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### Surrounded by Smartphones

#### Relationship Between Peer Phubbing, Psychological Distress, Problematic Smartphone use, Daytime Sleepiness, and Subjective Sleep Quality

Li, Yumei; Mu, Wenlong; Sun, Chaoran; Kwok, Sylvia Y.C.L.

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**Surrounded by smartphones: Relationship between peer phubbing, psychological distress, problematic smartphone use, daytime sleepiness, and subjective sleep quality.**

Abstract

Experiencing peer phubbing is likely to affect adolescents' quality of life negatively. The current study adopted structural equation modeling to explore the relationship between peer phubbing, individual mental health (i.e., psychological distress), behavior problems (i.e., problematic smartphone use), and physical functioning (i.e., daytime sleepiness and subjective sleep quality).

The total sample contained 742 children and adolescents (395 females; Mean age = 15.39,  $SD = 1.66$ , range = 12 – 19). The results indicated that peer phubbing, psychological distress, and problematic smartphone use were positively related to daytime sleepiness but negatively correlated with subjective sleep quality. When age and gender were controlled, the link between peer phubbing and daytime sleepiness/subjective sleep quality was mediated sequentially by psychological distress and problematic smartphone use and sequentially by problematic smartphone use and psychological distress. The direct effect of peer phubbing was significant on daytime sleepiness but not subjective sleep quality. These findings suggested that peer phubbing could cause psychological distress to children and adolescents, increase their problematic smartphone use and daytime sleepiness, and decrease their subjective sleep quality. Interventions for children and adolescents with daytime sleepiness or poor subjective sleep quality should pay attention to their problematic smartphone use and the phubbing from their peers.

*Keywords:* peer phubbing, psychological distress, problematic smartphone use, daytime sleepiness, subjective sleep quality.

## 1. Introduction

Adolescents' insufficient and poor sleep patterns have become a global public health concern (Garipey et al., 2020). Daytime sleepiness signals an individual's tendency to feel drowsy or sleepy during wakefulness, undermining attention (Ohayon, 2008). Sleep quality is a comprehensive assessment of sleep indicators (e.g., sleep duration and issues) (Krystal & Edinger, 2008). The overall sleep status can be summarized by the subjective sleep quality (i.e., retrospective assessment of the individual's recalled sleep experience) (Krystal & Edinger, 2008). Daytime sleepiness and poor sleep quality can undermine life quality, productivity, and mood state (Dewald et al., 2010). They may also worsen psychiatric symptoms, mental health problems, and cognitive deficits (Zou et al., 2020), increasing the risk of disease and mortality (Lo et al., 2018; Wang et al., 2020). The severe consequences of sleep issues highlight the need to research the factors influencing daytime sleepiness and sleep quality in adolescents.

Adolescent sleep issues are positively associated with susceptibility to peer influence (Semenza et al., 2020), inseparable from online activities (Su et al., 2022). According to the national report, 97.3% of adolescents surf the internet via smartphone, and the percentage of mobile phone ownership in adolescents has reached 65% in 2021 (China Internet Network Information Center, 2021). Nomophobia and phubbing have become an issue of concern among the teenage population (Tomczyk & Lizde, 2022). Phubbing manifests as people focusing on their phones and ignoring the surrounding others (Chotpitayasunondh & Douglas, 2016). Although there is a lack of literature on the direct connection between peer phubbing and daytime sleepiness/sleep quality, according to the social-ecological model, interpersonal relationship plays the role of the social-level impact factor on sleep (Grandner & Fernandez, 2021). Hoffman et al. (2007) have found that adolescents' health behaviors are greatly affected

24 by their peers' attitudes, beliefs, and behaviors. Scholars found that relational issues, such as peer  
25 aggression and victimization, were associated with daytime sleepiness (Zeringue et al., 2021)  
26 and poor sleep quality (van Geel et al., 2016). The negative perception of peer relationships was  
27 correlated with adolescents' subjective sleep quality (Delaruelle et al., 2020; Tu & Cai, 2020). As  
28 aforementioned, peer phubbing is classified as problematic peer relational behavior. It usually  
29 makes the individual feel neglected and perceives the relationship quality inferior (Capilla  
30 Garrido et al., 2021). Hence, this study posited that peer phubbing is positively correlated to  
31 daytime sleepiness but negatively related to subjective sleep quality in adolescents (Hypothesis  
32 1).

