth, 2011). High levels of self-control were negatively associated with PMPU (Khang, Woo, & Kim, 2012; Kim, Min, Min, Lee, & Yoo, 2018; Liu et al., 2018), while lower levels of self-control were a main pathway leading to PMPU (Billieux, 2012; Billieux, Maurage, Lopez-Fernandez, Kuss, & Griffiths, 2015). Moreover, empirical studies have demonstrated a relationship between self-control and PMPU. For example, self-control enables individuals to effectively cope with bad experiences and regulate their emotions, cognition and behavior (Li & Huang, 2012; Niu et al., 2020); that is, self-control may reduce the adverse effects of risk factors (e.g., escape motivation) on internalization and externalization of problems (e.g., PMPU).

The Deficient Self-regulation Model (Tokunaga & Rains, 2010) states that individuals with insufficient self-regulation and self-control may be unable to restrain their inner craving to use mobile phones (e.g., escape motivation), which may lead to an uncontrolled increase in mobile phone use time, eventually leading to PMPU. Studies have indicated that self-control plays a significant role in moderating adolescent behavioral problems (Li, Zhou, Li, & Zhou, 2016; Niu et al., 2020; Park, Kang, & Kim, 2014). For example, self-control is a protective factor of adolescent PMPU (Niu et al., 2020), and adolescents with low levels of self-control are more likely to develop problematic Internet use (Park et al., 2014). Specifically, during the COVID-19 pandemic, adolescents needing to escape reality may choose to use their smartphones to communicate with others online or watch videos for entertainment. During this time, adolescents with greater self-control can effectively adjust the duration of their mobile phone use, while those with less self-control may be immersed in the virtual world of mobile phones, leading to a tendency toward PMPU. These findings suggest that self-control may play different roles in the relationship between escape motivation and PMPU.

1.4. The present study

Building on these theories, we attempted to expand on the previous literature by testing a model that explores the relationship between loneliness and adolescent PMPU and its internal mechanisms (i.e.,

escape motivation and self-control) during the COVID-19 pandemic while seeking methods to guide the targeted intervention and correction of adolescent PMPU. As an integrated model, this study was developed to test the following hypotheses (Fig. 1).

H1: Loneliness is positively associated with adolescent PMPU during the COVID-19 pandemic.

H2: Escape motivation partially mediates the relationship between loneliness and adolescent PMPU.

H3: Impulse and self-control moderate the effect of escape motivation on adolescent PMPU.

2. Methods

2.1. Participants and procedures

Using cluster sampling, a series of self-reported questionnaires were distributed to 1094 adolescents from three high schools in Sichuan and Chongqing, China, between May 22, 2020 and May 29, 2020. Of the participants, 38 did not complete the surveys, and 22 answered all questions with the same response (i.e., they selected the same number) and were excluded from the analysis. Thus, the final sample included 1034 participants (valid response rate: 94.52%) comprising 633 boys and 401 girls aged 12–19 years (mean: 15.76 ± 1.20 years). No participants were suspected, confirmed, or cured of COVID-19.

The Human Investigations Committee of Southwest University approved the study. Before the investigation, all students were told that the study was being conducted anonymously and that their information would remain confidential. All students, their parents, and teachers gave their informed consent. Trained research assistants introduced the survey guidelines to the participants. All participants were volunteers and could withdraw from the study at any time.

2.2. Measures

2.2.1. Loneliness

Loneliness was measured by a validated Chinese version of the UCLA loneliness self-report scale (Liu & Wang, 2012) compiled by Russell (1996). This measure comprises 20 items (e.g., "Do you often feel lonely?"), including 11 positive and 9 negative scores. All items are scored on a 5-point Likert scale (1 = never, 5 = always), and higher total scores reflect higher loneliness levels. Cronbach's α was 0.90.

