Insomnia partially mediated the association between problematic Internet use and depression among secondary school students in China

JI-BIN LI1,2, JOSEPH T. F. LAU2,3*, PHOENIX K. H. MO2,3, XUE-FEN SU2,3, JIE TANG4, ZU-GUO QIN4 and DANIELLE L. GROSS2

1State Key Laboratory of Oncology in South China, Department of Clinical Research, Collaborative Innovation Center for Cancer Medicine, Sun Yat-sen University Cancer Center, Guangzhou, China
2Faculty of Medicine, Centre for Health Behaviours Research, The Jockey Club School of Public Health and Primary Care, The Chinese University of Hong Kong, Hong Kong, China
3Shenzhen Research Institute (SZRI), The Chinese University of Hong Kong, Shenzhen, China
4Department of Social Health Education, Center for Health Education in Guangdong Province, Guangzhou, China

(Received: July 13, 2017; revised manuscript received: November 6, 2017; accepted: December 3, 2017)

Background and aims: This study aims to examine the mediating effects of insomnia on the associations between problematic Internet use, including Internet addiction (IA) and online social networking addiction (OSNA), and depression among adolescents. Methods: A total of 1,015 secondary school students from Guangzhou in China participated in a cross-sectional survey. Levels of depression, insomnia, IA, and OSNA were assessed using the Center for Epidemiological Studies-Depression Scale, Pittsburgh Sleep Quality Index, Young’s Diagnostic Questionnaire, and Online Social Networking Addiction Scale, respectively. Logistic regression models were fit to test the associations between IA, OSNA, insomnia, and depression. The mediation effects of insomnia were tested using Baron and Kenny’s strategy. Results: The prevalence of depression at moderate level or above (CES-D ≥ 21), insomnia, IA, and OSNA were 23.5%, 37.2%, 8.1%, and 25.5%, respectively. IA and OSNA were significantly associated with depression (IA: AOR = 2.79, 95% CI: 1.71, 4.55; OSNA: AOR = 3.27, 95% CI: 2.33, 4.59) and insomnia (IA: AOR = 2.83, 95% CI: 1.72, 4.65; OSNA: AOR = 2.19, 95% CI: 1.61, 2.96), after adjusting for significant background factors. Furthermore, insomnia partially mediated 60.6% of the effect of IA on depression (Sobel Z = 3.562, p < .002) and 44.8% of the effect of OSNA on depression (Sobel Z = 3.919, p < .001), respectively. Discussion: The high prevalence of IA and OSNA may be associated with increased risk of developing depression among adolescents, both through direct and indirect effects (via insomnia). Findings from this study indicated that it may be effective to develop and implement interventions that jointly consider the problematic Internet use, insomnia, and depression.

Keywords: online social networking addiction, Internet addiction, insomnia, depression, mediation

INTRODUCTION

Globally, depression is one of the most widely reported psychiatric disorders among adolescents (Thapar, Collishaw, Potter, & Thapar, 2010). In China, the prevalence of mild, moderate, and severe depression, as assessed using Children’s Depression Inventory, was 14.6%, 15.3%, and 12.4% among middle school students, respectively (Feng & Zhang, 2005). Depression is positively associated with several negative health outcomes (e.g., substance use and suicidal behaviors) that could impact adolescents’ future development (Cairns, Yap, Pilkington, & Jorm, 2014; Thapar, Collishaw, Pine, & Thapar, 2012; Wu, Li, Lau, Mo, & Lau, 2016).

Problematic Internet use (PIU), defined as an impulse-control disorder (Shaw & Black, 2008), is a risk factor of depression among adolescents. PIU has been distinguished into a more generalized and a more specific form (Davis, 2001). Internet addiction (IA), in general, refers to individual’s overall Internet use in a compulsive way (Davis, 2001; Tsitsika et al., 2014). The high prevalence of IA has been reported among Asian adolescents, varying from 6.2% in Japan to 21.1% in the Philippines (Mak et al., 2014). In China, IA prevalence among adolescents is high 26.0% in 2011 (Chinese Internet Association of Adolescents, 2012).

Specific types of PIU has raised concerns in recent years, which refers to compulsive use of specific online functions (Davis, 2001), i.e., online social networking. The importance of investigating specific types of PIU has been highlighted in previous studies (Laconi, Tricard, & Chabrol, 2015). Online social networking addiction (OSNA), a specific type of PIU, is defined as compulsive use of online social networking (Kuss & Griffiths, 2011). Several studies reported the prevalence of OSNA among adolescents, greatly ranging from 1.6% in Nigeria (defined by 4th quartile of

DOI: 10.1556/2006.6.2017.085

ISSN 2062-5871 © 2017 The Author(s)
Problematic Internet use, insomnia, and depression

Facebook Addiction Symptoms Scale) to 34.3% in mainland China (defined by five or more “yes” answers of eight items selected from the Young’s Internet Addiction Test) (Alabi, 2013; Wolniczak et al., 2013; Zhou, 2010).

OSNA, as well as IA in general, is recent but insufficiently investigated phenomena. It is warranted to look at depression as a potential negative health outcome of both IA and OSNA among adolescents. IA and OSNA decline with adolescents’ social involvement, and then lead to increased symptoms of psychiatric disorder (i.e., depression) (Kraut et al., 1998). The positive relationship between IA and depression among adolescents has been repeatedly reported in both cross-sectional (Wu et al., 2016) and longitudinal studies (Ko et al., 2014; Lam & Peng, 2010). For instance, a 9-month longitudinal study showed that students with IA at baseline were 2.5 times more likely to develop depression than those without IA at baseline (Lam & Peng, 2010). Furthermore, adolescents with OSNA had a high level of depressive symptoms (Banyai et al., 2017). Some recent cross-sectional surveys reported a positive association between OSNA and depressive symptoms among young adults and adolescents (Koc & Gulyagci, 2013; Shensa et al., 2017).