33         Psychological factors are indispensable in daytime sleepiness and poor sleep quality.  
34 According to the expectancy-violation theory, the individual would experience distress when the  
35 expectation of others' attention fails (Burgoon, 1993). Peer phubbing implies rejection and  
36 neglect, so an adolescent who is phubbed is more prone to psychological distress (Xie et al.,  
37 2021). Psychological distress is when a person is in a state of emotional distress and experiences  
38 nonspecific symptoms (i.e., anxiety, depression, or stress) (Drapeau et al., 2012). Existing  
39 research indicated that being phubbed by peers was related to adolescent social anxiety (Chu et  
40 al., 2021). Teenagers who experienced parental phubbing were also prone to depressive  
41 symptoms (Xie & Xie, 2020) and social anxiety (Zhang et al., 2021). On the other hand, previous  
42 literature showed that daytime sleepiness (Shen et al., 2019) and poor sleep quality (Shanahan et  
43 al., 2014) partially resulted from anxiety and depression. The nine-year prospective study  
44 suggested that people with psychological distress, especially depression, reported higher levels  
45 of daytime sleepiness in the future (Lalberge et al., 2020). Psychological distress is positively  
46 associated with poor sleep quality in early adolescents (Jamieson et al., 2020). After surveying

47 more than five thousand adolescents, Sampasa-Kanyinga et al. (2018) recognized the negative  
48 effect of psychological distress on adolescents' subjective sleep quality. As explained in the  
49 context-process-outcome model (Roeser et al., 1996), the influences of contextual factors (e.g.,  
50 peer phubbing) are mediated by psychological conditions as process factors to outcomes (e.g.,  
51 sleep issues). Based on the theoretical and empirical views above, an assumption was made on  
52 the mediating role of psychological distress regarding the link between peer phubbing and  
53 daytime sleepiness/subjective sleep quality (Hypothesis 2).

54         Besides the influence of psychological distress, problematic smartphone use could be  
55 critical in the relation of peer phubbing with daytime sleepiness and subjective sleep quality.  
56 Problematic smartphone use refers to several criteria: the excessive browsing of smartphone;  
57 failure to regulate the behavior; interpersonal issues (i.e., family members, partners, and friends)  
58 induced by overuse of smartphone; upward mood online and downward mood when off-line  
59 (De-Sola Gutiérrez et al., 2016). According to social learning theory, exposure to a specific  
60 behavior could reinforce the practice of that behavior (Bandura, 1977). Although there is no  
61 research directly investigating the impact of peer phubbing on adolescent smartphone use,  
62 previous studies indicated that parent's phubbing contributes to the risk of problematic  
63 smartphone/social media use in adolescents and children (Chu et al., 2021; Jun Zhao et al.,  
64 2021). Furthermore, studies on teens aged 11 to 19 showed that peer neglect-related stress was  
65 tied to excessive social media use (Fabris et al., 2020). Being phubbed could make people  
66 perceive neglect and rejection with whom they interact (Chotpitayasunondh & Douglas, 2016;  
67 Roberts & David, 2016). Observing peer phubbing could also prompt the individual to  
68 internalize smartphone use, interfering with sleep. Results from 29 studies and 20,041  
69 individuals demonstrated that problematic smartphone use was positively correlated with sleep

70 disorders (e.g., poor subjective sleep quality and daytime sleepiness) (Zhang et al., 2022). The  
71 younger the participants, the stronger the association (Zhang et al., 2022). Therefore, this study  
72 supposed that problematic smartphone use is a mediator between peer phubbing and daytime  
73 sleepiness/subjective sleep quality (Hypothesis 3).

74 Numerous theoretical and empirical grounds support the positive association between  
75 psychological distress and problematic smartphone use. Some theories and empirical studies  
76 show that psychological distress can affect problematic smartphone use. The compensatory use  
77 theory advocates that problematic technology use is a coping mechanism corresponding to  
78 negative feelings in real life (Kardefelt-Winther, 2014). The severity of psychological distress  
79 symptoms such as depression was significantly and positively associated with problematic  
80 smartphone use (Yuan et al., 2021). Psychological distress symptoms (e.g., depression and  
81 anxiety) predicted future problematic smartphone use behaviors (Kang et al., 2020; Zhou et al.,  
82 2021). As stated in the Interaction of Person-Affect-Cognition-Execution (I-PACE) model of  
83 digital-related issues (Brand et al., 2019), the development of problematic use behaviors is  
84 gradual. In the early stage of development, the situation factors (e.g., peer phubbing) perceived  
85 by individuals could lead to affective and cognitive responses associated with the level of  
86 perceived stress (e.g., psychological distress after experiencing peer phubbing). In turn, the  
87 emotional and cognitive responses lead to decisions to obtain gratification in specific ways (e.g.,  
88 smartphone use behaviors to release psychological distress) with consequences (e.g., poor  
89 subjective sleep quality or daytime sleepiness). However, the development of problematic usage  
90 behavior is not one-way but a dynamic loop (Brand et al., 2019). In the later stage, craving for a  
91 smartphone may have become a cue-reactivity and habitual behavior, the level of experienced  
92 gratification decreases, and the negative emotions and experiences increase (Brand et al., 2016).