2.2.2. Escape motivation

Six items on escape motivation were drawn from Motivations for Smartphone Use adapted by Kim (2017) from Leung and Wei (2000). The scale has been demonstrated to have good reliability and validity in Chinese adolescents (Fu et al., 2020). A sample item is "It makes me feel less alone." All items are scored on a 5-point Likert scale (1 = totally disagree, 5 = totally agree). Higher scores indicate more escape motivation to use smartphones. Cronbach's α was 0.82.

2.2.3. Self-control

Self-control was measured using the Chinese version (Xie, Wang, Tao, Fan, & Gao, 2014) of the Dual-Mode of Self-Control Scale (DMSC-S) by Dvorak and Simons (2009). The 21-item scale measures two factors of self-control: impulse (e.g., "I am an impulsive person") and self-control (e.g., "When encountering problems, I will seriously think about what measures should be taken"). All items are scored on a 5-point Likert scale (1 = totally disagree, 5 = totally agree). Higher scores indicate higher levels of impulse or self-control. Cronbach's α was 0.87 for the whole scale and 0.86 each for the impulse and self-control subscales.

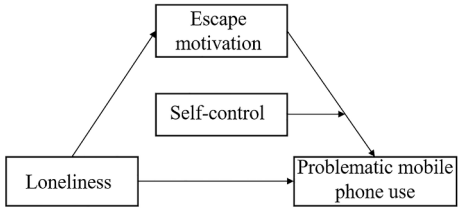

Fig. 1. Conceptual model.

2.2.4. Problematic mobile phone use

PMPU was evaluated via the Mobile Phone Addiction Index (Leung, 2008). This scale contains 17 items (e.g., "You can never spend enough time on your mobile phone") evaluating the four dimensions of PMPU (i.e., losing control and receiving complaints, anxiety and craving, withdrawal/escape, and productivity loss). The scale has been demonstrated to have good reliability and validity in Chinese adolescents (Yang, Zhou, Liu, & Fan, 2019). All items are scored on a 5-point Likert scale (1 = never, 5 = always), with higher scores indicating higher PMPU levels. Cronbach's α was 0.88.

2.3. Data analysis

Data entry and analysis were conducted using SPSS 25.0 and the PROCESS macro (http://www.afhayes.com) (Hayes, 2013). First, descriptive statistics, correlational analysis, and independent-samples t-tests were conducted on the main variables. Second, we used the PROCESS macro for SPSS (model 4) to examine the mediating effects of escape motivation in the relationship between loneliness and PMPU. Third, model 14 of the PROCESS macro was applied to investigate the moderating roles of impulse and self-control in the relationship between escape motivation and PMPU. The bootstrapping method was used to examine whether the mediating and moderating effects were significant based on 5000 bootstrapping samples. The 95% bias-corrected confidence intervals (95% CIs) did not contain zero, indicating that the effect was significant. P-values < 0.05 were considered significant.

3. Results

3.1. Preliminary analyses

Table 1 shows the correlations between study variables. Loneliness was positively associated with escape motivation, impulse, and PMPU, and negatively associated with self-control. Escape motivation was positively associated with impulse and PMPU and negatively associated with self-control. Impulse was positively associated with PMPU, and negatively associated with self-control. Self-control was negatively associated with PMPU. An independent-samples *t*-test revealed significant differences between men and women for the variables of escape motivation ($t = -2.50$, $p < 0.05$), self-control ($t = -2.17$, $p < 0.05$), and PMPU ($t = -3.77$, $p < 0.001$). No significant differences were found for loneliness ($t = -1.57$, $p > 0.05$) or impulse ($t = -1.78$, $p > 0.05$). Therefore, gender was used as a covariate in subsequent analyses.

Table 1
Correlations and means of study variables ($N = 1034$).

	$M \pm SD$	1	2	3	4	5
Loneliness	44.88 ± 10.19	1				
Escape motivation	18.26 ± 5.39	0.23***	1			
Impulse	29.08 ± 8.17	0.23***	0.29***	1		
Self-control	30.69 ± 5.95	−0.14***	−0.03	−0.25***	1	
Problematic mobile phone use	2.45 ± 0.72	0.14***	0.52***	0.41***	−0.07*	1

Notes. *$p < 0.05$, ***$p < 0.001$.