Insomnia is another significant public health concern in adolescents. It is a heterogeneous complaint reflecting reduced quality, duration, or frequency of sleep (Tsai et al., 2005). Insomnia is significantly linked with behavioral and emotional problems among adolescents, including depression (Taylor, Lichstein, & Durrence, 2003; Xu et al., 2012). Researchers have pointed out that insomnia is a potential predictor as well as a symptom of depression (Baglioni et al., 2011). Poor sleep quality [defined by the Pittsburgh Sleep Quality Index (PSQI)] is associated with depressive symptoms among adolescents (Xu et al., 2012). A longitudinal study conducted among adolescents reported that late bedtime and short sleep duration (components of insomnia) strongly predicted development of anxiety and depression (Matamura et al., 2014). It is possible that insufficient sleep leads to fatigue and apathy at school, impaired social functioning, and impaired ability to regulate mood and emotional responses (Chorney, Detweiler, Morris, & Kuhn, 2008).

Sleep problems and PIU are common among children and adolescents. IA and OSNA compete with off-line activities including time that could be used for sleeping, and hence potentially cause insomnia. Excessive Internet use among adolescents often occurs at night (Primack, Swanier, Georgiopoulous, Land, & Fine, 2009), and adolescents with a higher IA score reported getting to bed later, requiring more time to fall asleep, and disrupting their sleep–wake schedule (i.e., increased number of awakenings at night) than those with lower IA score (Ekinci, Celik, Savas, & Toros, 2014; Van den Bulck, 2004). Adolescents with OSNA are at a high risk of insomnia (Hanprathet, Manwong, Khumsri, Yingyeun, & Phanasathit, 2015). A recent study conducted among undergraduate students in Peru showed that prevalence of insomnia (PSQI score > 5) among Facebook addicts was 1.31 times higher than that among non-addicts (Wolniczak et al., 2013). However, there is a dearth of studies investigating the relationship between IA/OSNA and insomnia among adolescents, especially OSNA.

PIU (both IA and OSNA) is a potential risk factor of both adolescents’ insomnia and depression. Given the interrelationships between IA/OSNA, insomnia, and depression, it is logical to contend that insomnia could potentially mediate the relationships between PIU (i.e., IA and OSNA) and depression among adolescents. Two previous cross-sectional studies assessed the mediation effect of insomnia on the association between IA and depression among adolescents. One of them was conducted among Nepali undergraduate adolescents, reporting that insomnia mediates 30.9% effect of IA on depression (Bhandari et al., 2017), whereas another study conducted among Hong Kong adolescents reported a low mediation effect (5%) of IA on depression (Cheung & Wong, 2011). However, these two studies did not involve OSNA. A recent longitudinal study showed that 53% of the association between problematic online social networking use (as measured by four items that were adapted from the Young’s Internet Addiction Scale) and depressed mood was mediated by sleep disruptions (Vernon, Modecki, & Barber, 2017).

In this study, we aimed to investigate the prevalence of IA, OSNA, insomnia, and depression among secondary school students in Guangzhou, China. We also investigated the associations between IA/OSNA and depression, and those between IA/OSNA and insomnia, adjusted for significant background factors. We then tested the mediation effect of insomnia on the associations between IA/OSNA and depression. We hypothesized that insomnia would partially mediate the associations between IA/OSNA and depression, after adjusting for significant background factors.

METHODS

Participants and procedure

This cross-sectional survey selected two secondary schools by convenience sampling, one from an urban area and one from a rural area in Guangzhou, mainland China. The study procedure and sampling methodology has been described in detail in a previously published paper that was based on the same sample (Li et al., 2016), which validated an instrument that could be used to assess adolescents’ online social networking use intensity.

A total of 1,088 students were invited to join the study and completed the questionnaire. The data obtained from 73 participants were removed from data analysis, considering that they had more than 20% of items missing for one or more measurement scales. The remaining 1,015 questionnaires (93.3%) had only 0.11%–3.74% of missing item responses, which were imputed by mode values. The data of 1,015 participants were then analyzed in this study.

Measures

Depression. Level of depression was assessed using the Chinese version of the 20-item Center for Epidemiological Studies-Depression scale (CES-D), which is a commonly used self-reported instrument for screening depressive symptoms. Its Chinese version of CES-D has been validated (Chen, Yang, & Li, 2009; Cheng, Yen, Ko, & Yen, 2012).
and widely used among Chinese student population (Que, Tao, He, Zhang, & Zhu, 2007; Zhang et al., 2010). Participants rated how often they experienced the symptoms such as restless sleep and feeling lonely in the previous week on a 4-point Likert scale (ranging from 0 = rarely or none of the time to 3 = almost or all of the time). The total score ranged from 0 to 60, with higher scores indicating more symptoms of depressive. In this study, the Cronbach’s α was .87. Students with CES-D scores between 16 and 21 were defined as “mildly depressed,” 21–24 as “moderately depressed,” and ≥25 as “severely depressed” (Song et al., 2008).

Internet addiction (IA). Internet addiction was assessed using Young’s 8-item Diagnostic Questionnaire, which involved “yes/no” response categories. Participants who provided five or more “yes” answers were classified as Internet addicts (Aboujaoude, 2010; Young, 1998). The scale has been successfully used in Chinese student with acceptable psychometric properties (Fu, Chan, Wong, & Yip, 2010; Li, Zhang, Lu, Zhang, & Wang, 2014). Its Cronbach’s α was .73 in our sample.