93 Longitudinal evidence has found that problematic smartphone use precedes psychological  
94 distress and can affect future symptoms of psychological distress (Chen, Pakpour, et al., 2020;  
95 Lapierre et al., 2019). Besides, longitudinal studies also indicate a bidirectional association  
96 between psychological distress and problematic smartphone use (Liu et al., 2018; Stanković et  
97 al., 2021). Therefore, the link between peer phubbing and daytime sleepiness/subjective sleep  
98 quality can be mediated sequentially by psychological distress and problematic smartphone use  
99 (Hypothesis 4a) or sequentially by problematic smartphone use and psychological distress  
100 (Hypothesis 4b).

101 The present study aimed to explore the potential mechanisms by which adolescents  
102 develop daytime sleepiness/poor subjective sleep quality under the influence of peer phubbing.  
103 In the first model, psychological distress was the first mediator; problematic smartphone use was  
104 the second mediator. In the second model, problematic smartphone use was the first mediator;  
105 psychological distress was the second mediator. This study expanded the literature on phubbing  
106 and sleep. In this regard, the current findings can shed light on interventions for teenage sleep  
107 issues from a peer phubbing perspective.

## 108 2. Methods

### 109 2.1 Participants and procedures

110 The online data collection was launched from May to June 2021 after obtaining the ethics  
111 review approval from the Ethics Sub-Committee of the [REDACTED]. Students  
112 from a comprehensive school (including a junior high school and a high school) in Chongqing,  
113 China, were recruited. School administrators and teachers helped send the survey links to grades  
114 7 to 12. Participants under the age of 12 were excluded from the survey. Participants under the  
115 age of 18 need to obtain the online informed consent of their guardians before participating in the



116 survey. A total of 742 participants (347 males and 395 females, Mage = 15.39, SD = 1.66, aged  
117 12 to 19) voluntarily participated in this survey and completed the measurement of all variables  
118 in the current study. Among the participants, 337 were from junior high school (45.42%), 382  
119 were from high school (51.48%), and 23 (3.10%) did not report their grades. The mean duration  
120 of smartphone use by the participants over the past three months was 3.05 hours per day, with a  
121 standard deviation of 3.42 hours.

## 122 **2.2 Measures**

### 123 **2.2.1 Peer phubbing**

124 The 7-item Parental Phubbing Scale (Pancani et al., 2020) was adapted to measure the  
125 participants' perception of peer phubbing. The term "mother" or "father" in the original scale were  
126 replaced with "friends." A sample item is "During leisure time that we spend together, my friends  
127 pay more attention to her/his smartphone than to me." The responses on the five-point Likert scale  
128 were averaged. A higher score means a higher degree of peer phubbing perceived by the  
129 participants. The Parental Phubbing Scale was initially adapted from the 9-item Partner Phubbing  
130 Scale (Roberts & David, 2016), which measured the perceived phubbing from others, especially  
131 the partner. The Partner Phubbing Scale has been adapted to measure peer phubbing and showed  
132 good internal reliability and structure validity among Chinese university students (J. Zhao et al.,  
133 2021). The Parental Phubbing Scale removed a potentially confusing reverse scoring item, and an  
134 item focused on romantic relationships from the Partner Phubbing Scale. Hence, the current study  
135 adopted the Parental Phubbing Scale to measure peer phubbing. The adapted peer phubbing scale  
136 showed an acceptable one-factor model fit in the present study ( $\chi^2(14) = 111.271, p < .001, CFI =$   
137  $0.975, TLI = 0.963, RMSEA = 0.097, 90\% CI = 0.081-0.114, SRMR = 0.022$ ). The Cronbach's  
138 alpha was .935.

### 139 **2.2.2 Psychological distress**

140 Participants' responses to the 21-item Depression, Anxiety, and Stress Scale-21 (Lovibond  
141 & Lovibond, 1995) were used to evaluate the degree of psychological distress. The 4-point scale  
142 contains three dimensions: anxiety, depression, and stress. A high overall score for a response  
143 indicates that the person is experiencing high psychological distress. The Chinese version scale  
144 applies to Chinese adolescents (Gao et al., 2020). The Cronbach's alpha of this scale was .963.

### 145 **2.2.3 Problematic smartphone use**

146 Problematic smartphone use in adolescents was assessed using the 6-item Smartphone  
147 Application-Based Addiction Scale (Csibi et al., 2018). The more frequently the smartphone is  
148 used, the higher the total score on this six-point Likert scale. The Chinese version has good  
149 psychometric properties in Chinese children (Chen, Ahorsu, et al., 2020). The Cronbach's alpha  
150 was .867.

### 151 **2.2.4 Daytime sleepiness**

152 The 7-item Chinese Adolescent Daytime Sleepiness Scale (Liu et al., 2017) was adopted  
153 to assess drowsiness and dozing in the daytime over the past month. Participants were required to  
154 answer items on a 5-point Likert scale. The higher the overall score on this scale, the more the  
155 participants dozed off or felt sleepy during the day; that is, the higher the degree of daytime  
156 sleepiness. The Cronbach's alpha was .892.