3.2. Mediating role of escape motivation

To test the mediating role of escape motivation between loneliness and PMPU, we ran the PROCESS macro, model 4, in SPSS with 5000 bootstrapping samples, using gender as a covariate (Hayes, 2013). All data were standardized. Escape motivation (0.11) exhibited a significant mediating effect (see Table 2 and Fig. 2). Loneliness affected PMPU only through the mediating role of escape motivation, accounting for 83.55% of the total effect. Thus, escape motivation fully, rather than partially, mediates the relationship between loneliness and adolescent PMPU.

3.3. Moderating effect of impulse and Self-control

To test the moderating roles of impulse and self-control, we ran the PROCESS macro (model 14) with gender as a covariate (Hayes, 2013). Self-control had a significant moderating effect in the relationship between escape motivation and PMPU (Table 3, Fig. 2). The moderating effect of impulse was not significant.

To better explain self-control in moderating escape motivation and PMPU, we divided self-control into high (M + 1SD) and low (M − 1SD) groups, with gender as a covariate. Simple slope tests suggested that at both levels of self-control, escape motivation had a significant positive predictive effect on PMPU (Fig. 3; low self-control individuals: $\beta = 0.56$, $SE = 0.03$, $t = 16.20$; high self-control individuals: $\beta = 0.46$, $SE = 0.03$, $t = 13.79$; all $p < 0.001$), indicating that self-control reduced the influence of escape motivation on PMPU.

4. Discussion

We constructed a moderated mediation model based on the I-PACE model to explore the underlying mechanisms between loneliness and adolescent PMPU during the COVID-19 pandemic. Escape motivation was a potential mediator, and self-control (not impulse) was a potential moderator in explaining this relationship.

4.1. Relationship between loneliness and PMPU

Loneliness was significantly and positively associated with PMPU during the COVID-19 pandemic, thus supporting H1. This is consistent with previous findings (Hilal, Yeliz, & Emin, 2018; Liu, Yang, Zhu, & Zhang, 2019). For example, some lonely adolescents may satisfy their individual social needs through social relationships on the Internet (Kardefelt-Winther, 2014). Further, the results verified the I-PACE model (Brand et al., 2019, 2016); that is, loneliness may influence one's decision to use the Internet for gratification, which will in turn influence PMPU. With COVID-19, because of the need to prevent furthering the epidemic (Killgore et al., 2020), adolescents have fewer opportunities for outdoor activities; hence, mobile phone applications may be one of their main approaches to temporarily reducing inner emptiness and loneliness. Additionally, our studies revealed that a complex relationship exists between loneliness and PMPU, and loneliness is not the only factor influencing PMPU.

Table 2
Escape motivation mediated the effects of loneliness on problematic mobile phone use.

Path	β	SE	t	95% CI
Total effect model				
Loneliness → problematic mobile phone use	0.14	0.03	4.47***	(0.08, 0.20)
Direct effects				
Loneliness → problematic mobile phone use	0.03	0.03	0.83	(−0.03, 0.08)
Loneliness → escape motivation	0.23	0.03	7.48***	(0.17, 0.29)
Escape motivation → problematic mobile phone use	0.44	0.03	18.47***	(0.39, 0.49)
Indirect effects	*ab*	*SE*		95% *CI*
Loneliness → escape motivation → problematic mobile phone use	0.11	0.02		(0.08, 0.15)

Notes. ***$p < 0.001$.

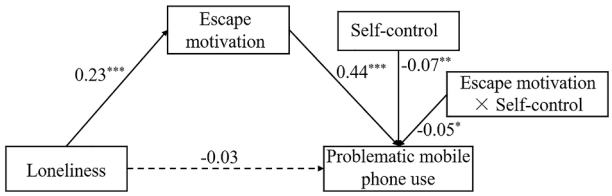

Fig. 2. The relationship between loneliness and problematic mobile phone use
Notes. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Table 3
The moderating effect of impulse and self-control on the escape motivation and problematic mobile phone use.