Online social networking addiction (OSNA). Online social networking addiction was measured using an adapted version of the Facebook Addiction Scale (Koc & Oulyagci, 2013). OSNA scale included eight items by describing core addictive symptoms. Response categories ranged from 1 (not true) to 5 (extremely true), with a total score ranging from 8 to 40; higher scores indicate higher levels of addictiveness to online social networking. The development and psychometric properties of OSNA have been thoroughly evaluated in our previously published paper (Cronbach’s α = .86) (Li et al., 2016). There is currently no established cut-off value for defining OSNA status. Following the cut-off point strategy used in some previous studies (Alabi, 2013; Yaghjyan et al., 2017), we divided the students’ scores into four quartile groups, and those in the fourth quartile (i.e., OSNA score ≥ 21) were defined as having OSNA.

Insomnia. PSQI was used to classify insomnia over the past month. Its Chinese version has been shown to have good overall psychometric properties (Tsai et al., 2005), and been widely used in Chinese adolescents (An et al., 2014; Zhou et al., 2012). The 18-item PSQI evaluated participants’ experience in seven components: sleep latency, sleep duration, habitual sleep efficiency, subjective sleep quality, use of sleep medication, sleep disturbances, and daytime dysfunction. Each component ranges from 0 (no difficulty) to 3 (severe difficulty). In this study, the Cronbach’s α of seven PSQI components was .62. A global score (range: 0–21) was generated by adding up these component scores, with higher scores implying poorer sleep quality. Insomnia is defined as those with PSQI global scores exceeding 5 (Tsai et al., 2005).

Background covariates. Background covariates that were selected in this study included sociodemographic variables (i.e., gender, school district, grade, parental education level, perceived family financial situation, and smartphone ownership) and school-related variables (i.e., self-reported academic performance and perceived study pressure).

Statistical analysis

Descriptive statistics (e.g. means, standard deviation, and percentages) were presented. Depression at moderate or above level (CES-D ≥ 21) was used as the dependent variable in this study (Song et al., 2008; Wu et al., 2016). Univariate odds ratios were estimated using univariate logistic regression analysis. The associations between IA/OSNA/insomnia and depression, and those between IA/OSNA and insomnia were tested by fitting logistic regression models, adjusted for background variables with p < .10 in the univariate associations. Adjusted odds ratios with corresponding 95% confidence intervals (95% CIs) were reported.

The mediating effects of insomnia for the relationships between IA/OSNA and depression were tested using a series of hierarchical logistic regression models, adjusting for significant background variables. Based on Baron and Kenny’s (1986) strategy, mediation is demonstrated when (a) the independent variable (i.e., IA and OSNA) is significantly associated with the dependent variable (i.e., depression); (b) the independent variable (i.e., IA and OSNA) is significantly associated with the potential mediator (i.e., insomnia); and (c) the potential mediator is significantly associated with the dependent variable (i.e., depression) when the independent variable (i.e., IA and OSNA) is controlled for. The size of mediation effect through insomnia was evaluated by ab/(ab + c’)(MacKinnon, Fairchild, & Fritz, 2008), where a is the regression coefficient between the independent variable and the mediator, b is that between the mediator and the dependent variable adjusting for the independent variable, and c’ is that between the independent variable and the dependent variable adjusting for the mediator. The Sobel Z test was used to assess whether the mediation effects of insomnia for the associations between IA/OSNA and depression were statistically significant (MacKinnon et al., 2008). All statistical analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA). The statistical significant level was 0.05 (two-sided).

Ethics

The study procedures were carried out in accordance with the Declaration of Helsinki. School consent and permission for the in-school survey were obtained from the school principals, and verbal consent was obtained from participants themselves. The study and the consent procedure were approved by the Survey and Behavioral Research Ethics Committee of the Chinese University of Hong Kong.

RESULTS

Sample characteristics

Sample characteristics are presented in Table 1. Of the 1,015 students, 44.0%, 39.3%, and 16.7% were 7th, 8th, and 9th grade (i.e., 7–9 years of formal education) students, respectively; 58.8% of the participants were males. About one third (32.2%) self-reported high levels of academic pressure, and about two third (60.4%) had a smartphone.

Insomnia and components of PSQI

As shown in Table 1, around one fifth of the participants (20.1%) perceived poor/very poor subjective sleep quality,
and 30.8% slept for less than 7 hr per night. About 3.0% of the students used sleep medicine during the last month. The overall prevalence of insomnia in our sample was 37.2%.

Prevalence and levels of IA, OSNA, and depression

Of the 1,015 participants, 3.3% reported that they did not use the Internet, and 10.3% did not use online social networking; 8.1% were classified as Internet addicts; 25.5% were as having OSNA (defined as participants in the 4th quartile of OSNA scores, i.e., ≥21). Moreover, 28.1% of the participants had either IA or OSNA, and 5.5% of participants had both IA and OSNA. Prevalence of depression at a mild level or above (CES-D ≥16), moderate level or above (CES-D ≥21), and severe level (CES-D ≥25) was 41.2%, 23.5%, and 13.4%, respectively. The prevalence is presented in Table 1.

Associations between background variables and depression

The univariate associations between background variables and depression are presented in Table 2. All background variables associated with depression under \( p < .10 \) level, including school district, grade, perceived family financial situation, smartphone ownership, academic performance, and perceived study pressure, were adjusted for in the subsequent analyses for the associations between IA/OSNA and depression and between IA/OSNA and insomnia.

Associations between IA/OSNA and insomnia

Adjusted for the background variables that are presented in Table 2, OSNA and IA were both positively and significantly associated with insomnia (AOR = 2.19, 95% CI: 1.61, 2.96 for OSNA; AOR = 2.83, 95% CI: 1.72, 4.65 for IA; see Table 3).