### 157 **2.2.5 Subjective sleep quality**

158 The single item "How is your sleep quality?" was adopted. Participants' responses on the  
159 5-point Likert scale indicated their subjective sleep quality. Participants scored 1, indicating  
160 inferior sleep quality, and 5 indicating excellent sleep quality. Previous studies on subjective  
161 sleep quality have shown that this single measurement item can effectively assess subjective

162 sleep quality (Matsumoto et al., 2022) and is applicable to the Chinese population (Liu et al.,  
163 2020).

### 164 **2.3 Statistical analysis**

165 Pearson correlation analysis was adopted to explore the correlation between key variables  
166 in SPSS 26.0. The mediating roles of psychological distress and problematic smartphone use  
167 were examined by structural equation modeling in Mplus 8.3. Peer phubbing was the  
168 independent variable in the mediation analysis, and daytime sleepiness and subjective sleep  
169 quality were **correlated dependent variables. Empirical evidence has indicated that age and**  
170 **gender can be significant confounders in the studies of phubbing, problematic smartphone use,**  
171 **psychological distress, and sleep issues (Chotpitayasunondh & Douglas, 2016; Keles et al., 2020;**  
172 **Wallace et al., 2022). Therefore, gender and age were controlled for as confounding variables in**  
173 **the mediation models.** For model parsimony (Little et al., 2002), three dimensions of  
174 psychological distress were used as indicators of the variable instead of the original 21 items.  
175 The bias-corrected bootstrap resampling of 5,000 iterations was performed to test the mediation  
176 effect. The 95% confidence interval (95% CI) with no zero value signifies a significant  
177 mediation effect.

## 178 **3. Results**

### 179 **3.1 Descriptive analysis**

180 **Table 1** presents the descriptive analysis results and correlations of key variables in the  
181 current study. Peer phubbing was positively correlated with psychological distress, problematic  
182 smartphone use, and daytime sleepiness. Peer phubbing was negatively correlated with  
183 subjective sleep quality. Both psychological distress and problematic smartphone use were  
184 positively correlated with daytime sleepiness. These two variables were negatively correlated

185 with subjective sleep quality. Daytime sleepiness was negatively correlated with subjective sleep  
186 quality.

### 187 **3.2 Psychological distress and problematic smartphone use as serial mediators**

188 The fit index of the measurement model ( $\chi^2(281) = 1069.898, p < .001, CFI = 0.936, TLI$   
189  $= 0.926, RMSEA = 0.062, 90\% CI = 0.058-0.065, SRMR = 0.035$ ) demonstrated that the  
190 structural equation model with **psychological distress and problematic smartphone use as the**  
191 **serial mediators** has a good model fit. The results are presented in **Figure 1** and **Table 2**. Peer  
192 phubbing was positively associated with psychological distress, problematic smartphone use, and  
193 daytime sleepiness. Peer phubbing had a direct positive effect on daytime sleepiness.  
194 Psychological distress and problematic smartphone use mediated the association between peer  
195 phubbing and daytime sleepiness individually and sequentially. Peer phubbing did not have a  
196 direct effect on subjective sleep quality. Psychological distress and problematic smartphone use  
197 mediated the association between peer phubbing and subjective sleep quality individually and  
198 sequentially.

### 199 **3.3 Problematic smartphone use and psychological distress as serial mediators**

200 The structural equation model with problematic smartphone use and psychological  
201 distress as the serial mediators has a good model fit ( $\chi^2(281) = 1069.898, p < .001, CFI = 0.936,$   
202  $TLI = 0.926, RMSEA = 0.062, 90\% CI = 0.058-0.065, SRMR = 0.035$ ). The results are  
203 presented in **Figure 2** and **Table 3**. Problematic smartphone use and psychological distress  
204 mediated the association between peer phubbing and subjective sleep quality individually and  
205 sequentially.

## 206 **4. Discussion**

207           This study examined the effects of peer phubbing on daytime sleepiness and subjective  
208 sleep quality in adolescents by constructing two mediation models. The results revealed that peer  
209 phubbing, problematic smartphone use, and psychological distress were positively correlated  
210 with daytime sleepiness. Besides, they were negatively correlated with subjective sleep quality.  
211 Psychological distress and problematic smartphone use sequentially mediated the path from peer  
212 phubbing to daytime sleepiness/subjective sleep quality. **When psychological distress and**  
213 **problematic smartphone use switch positions, i.e., problematic smartphone use as the first**  
214 **mediating variable and psychological distress as the second mediating variable, the path still**  
215 **holds.** Peer phubbing has a significant direct effect on daytime sleepiness but not on subjective  
216 sleep quality.