Path	β	SE	t	95%CI
Impulse → Problematic mobile phone use	0.28	0.03	10.40***	(0.23, 0.33)
Escape motivation × Impulse → Problematic mobile phone use	0.03	0.03	1.25	(-0.02, 0.07)
Gender	0.14	0.05	2.64**	(0.04, 0.24)
			$R^2 = 0.34$, $F = 107.78$***	
Self-control → Problematic mobile phone use	−0.07	0.03	−2.65**	(−0.13, −0.02)
Escape motivation × Self-control → Problematic mobile phone use	−0.05	0.02	−2.27*	(−0.09, −0.01)
Gender	0.16	0.05	2.88**	(0.05, 0.27)
			$R^2 = 0.28$, $F = 80.05$***	

Notes. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

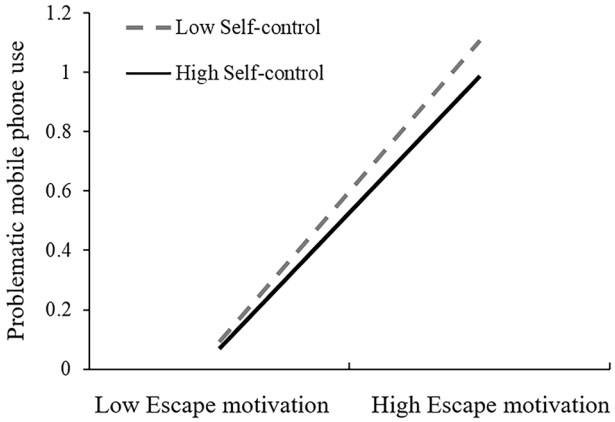

Fig. 3. The moderating effect of self-control.

4.2. The mediating role of escape motivation

Escape motivation fully, rather than partially mediated the effects of loneliness on PMPU. That is, adolescents who were lonelier were more likely to experience increased escape motivation, indirectly resulting in PMPU. Although the results did not support H2, we found a more important role than expected for escape motivation on the relationship between loneliness and PMPU, which is similar to previous findings that escape motivation may mediate the relationship between one's characteristics and problematic behaviors (Kircaburun et al., 2020; Shen & Wang, 2019), further supporting the I-PACE model (Brand et al., 2019).

Escape motivation is one predictor of PMPU, and its full mediating effect confirmed that it is an important risk factor for adolescent PMPU, which is similar to those of previous studies on Chinese college students (Shen & Wang, 2019; Wang, Wang, Gaskin, & Wang, 2015). On the one hand, the main motivation for addictive behavior is to reduce negative emotions by escaping (Burglass, 1985). As a type of media, smart phones can allow people to escape negative emotions induced by the real world (Shen & Ran, 2018), such as loneliness caused by the COVID-19 pandemic. Some studies have demonstrated that loneliness is an important factor affecting the level of escape motivation that people experience (Kim, 2017; Zhen et al., 2019). During the COVID-19 pandemic, individuals who are very lonely have strong negative experiences with real-life interpersonal relationships (Bu et al., 2020) and may use virtual networks to escape their loneliness and depression in the real world (Fu et al., 2020; Yang, Liu, Lian, & Zhou, 2020), which may cause problems with smartphone use (Wang et al., 2015). On the other hand, especially for adolescents, because of COVID-19, middle and high school students cannot go to school or communicate in person with their classmates, which may make them feel lonelier (Bu, Steptoe, & Fancourt, 2020; Killgore et al., 2020). Therefore, to escape the loneliness of this reality, these students may choose to use mobile phones to communicate with others online and listen to music and watch videos to relieve stress, which may increase the risk of PMPU.