### Table 1. Sample characteristics (n = 1,015)

| Social-demographic variables | n   | %   |
|------------------------------|-----|-----|
| Gender                       |     |     |
| Female                       | 418 | 41.2|
| Male                         | 597 | 58.8|
| School district              |     |     |
| Urban                        | 464 | 45.7|
| Rural                        | 551 | 54.3|
| Grade                        |     |     |
| Seven                        | 447 | 44.0|
| Eight                        | 399 | 39.3|
| Nine                         | 169 | 16.7|
| Father’s education level     |     |     |
| Primary school or below      | 157 | 15.5|
| Junior high school           | 510 | 50.3|
| Senior high school           | 234 | 23.1|
| University or above          | 72  | 7.1 |
| Unknown                      | 42  | 4.1 |
| Mother’s education level     |     |     |
| Primary school or below      | 212 | 20.9|
| Junior high school           | 483 | 47.6|
| Senior high school           | 217 | 21.4|
| University or above          | 56  | 5.5 |
| Unknown                      | 47  | 4.6 |
| Perceived family financial situation |     |     |
| Very good/good               | 366 | 36.1|
| Medium                       | 609 | 60.0|
| Very poor/poor               | 40  | 3.9 |
| Smartphone ownership         |     |     |
| No                           | 402 | 39.6|
| Yes                          | 613 | 60.4|
| School-related variables     |     |     |
| Academic performance         |     |     |
| Upper                        | 224 | 22.1|
| Medium                       | 565 | 55.7|
| Lower                        | 226 | 22.3|
| Perceived study pressure     |     |     |
| No/little                    | 118 | 11.6|
| General                      | 570 | 56.2|
| Heavy/very heavy             | 327 | 32.2|
| PSQI components              |     |     |
| Subjective sleep quality     |     |     |
| Very good/good               | 811 | 79.9|
| Poor/very poor               | 204 | 20.1|
| Sleep duration               |     |     |
| >7 hr                        | 702 | 69.2|
| 5–7 hr                       | 233 | 23.0|
| <5 hr                        | 80  | 7.8 |
| Habitual sleep efficiency    |     |     |
| >85%                         | 816 | 80.4|
| 65%–85%                      | 87  | 8.6 |
| <65%                         | 112 | 11.0|
| Sleep medicine use           |     |     |
| No, during the last month    | 985 | 97.0|
| Yes, during the last month   | 30  | 3.0 |
| Sleep latency\(^a\)         | 0.86 ± 0.85 |
| Sleep disturbance\(^a\)      | 0.93 ± 0.55 |
| Daytime dysfunction\(^a\)    | 1.38 ± 0.87 |
| Insomnia (defined as PSQI > 5) |     |     |
| No                           | 637 | 62.8|
| Yes                          | 378 | 37.2|

### Table 1. (Continued)

| Level of Internet use          | n   | %   |
| No Internet use               | 33  | 3.3 |
| Non-IA                        | 900 | 88.6|
| IA (defined as YDQ > 5)       | 82  | 8.1 |
| Level of OSN use              |     |     |
| No OSN use                    | 105 | 10.3|
| Non-OSNA                      | 651 | 64.1|
| OSNA (defined as score in 4th quartile) | 259 | 25.5|
| Depression                    |     |     |
| No (CES-D < 16)               | 597 | 58.8|
| Mild (CES-D ≥16 and CES-D < 21) | 180 | 17.7|
| Moderate (CES-D ≥21 and CES-D < 25) | 102 | 10.1|
| Severe (CES-D ≥25)            | 136 | 13.4|

Note. OSN: online social networking; OSNA: online social networking addiction; IA: Internet addiction; PSQI: Pittsburgh Sleep Quality Index; YDQ: Young’s Diagnostic Questionnaire; CES-D: Center for Epidemiologic Studies-Depression Scale.

\(^a\)Continuous variables, presented by mean ± SD.
Table 2. Background variables as factors of depression (n = 1,015)

|                          | Depression |       | ORu (95% CI) |       |
|--------------------------|------------|-------|--------------|-------|
|                          | n          | %     |              |       |
| **Social-demographic variables** |            |       |              |       |
| Gender                   |            |       |              |       |
| Female                   | 90         | 21.5  | 1            |       |
| Male                     | 148        | 24.8  | 1.20 (0.89, 1.62) |       |
| School district          |            |       |              |       |
| Urban                    | 96         | 20.7  | 1            |       |
| Rural                    | 142        | 25.8  | 1.33 (0.99, 1.79) \(\dagger\) |       |
| Grade                    |            |       |              |       |
| Seven                    | 79         | 17.7  | 1            |       |
| Eight                    | 103        | 25.8  | 1.62 (1.17, 2.26) ** |       |
| Nine                     | 56         | 33.1  | 2.31 (1.54, 3.45) *** |       |
| Father’s education level |            |       |              |       |
| Primary school or below  | 45         | 15.5  | 1            |       |
| Junior high school       | 116        | 50.3  | 0.73 (0.49, 1.10) |       |
| Senior high school       | 54         | 23.1  | 0.75 (0.47, 1.18) |       |
| University or above      | 16         | 7.1   | 0.71 (0.37, 1.37) |       |
| Unknown                  | 7          | 4.1   | 0.50 (0.21, 1.20) |       |
| Mother’s education level |            |       |              |       |
| Primary school or below  | 54         | 20.9  | 1            |       |
| Junior high school       | 115        | 47.6  | 0.91 (0.63, 1.33) |       |
| Senior high school       | 44         | 21.4  | 0.74 (0.47, 1.17) |       |
| University or above      | 14         | 5.5   | 0.98 (0.50, 1.92) |       |
| Unknown                  | 11         | 4.6   | 0.89 (0.43, 1.88) |       |
| Perceived family financial situation |            |       |              |       |
| Very good/good           | 70         | 19.1  | 1            |       |
| Medium                   | 155        | 25.5  | 1.44 (1.05, 1.98) \(\dagger\) |       |
| Very poor/poor           | 13         | 32.5  | 2.04 (1.00, 4.15) \(\dagger\) |       |
| Smartphone ownership     |            |       |              |       |
| No                       | 75         | 18.7  | 1            |       |
| Yes                      | 163        | 26.6  | 1.58 (1.16, 2.15) ** |       |
| **School-related variables** |            |       |              |       |
| Academic performance     |            |       |              |       |
| Upper                    | 40         | 224   | 1            |       |
| Medium                   | 126        | 565   | 1.32 (0.89, 1.96) |       |
| Lower                    | 72         | 226   | 2.15 (1.38, 3.35) *** |       |
| Perceived study pressure |            |       |              |       |
| No/little                | 20         | 17.0  | 1            |       |
| General                  | 98         | 17.2  | 1.02 (0.60, 1.73) |       |
| Heavy/very heavy         | 120        | 36.7  | 2.84 (1.67, 4.83) *** |       |

**Note.** ORu: univariate odds ratios, obtained by univariate logistic regression models; 95% CI: 95% confidence interval.
\(\dagger\)p < .10. *p < .05. **p < .01. ***p < .001.