217           The research findings supported the first, second, and third hypotheses that peer phubbing  
218 was significantly correlated with subjective sleep quality and daytime sleepiness. Besides, peer  
219 phubbing was associated with them through psychological distress and problematic smartphone  
220 use. As stated in the self-determination theory, relatedness is one of the basic human needs  
221 (Ryan & Deci, 2017). The nature of peer phubbing enlists social rejection and neglect  
222 (Chotpitayasunondh & Douglas, 2016). Given that peer phubbing could make others feel  
223 excluded, less needed, and less cared for (Pancani et al., 2020), it is not conducive to adolescents'  
224 need for relatedness. Research on college students indicated that those who were phubbed by  
225 peers tend to have more attention-seeking behavior to compensate for their social needs (Hao et  
226 al., 2021). Due to the need for relational connectedness, teenagers may turn to social networking  
227 sites, which significantly overlap with problematic smartphone use (Jeong et al., 2016). Besides,  
228 a four-year longitudinal study found that peer problematic internet use could explain changes in  
229 individuals' future problematic internet use, and satisfaction with friendships could moderate the

230 effects of peer problematic use on individual problematic internet use (Jia et al., 2021). Based on  
231 the social-ecological model of sleep health (Grandner, 2019), the social circle within the school  
232 is an essential factor impacting sleep. Thus, the presence of a peer phubbing environment and the  
233 resulting psychological distress and problematic smartphone use in adolescents may be related to  
234 sleep-related issues. These findings suggested the importance of reducing phubbing by  
235 encouraging face-to-face interaction and lowering all students' smartphone usage in school. Less  
236 peer phubbing might be associated with reduced psychological distress and problematic  
237 smartphone use, daytime sleepiness, and improved sleep quality.

238       Specifically, **psychological distress and problematic smartphone use sequentially**  
239 **mediated the path from peer phubbing to sleep issues and vice versa.** These results supported the  
240 **I-PACE model.** According to the I-PACE model, in the early stage of the development of  
241 **problematic use behaviors, individuals perceive internal triggers in specific situations that create**  
242 **the impulse to act in a specific way.** The expectancy-violation theory (Burgoon, 1993) suggests  
243 **adolescents could experience negative emotions and psychological distress when expectations of**  
244 **conservative treatment during interactions with peers are violated (e.g., peer phubbing).** In this  
245 **case, adolescents may try to meet their psychological and social needs by using their**  
246 **smartphones for socializing or online gaming.** Over time, the association between using  
247 **smartphones to compensate for psychological distress arising from peer phubbing may become**  
248 **more robust.** Longitudinal studies in a meta-analysis indicated that problematic social media use  
249 was a risk factor for psychological distress and poor sleep quality in adolescence (Yang et al.,  
250 2020). **On the one hand, problematic smartphone use can lead to adverse consequences, such as**  
251 **sleep issues (e.g., daytime sleepiness and poor subjective sleep quality).** On the other hand,  
252 **problematic smartphone use can gradually become habitual behavior. In the later stages of the**

253 problematic use process, the gratification experienced by the individual decreases, and the  
254 negative emotional and psychological experience is brought about by the increased negative  
255 consequences of the problematic use. Consequently, the results of the current study's two  
256 mediated pathways supported the I-PACE model's early and late stages, respectively.  
257 Consequently, the results of the current study's two mediated pathways supported the I-PACE  
258 model's early and late stages, respectively.

259 Interestingly, the direct association between peer phubbing and daytime sleepiness was  
260 not replicated in the association between peer phubbing and sleep quality. In contrast, peer  
261 phubbing can only influence subjective sleep quality through psychological distress and/or  
262 problematic smartphone use rather than directly associated with it. One possible reason is that  
263 daytime sleepiness occurs during the day, but subjective sleep quality is a retrospective  
264 assessment of nighttime sleep. A prospective cohort analysis of a psychomotor vigilance task  
265 demonstrated that individual attention was associated with daytime sleepiness but independent of  
266 sleep quality and duration (Yun et al., 2015). The face-to-face interaction between peers during  
267 the day can help stimulate one's cognitive and behavioral responses, arouse one's attention to the  
268 content of the exchange, and then reduce the occurrence of sleepiness. Conversely, if they are  
269 phubbed by peers and lose interaction, they may lack evocation of attention, resulting in daytime  
270 sleepiness. However, the findings of the current study indicate that even if a person perceives  
271 peer phubbing, it may not directly relate to sleep quality at night if they do not feel distressed by  
272 phubbing or develop problematic smartphone use. It suggests that there may be some  
273 moderators, such as resilience (Li et al., 2022), self-control (Niu et al., 2020), and self-regulation  
274 (Wang & Jiang, 2022), which may help individuals adaptively to cope with poor relationships

275 and avoid psychological distress or problematic smartphone use, thereby protect the individual  
276 from poor sleep quality.