4.3. The moderating role of self-control

Consistent with H3, we found that the moderating role of self-control on escape motivation and PMPU was significant, but the role of impulse was not, which partially supports H3. As mentioned, the impulse system may be positively associated with problematic behaviors (Hofmann et al., 2009; Li & Huang, 2012), making it more likely to lead to PMPU. However, during the COVID-19 pandemic, if adolescents want to communicate with their friends to escape the loneliness caused by the disease control measures (Tull et al., 2020), they must use mobile phones online regardless of whether their individual impulse is high or low. Thus, escape motivation was positively associated with PMPU regardless of impulse level.

Compared with that of adolescents with high levels of self-control, escape motivation more effectively predicts PMPU in those with lower self-control, indicating that escape motivation may exert an increased influence on the behavior of adolescents with lower self-control. That is, those with lower self-control are at higher risk of PMPU owing to their idea of escaping from reality (Tangney, Baumeister, & Boone, 2010). It also confirms the Deficient Self-regulation Model (Tokunaga & Rains, 2010) in that good self-regulation and self-control may reduce the risk of PMPU. For example, during the COVID-19 pandemic, people with high levels of self-control may partly overcome the escape motivation induced by loneliness by chatting with family members and learning to cook homemade food (Killgore et al., 2020), thereby reducing mobile phone use time and avoiding excessive mobile phone use. These results are similar to those of previous studies, which showed that individuals with high levels of self-control were less likely to escape the real world by immersing themselves in a virtual world and thus less likely to use their mobile phones indiscriminately (Li et al., 2016). Adolescents with low self-control may be unable to resist the temptation of mobile phones and eventually show a tendency toward PMPU (Khang et al., 2012; Wilson, Fornasier, & White, 2010). Thus, whether it's during the COVID-19 pandemic or in normal life before it, self-control could alleviate the influences of escape motivation on PMPU.

4.4. Limitations, implications, and future directions

This study had some limitations. First, by the time we collected the data, COVID-19 was mostly under control in China, and some students had returned to school; therefore, these data may differ from other regional data during the COVID-19 pandemic. Second, response bias may exist in self-reporting, although we took measures to reduce adolescents' worries about participating, such as giving them clear instructions, telling them there were no right or wrong answers to the questions, and emphasizing the confidentiality of the results. Future research should include experimental methods to measure variables, or include third-party evaluations from parents, teachers, and classmates. Third, escape motivation was the only motivational factor considered in the study; no relationships between other motivational factors and PMPU were evaluated. Finally, a cross-sectional study cannot determine a causal relationship between loneliness and PMPU. Future studies should explore other motivations and use a longitudinal approach.

Despite these limitations, and regarding the theoretical and practical implications for intervention, first, we reiterate the importance of loneliness caused by lockdown restrictions, which may be a significant mental health concern during the COVID-19 pandemic (Killgore et al., 2020; Li & Wang, 2020). Second, when exploring the relationship between personal characteristics and problematic behaviors, the reasons for individual overuse (e.g., motivation) should be examined. Here, the combination of loneliness and escape motivation helped further clarify the causes of adolescent PMPU. Third, improving self-control, such as maintaining a regular academic study program (Oaten & Cheng, 2006), may be instrumental in decreasing the likelihood of adolescent PMPU.

Compliance with Ethical Standards

Ethical Approval

The Human Investigations Committee of Southwest University approved this research. The groups were tested prior to obtaining consent from the students, parents, and teachers.

CRediT authorship contribution statement

Jiayu Li: Conceptualization, Data curation, Formal analysis, Investigation, Methodology. **Danni Zhan:** Investigation, Methodology, Data curation. **Yuhong Zhou:** Data curation. **Xuemei Gao:** Conceptualization, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

This research was funded by the National social Science Foundation of China (Grant No. 19BSH112), Chongqing Research Program of Basic Research and Frontier Technology (cstc2018jcyjAX0480), the Fundamental Research Funds for the Central Universities (Grant No. SWU1909226).

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