Table 3. Associations between OSNA/IA and insomnia among adolescents (n = 1,015)

|                          | Insomnia |       | ORu (95% CI) | AOR (95% CI) |
|--------------------------|----------|-------|--------------|--------------|
|                          | n        | %     |              |              |
| **OSNA**                 |          |       |              |              |
| Non-OSNA/no OSN use      | 238      | 31.5  | 1            | 1            |
| OSNA                     | 140      | 54.1  | 2.56 (1.92, 3.42) *** | 2.19 (1.61, 2.96) *** |
| IA status                |          |       |              |              |
| Non-IA/no Internet use   | 324      | 34.7  | 1            | 1            |
| IA                       | 54       | 65.9  | 3.69 (2.27, 6.00) *** | 2.83 (1.72, 4.65) *** |

**Note.** ORu: univariate odds ratios, obtained by univariate logistic regression models. AOR: adjusted odds ratio, obtained by binary logistic regression after adjustment of school district, grade, perceived family financial situation, smartphone ownership, academic performance, and perceived study pressure; 95% CI: 95% confidence interval; IA: Internet addiction; OSN: online social networking; OSNA: online social networking addiction.

***p < .001.
**Associations between IA/OSNA/insomnia and depression**

Adjusted results showed that both IA and OSNA were significantly associated with depression (AOR = 2.79, 95% CI: 1.71, 4.55 for IA in Model 1; AOR = 3.27, 95% CI: 2.33, 4.59 for OSNA in Model 2; see Table 4). The adjusted model showed that insomnia was positively and significantly associated with depression (AOR = 3.46, 95% CI: 2.53, 4.76 in Model 3; see Table 4). When IA and OSNA were entered together into Model 4, IA and OSNA were still significantly associated with depression, but the odds ratio of IA on depression was smaller than that of OSNA on depression (AOR = 1.80, 95% CI: 1.07, 3.04 for IA; AOR = 3.12, 95% CI: 2.22, 4.40 for OSNA).

**Testing insomnia as a mediator on the associations between IA/OSNA and depression**

When insomnia was added to Model 1 that only contained IA, the odds ratio of IA on depression remained statistically significant but diminished from 2.79 to 2.23. Similarly, when insomnia was added to Model 2 that only contained OSNA, the odds ratio of OSNA on depression was still statistically significant but diminished from 3.27 to 2.80. The results suggested that insomnia partially mediated the associations between IA/OSNA and depression. The mediation effect sizes of insomnia were 60.6% for the association between IA and depression (Sobel $Z = 3.562$, $p < .001$) and 44.8% for the association between OSNA and depression (Sobel $Z = 3.919$, $p < .001$), respectively.

**DISCUSSION**

A high prevalence of depression at moderate or above level was observed in this study. Depression defined by a screening instrument (i.e., CES-D) was a significant predictor of clinical depression diagnosis (Pietsch et al., 2013) and other physical and psychological problems (i.e., eating disorders, substance use, and suicidal ideation and attempts) (Birmaher, Arbelaez, & Brent, 2002). As the most frequently reported mental health issue among adolescents, the high prevalence of depression signifies the need for mental health promotion among adolescents in China.

In line with previous cross-sectional and longitudinal studies (Lam & Peng, 2010; Yoo, Cho, & Cha, 2014), adolescents with IA in this study are more likely to be depressed compared with those without IA. Furthermore, OSNA has become a significant public health concern, alongside the growing popularity of online social networking among adolescents (Shi & Niu, 2010; Wang, Jackson, Gaskin, & Wang, 2014). Our findings revealed that adolescents with OSNA were 3.27 times more likely than others to be depressed. The finding was consistent with those of previous studies that reported positive association between addictive online social networking and high level of depression (Hanprathet et al., 2015; Koc & Gulyagci, 2013). Interestingly, our findings showed that when IA and OSNA were entered together into the same model, OSNA and IA have independent effects on depression but the effect of OSNA was larger than that of IA.

**Table 4. Associations between Insomnia, OSNA, IA, and depression among adolescents (n = 1,015)**

| Depression, n (%) | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 | Model 6 |
|-------------------|---------|---------|---------|---------|---------|---------|
|                   | AOR (95% CI) | AOR (95% CI) | AOR (95% CI) | AOR (95% CI) | AOR (95% CI) | AOR (95% CI) |
| IA status         |          |         |         |         |         |         |
| Non-IA/no Internet use | 197 (21.1) | 1      | 2.79 (1.71, 4.55)** | 1.80 (1.07, 3.04)* | 2.23 (1.34, 3.70)** | 2.80 (1.98, 3.98)** |
| IA                 | 41 (50.0) | 1.80 | 1.80 (1.07, 3.04)* | 1.80 (1.07, 3.04)* | 2.23 (1.34, 3.70)** | 2.80 (1.98, 3.98)** |
| OSNA status       |          |         |         |         |         |         |
| Non-OSNA/no OSN use | 126 (66.7) | 1      | 3.27 (2.33, 4.59)** | 3.12 (2.22, 4.40)*** | 3.27 (2.33, 4.59)** | 3.46 (2.53, 4.76)** |
| OSNA              | 112 (43.2) | 3.27 | 3.27 (2.33, 4.59)** | 3.12 (2.22, 4.40)*** | 3.27 (2.33, 4.59)** | 3.46 (2.53, 4.76)** |
| Insomniacs        |          |         |         |         |         |         |
| No                | 87 (43.7) | 3.46 | 3.46 (2.53, 4.76)** | 3.46 (2.53, 4.76)** | 3.46 (2.53, 4.76)** | 3.46 (2.53, 4.76)** |
| Yes               | 151 (40.0) | 1      | 3.46 (2.53, 4.76)** | 3.46 (2.53, 4.76)** | 3.46 (2.53, 4.76)** | 3.46 (2.53, 4.76)** |