277         Some limitations also need to address. First, the nature of the cross-sectional study made  
278 the current findings not provable of a causal relationship. Future studies need to conduct  
279 longitudinal studies to clarify the cross-lagged or bidirectional relationship in the loop of the I-  
280 PACE model. Second, the extent of daytime sleepiness and sleep quality were self-reported and  
281 could be affected by recall bias. Other's observations should also be considered, such as teacher's  
282 reports, parental reports, etc. Third, according to the I-PACE model (Brand et al., 2019), the  
283 predisposing variables (e.g., negative early childhood experiences, coping styles,  
284 psychopathology, and temperamental features) may interact with the affective and cognitive  
285 processes to influence problematic use behaviors and the consequences. Empirical studies also  
286 suggest the existence of potential factors (e.g., resilience, self-control, and self-regulation) that  
287 moderate the pathways from being phubbed to psychological factors and problematic use  
288 behaviors (Li et al., 2022; Niu et al., 2020; Wang & Jiang, 2022). Therefore, there is a need to  
289 include these moderating variables or control for them in future studies to capture more potential  
290 pathways from peer phubbing to problematic smartphone use and sleep issues. Fourth, the  
291 findings need to be interpreted cautiously because the current research focuses on Chinese  
292 adolescents. Given that adolescent sleep behaviors might vary across countries (Garipey et al.,  
293 2020), the research findings need more cross-cultural repetitive validation to test the universality  
294 of the influence of peer phubbing.

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538

**Table 1** Means, standard deviations, bivariate correlations, skewness, and kurtosis of the study variables ( $n = 742$ ).

| Variables                    | 1        | 2        | 3        | 4        | 5     |
|------------------------------|----------|----------|----------|----------|-------|
| 1 Peer phubbing              | 1        |          |          |          |       |
| 2 Psychological distress     | 0.28***  | 1        |          |          |       |
| 3 Problematic smartphone use | 0.38***  | 0.31***  | 1        |          |       |
| 4 Daytime sleepiness         | 0.29***  | 0.27***  | 0.37***  | 1        |       |
| 5 Subjective sleep quality   | -0.17*** | -0.28*** | -0.24*** | -0.39*** | 1     |
| Mean                         | 2.80     | 23.55    | 18.25    | 16.53    | 3.49  |
| SD                           | 0.84     | 14.72    | 6.05     | 5.94     | 1.03  |
| Skewness                     | -0.23    | 0.31     | -0.07    | 0.40     | -0.27 |
| Kurtosis                     | 0.12     | -0.35    | -0.36    | 0.11     | -0.24 |

Note. SD = standard deviations; \*\*\* $p < 0.001$ , \*\* $p < 0.01$ , \* $p < 0.05$

**Table 2** Standardized direct and indirect effects from peer phubbing to daytime sleepiness and subjective sleep quality via **psychological distress and problematic smartphone use** ( $n = 742$ ).

| <b>Effects on daytime sleepiness</b>       | $\beta$ (SE)   | <i>P</i> | 95% CI           |
|--|----------------|----------|------------------|
| Direct Path                                |                |          |                  |
| PP→DS                                      | 0.127 (0.038)  | 0.001    | [0.026, 0.221]   |
| Indirect Path                              |                |          |                  |
| Total: PP→DS                               | 0.173 (0.024)  | < 0.001  | [0.116, 0.240]   |
| PP→PD→DS                                   | 0.041 (0.013)  | 0.002    | [0.009, 0.079]   |
| PP→PSU→DS                                  | 0.110 (0.021)  | < 0.001  | [0.062, 0.172]   |
| PP→PD→PSU→DS                               | 0.022 (0.006)  | < 0.001  | [0.010, 0.042]   |
| <b>Effects on subjective sleep quality</b> | $\beta$ (SE)   | <i>P</i> | 95% CI           |
| Direct Path                                |                |          |                  |
| PP→SSQ                                     | -0.032 (0.042) | 0.446    | [-0.145, 0.070]  |
| Indirect Path                              |                |          |                  |
| Total: PP→SSQ                              | -0.140 (0.023) | < 0.001  | [-0.206, -0.087] |
| PP→PD→SSQ                                  | -0.068 (0.015) | < 0.001  | [-0.111, -0.036] |
| PP→PSU→SSQ                                 | -0.060 (0.018) | 0.001    | [-0.113, -0.018] |
| PP→PD→PSU→SSQ                              | -0.012 (0.004) | 0.004    | [-0.026, -0.004] |

*Notes.* PP = peer phubbing, PD = psychological distress, PSU = problematic smartphone use, DS = daytime sleepiness, SSQ = subjective sleep quality

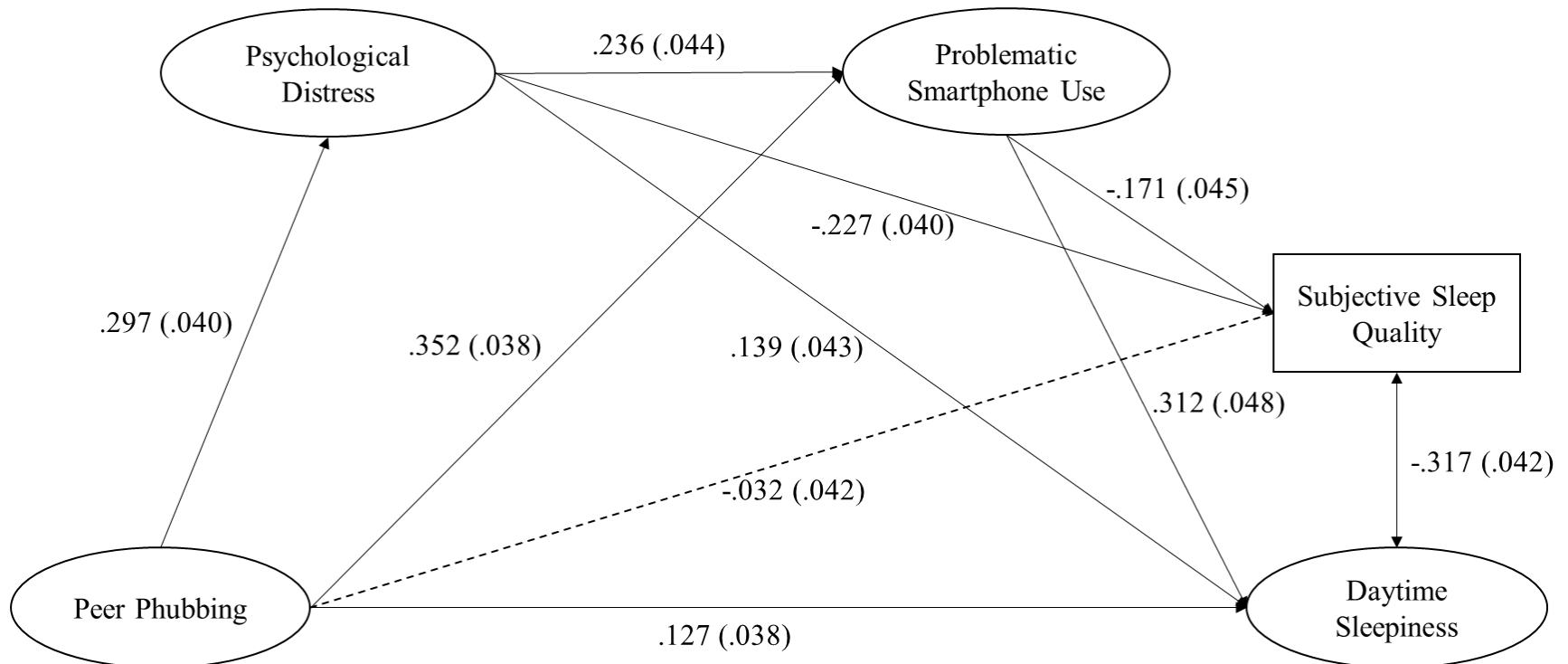
**Table 3** Standardized direct and indirect effects from peer phubbing to daytime sleepiness and subjective sleep quality via problematic smartphone use and psychological distress ( $n = 742$ ).

| <b>Effects on daytime sleepiness</b>       | <b><math>\beta</math> (SE)</b> | <b><i>P</i></b> | <b>95% CI</b>    |
|--|--------------------------------|-----------------|------------------|
| Direct Path                                |                                |                 |                  |
| PP→DS                                      | 0.127 (0.038)                  | 0.001           | [0.026, 0.221]   |
| Indirect Path                              |                                |                 |                  |
| Total: PP→DS                               | 0.173 (0.024)                  | < 0.001         | [0.116, 0.240]   |
| PP→PSU→DS                                  | 0.132 (0.023)                  | < 0.001         | [0.077, 0.196]   |
| PP→PD→DS                                   | 0.026 (0.010)                  | 0.010           | [0.006, 0.058]   |
| PP→PSU→PD→DS                               | 0.015 (0.006)                  | 0.009           | [0.003, 0.035]   |
| <b>Effects on subjective sleep quality</b> | <b><math>\beta</math> (SE)</b> | <b><i>P</i></b> | <b>95% CI</b>    |
| Direct Path                                |                                |                 |                  |
| PP→SSQ                                     | -0.032 (0.042)                 | 0.446           | [-0.145, 0.070]  |
| Indirect Path                              |                                |                 |                  |
| Total: PP→SSQ                              | -0.140 (0.023)                 | < 0.001         | [-0.206, -0.087] |
| PP→PSU→SSQ                                 | -0.072 (0.021)                 | < 0.001         | [-0.132, -0.021] |
| PP→PD→SSQ                                  | -0.043 (0.013)                 | 0.001           | [-0.081, -0.015] |
| PP→PSU→PD→SSQ                              | -0.025 (0.007)                 | < 0.001         | [-0.049, -0.011] |