Note. All models were adjusted by school district, grade, perceived financial situation, academic performance, perceived study pressure, and smartphone ownership. OSNA: online social networking addiction; IA: Internet addiction; CI: confidence interval; OR: Odds ratio; 95% CI: 95% confidence interval; AOR: adjusted odds ratio; ---: not applicable.

A high prevalence of depression at moderate or above level was observed in this study. Depression defined by a screening instrument (i.e., CES-D) was a significant predictor of clinical depression diagnosis (Pietsch et al., 2013) and other physical and psychological problems (i.e., eating disorders, substance use, and suicidal ideation and attempts) (Birmaher, Arbelaez, & Brent, 2002). As the most frequently reported mental health issue among adolescents, the high prevalence of depression signifies the need for mental health promotion among adolescents in China.
Interventions should hence pay attention to both specific and general aspects of PIU. As the strength of associations between OSNA and depression was stronger than that between IA and depression, the findings highlighted the importance of investigating specific types of Internet addictive behaviors, OSNA in our case (Montag et al., 2014). Evidence-based interventions on reducing OSNA are hence warranted.

Our findings further suggested that insomnia was common among secondary school students in China (37.2%). In this study, both IA and OSNA were significant risk factors of insomnia after adjusting for the significant background variables. Both IA and OSNA contributed to the high prevalence of insomnia. It is plausible that excessive Internet use/online social networking inhibits adolescents’ sleeping patterns. Addicts might need more time to fall asleep and may have shorter sleep duration than non-addicts, contributing to a higher risk of insomnia (Ekinci et al., 2014; Harbard, Allen, Trinder, & Bei, 2016; Nalwa & Anand, 2003). Furthermore, excessive Internet use may significantly disturb adolescents’ sleep–wake schedules, which may lead to irregular sleep patterns and insomnia (Chen & Gau, 2016; Lam, 2014). A previous study showed that the use of electronic media prior to bedtime reduced sleep duration and quality (Vernon et al., 2017). It is possible to improve adolescents’ sleep quality by conducting effective interventions to reduce PIU, especially that of OSNA.

The mechanism between PIU and depression is under-researched. Life events (Yang et al., 2014), psychosocial factors (e.g., self-esteem) (Wu et al., 2016), and sleep quality (Bhandari et al., 2017) are potential mediators of the aforementioned association. We found that 61% of the relationship between IA and depression, and 45% of the relationship between OSNA and depression were mediated by insomnia, respectively. The mediation effect size of insomnia for the association between IA and depression in this study was largely higher than those reported in two previous studies (61% vs. 30.9% and 5.0%) (Bhandari et al., 2017; Cheung & Wong, 2011). The discrepancy in these studies may be partially attributed to differences in populations (i.e., undergraduate students) and/or instruments used for screening depression (i.e., 9-item Patient Health Questionnaire or 12-item General Health Questionnaire) and IA (i.e., Young’s 20-item Internet Addiction Test). The actual reason is unknown and beyond the scope of this study. More studies are required to estimate the potential mediation of insomnia.

The mediation findings in this study contend that adolescent PIU, especially OSNA, would increase the risk of developing insomnia, which in turn would increase the vulnerability for depression. Thus, effective treatments for insomnia and PIU should be integrated with treatments and prevention for depression among adolescents. Special attention should be paid toward managing addictive online social networking.

This study has some limitations. First, as we relied upon self-reported data collection method, there may be reporting bias. The level of depression was measured using CES-D rather than a clinical diagnosis of depression, which was not conducted in this study due to a limitation of resources. Second, PSQI was originally developed and validated for adults, although it has been widely applied among adolescents, its psychometric properties and suitability should be reevaluated. Moreover, insomnia status defined by PSQI in our school-based study is different from clinically diagnostic insomnia, and there may be potential misclassifications and overestimation the prevalence of insomnia. Third, although the findings suggest a plausible mechanism of how PIU may increase depressive symptoms through its negative impact on sleep quality, the nature of cross-sectional study design does not allow us to infer temporal and causal mechanisms. Cautions should be considered when interpreting the mediation effect. For instance, there might be an alternative model in which depressed mood causes insomnia, which in turn increases the risk of PIU. Longitudinal studies are needed to delineate the causal relationships of these variables and their underlying mechanisms. Fourth, caution should be given that OSNA was defined as those in the 4th quartile in the absence of an established cut-off point, even though similar definitions were used in other studies. Fifth, the sample was drawn from only two secondary schools in Guangzhou, and may not be representative of the schools in Guangzhou and other cities. Therefore, caution is required when generalizing results to other populations.

In conclusion, this study found high prevalence of depressive symptoms, PIU behaviors, and insomnia among adolescents. PIU, including IA and OSNA, has direct effects on both insomnia and depression. Furthermore, the findings suggest that a high level of PIU may increase the probability of insomnia, which may further increase the risk of depression among adolescents. Interventions jointly considering the three problems should be devised and implemented.

Funding sources: This study was supported by the Jockey Club School of Public Health and Primary Care Research Postgraduate Students’ Research Grants and CUHK research Postgraduate Student Grants for Overseas Academic Activities in the Chinese University of Hong Kong, and the study was also partially supported by National Science Foundation of China (no.: 81373021).

Authors’ contribution: J-BL, JTFL, PKHM, and X-FS designed and conducted the research; J-BL, JT, and Z-GQ conducted the data collection; J-BL, JTFL, and PKHM analyzed data, interpreted results, and wrote the manuscript; DLG wrote and edited the manuscript. All authors read and approved the final manuscript.

Conflict of interest: The authors declare no conflict of interest.

Acknowledgements: The authors would like to give great appreciation to all participants and schools. The authors would also greatly thank Mr. Christopher Lavender’s help for the language editing of the manuscript.
REFERENCES

Aboujaoude, E. (2010). Problematic Internet use: An overview. *World Psychiatry, 9*(2), 85–90. doi:10.1002/j.2051-5545.2010.tb00278.x

Alabi, O. F. (2013). A survey of Facebook addiction level among selected Nigerian University undergraduates. *New Media and Mass Communication, 10*, 70–80. Available at http://ijste.org/Journals/index.php/NMMC/article/view/4533/4606

An, J., Sun, Y., Wan, Y., Chen, J., Wang, X., & Tao, F. (2014). Associations between problematic Internet use and adolescents’ physical and psychological symptoms: Possible role of sleep quality. *Journal of Addiction Medicine, 8*(4), 282–287. doi:10.1097/adm.0000000000000026

Baglioni, C., Battaglise, G., Feige, B., Spiegelhalder, K., Nissen, C., Voderholzer, U., Lombardo, C., & Riemann, D. (2011). Insomnia as a predictor of depression: A meta-analytic evaluation of longitudinal epidemiological studies. *Journal of Affective Disorders, 135*(1–3), 10–19. doi:10.1016/j.jad.2011.01.011

Banyai, F., Zsila, A., Kiraly, O., Maraz, A., Elekes, Z., Griffiths, M. D., Andreasen, C. S., & Demetrovics, Z. (2017). Problematic social media use: Results from a large-scale nationally representative adolescent sample. *PLoS One, 12*(1), e0169839. doi:10.1371/journal.pone.0169839

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 51*(6), 1173–1182. doi:10.1037/0022-3514.51.6.1173

Bhandari, P. M., Neupane, D., Rijal, S., Thapa, K., Mishra, S. R., & Poudyal, A. K. (2017). Sleep quality, Internet addiction and depressive symptoms among undergraduate students in Nepal. *BMC Psychiatry, 17*(1), 106. doi:10.1186/s12888-017-1275-5

Birmaher, B., Arbelaez, C., & Brent, D. (2002). Course and outcome of child and adolescent major depressive disorder. *Child and Adolescent Psychiatric Clinics of North America, 11*(3), 619–637. doi:10.1016/S1056-4993(02)00011-1

Cairns, K. E., Yap, M. B., Pilkington, P. D., & Jorm, A. F. (2014). Risk and protective factors for depression that adolescents can modify: A systematic review and meta-analysis of longitudinal studies. *Journal of Affective Disorders, 169*, 61–75. doi:10.1016/j.jad.2014.08.006

Chen, Y. L., & Gau, S. S. (2016). Sleep problems and Internet addiction among children and adolescents: A longitudinal study. *Journal of Sleep Research, 25*(4), 458–465. doi:10.1111/jsr.12388

Chen, Z. Y., Yang, X. D., & Li, X. Y. (2009). Psychometric structure of the Center for Epidemiologic Studies Depression Scale in Chinese adolescents. *Chinese Journal of Clinical Psychology, 17*(4), 443–448. doi:10.16128/j.cnki.1005-3611.2009.04.027

Cheng, C. P., Yen, C. F., Ko, C. H., & Yen, J. Y. (2012). Factor structure of the Center for Epidemiologic Studies Depression Scale in Taiwanese adolescents. *Comprehensive Psychiatry, 53*(3), 299–307. doi:10.1016/j.comppsych.2011.04.056

Cheung, L. M., & Wong, W. S. (2011). The effects of insomnia and Internet addiction on depression in Hong Kong Chinese adolescents: An exploratory cross-sectional analysis. *Journal of Sleep Research, 20*(2), 311–317. doi:10.1111/j.1365-2869.2010.00883.x

Chinese Internet Association of Adolescents. (2012). 2011 Internet addiction report among adolescents [in Chinese]. Beijing, China: Communication University of China.

Chorney, D. B., Detweiler, M. F., Morris, T. L., & Kuhn, B. R. (2008). The interplay of sleep disturbance, anxiety, and depression in children. *Journal of Pediatric Psychology, 33*(4), 339–348. doi:10.1093/jpepsy/jsm105

Davis, R. A. (2001). A cognitive-behavioral model of pathological Internet use. *Computers in Human Behavior, 17*(2), 187–195. doi:10.1016/S0747-5632(00)00041-8

Ekinci, O., Celik, T., Savas, N., & Toros, F. (2014). Association between Internet use and sleep problems in adolescents. *Noro Psikiyatr Ars, 51*(2), 122–128. doi:10.4274/npa.y6751

Feng, Z. Z., & Zhang, D. J. (2005). An epidemiological study on depression in Hong Kong Chinese adolescents. *Chinese Journal of Behavioral Addictions 6*(4), pp. 554–563. doi:10.1186/s12888-017-1275-5

Feng, Z. Z., & Zhang, D. J. (2005). An epidemiological study on depression in Hong Kong Chinese adolescents. *Chinese Journal of Behavioral Addictions 6*(4), pp. 554–563. doi:10.1186/s12888-017-1275-5

Feng, Z. Z., & Zhang, D. J. (2005). An epidemiological study on depression in Hong Kong Chinese adolescents. *Chinese Journal of Behavioral Addictions 6*(4), pp. 554–563. doi:10.1186/s12888-017-1275-5