*Notes.* PP = peer phubbing, PSU = problematic smartphone use, PD = psychological distress, DS = daytime sleepiness, SSQ = subjective sleep quality

**Figure 1**

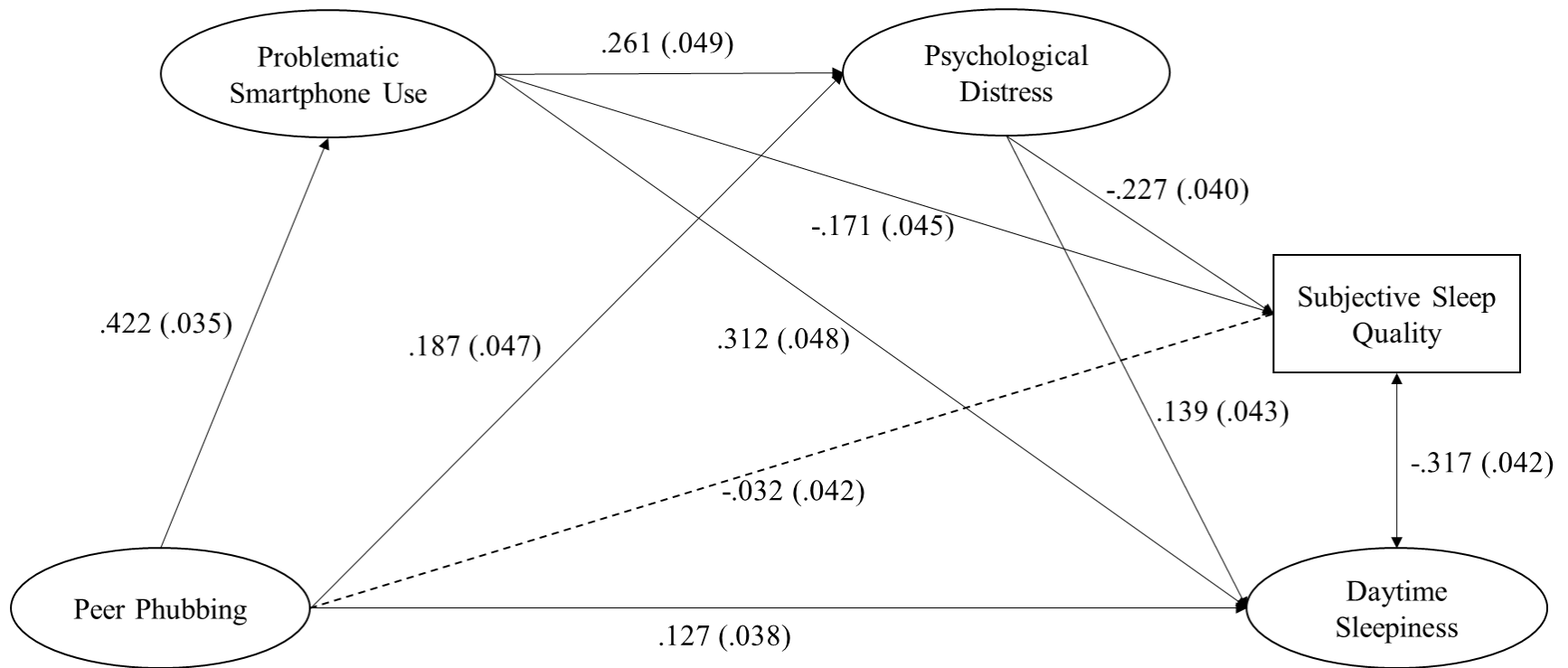
Serial mediation role of psychological distress and problematic smartphone use between peer phubbing and daytime sleepiness/ subjective sleep quality ( $n = 742$ ).



*Notes.* Gender and age were controlled for as confounders in the model. All the solid lines with a single arrow in the figure indicate that the relationship between the variables was significant ( $p \leq 0.001$ ). The dashed line indicates that the relationship between the variables was insignificant ( $p > 0.05$ ). The double-arrow solid line represents significant residual covariance between the two variables ( $p < 0.001$ ).

**Figure 2**

Serial mediation role of problematic smartphone use and psychological distress between peer phubbing and daytime sleepiness/ subjective sleep quality ( $n = 742$ ).



*Notes.* Gender and age were controlled for as confounders in the model. All the solid lines with a single arrow in the figure indicate that the relationships between the variables were significant ( $p \leq 0.001$ ). The dashed line indicates that the relationship between the variables was insignificant ( $p > 0.05$ ). The double-arrow solid line represents significant residual covariance between the two variables ( $p < 0.001$ ).