Harvard, E., Allen, N. B., Trinder, J., & Bei, B. (2016). What’s keeping teenagers up? Prebedtime behaviors and actigraphy-assessed sleep over school and vacation. *Journal of Adolescent Health, 58*(4), 426–432. doi:10.1016/j.jadohealth.2015.12.011

Ko, C. H., Liu, T. L., Wang, P. W., Chen, C. S., Yen, C. F., & Yen, J. Y. (2014). The exacerbation of depression, hostility, and social anxiety in the course of Internet addiction among adolescents: A prospective study. *Comprehensive Psychiatry, 55*(6), 1377–1384. doi:10.1016/j.comppsych.2014.05.003

Koc, M., & Gulyagci, S. (2013). Facebook addiction among Turkish college students: The role of psychological health, demographic, and usage characteristics. *Cyberspsychology, Behavior, and Social Networking, 16*(4), 279–284. doi:10.1089/cyber.2012.0249

Kraut, R., Patterson, M., Lundmark, V., Kiesler, S., Mukopadhyay, T., & Scherlis, W. (1998). Internet paradox. A social technology that reduces social involvement and psychological well-being? *American Psychologist, 53*(9), 1017–1031. doi:10.1037/0003-066X.53.9.1017

Kuss, D. J., & Griffiths, M. D. (2011). Excessive online social networking: Can adolescents become addicted to Facebook. *Education and Health, 29*(4), 68–71. doi:10.1037/0003-066X.53.9.1017

Lacconi, S., Tricard, N., & Chabrol, H. (2015). Differences between boys and girls in Internet addiction report among adolescents [in French]. *Journal of Addiction Medicine, 8*(6), 486–492. doi:10.1119/jbhp.b.109.073002

Manprathet, N., Manwong, M., Khumsri, J., Yingyeun, R., & Phanasathit, M. (2015). Facebook addiction and its relationship with mental health among Thai high school students. *Journal of the Medical Association of Thailand, 98*(Suppl 3), S81–S90. Available at http://www.jmatonline.com/index.php/jmat/article/view/6313

Hutchinson, C., Eklund, E., & White, M. (2012). Problematic Internet use among adolescents. *Journal of Adolescent Health, 51*(4), 444. doi:10.1016/j.jadohealth.2012.02.049
Lam, L. T., & Peng, Z. W. (2010). Effect of pathological use of the Internet on adolescent mental health: A prospective study. *Archives of Pediatrics & Adolescent Medicine, 164*(10), 901–906. doi:10.1001/archpediatrics.2010.159

Li, J. B., Lau, J. T., Mo, P. K., Su, X., Wu, A. M., Tang, J., & Qin, Z. (2016). Validation of the Social Networking Activity Intensity Scale among junior middle school students in China. *PLoS One, 11*(10), e0165955. doi:10.1371/journal.pone.0165955

Li, Y., Zhang, X., Lu, F., Zhang, Q., & Wang, Y. (2014). Internet addiction among elementary and middle school students in China: A nationally representative sample study. *Cyberpsychology, Behavior, and Social Networking, 17*(2), 111–116. doi:10.1089/cyber.2012.0482

MacKinnon, D. P., Fairchild, A. J., & Fritz, M. S. (2008). Mediation analysis. *Annual Review of Psychology, 59*(1), 593–614. doi:10.1146/annurev.psych.58.110405.085542

Mak, K. K., Lai, C. M., Watanabe, H., Kim, D.-I., Bahar, N., Ramos, M., Young, K. S., Ho, R. C., Aum, N. R., & Cheng, C. (2014). Epidemiology of Internet behaviors and addiction among adolescents in six Asian countries. *Cyberpsychology, Behavior, and Social Networking, 17*(11), 720–728. doi:10.1089/cyber.2014.0139

Matamura, M., Tochigi, M., Usami, S., Yonehara, H., Fukushima, M., Nishida, A., Togo, F., & Sasaki, T. (2014). Associations between sleep habits and mental health status and suicidality in a longitudinal survey of monozygotic twin adolescents. *Journal of Sleep Research, 23*(3), 292–296. doi:10.1111/jsr.12127

Montag, C., Bey, K., Sha, P., Li, M., Chen, Y. F., Liu, W. Y., Zhu, Y. K., Li, C. B., Markett, S., & Keiper, J. (2014). Is it meaningful to distinguish between generalized and specific Internet addiction? Evidence from a cross-cultural study from Germany, Sweden, Taiwan and China. *Asia-Pacific Psychiatry, 7*(1), 20–26. doi:10.1111/appy.12122

Natwa, K., & Anand, A. P. (2003). Internet addiction in students: A cause of concern. *CyberPsychology & Behavior, 6*(6), 653–656. doi:10.1089/10949310332275441

Pietsch, K., Allgaier, A.-K., Frühe, B., Hoyler, A., Rohde, S., & Schulte-Körne, G. (2013). Screening for adolescent depression in paediatric care: Validity of a new brief version of the Child for Epidemiological Studies Depression Scale. *Child and Adolescent Mental Health, 18*(2), 76–81. doi:10.1111/j.1475-3588.2012.00650.x

Primack, B. A., Swanier, B., Georgiopoulos, A. M., Land, S. R., & Fine, M. J. (2009). Association between media use in adolescence and sleep in young adulthood: A longitudinal study. *Archives of General Psychiatry, 66*(2), 181–188. doi:10.1001/archgenpsychiatry.2008.532

Que, M., Tao, F. B., He, C. Y., Zhang, L. H., & Zhu, P. (2007). Study on the relationship between mental health and overweight, obesity, different sex among junior middle school students. *Chinese Journal of Epidemiology, 28*(5), 460–463. doi:10.3760/j.issn.0254-6450.2007.05.012

Shaw, M., & Black, D. W. (2008). Internet addiction: Definition, assessment, epidemiological and clinical management. *CNS Drugs, 22*(5), 353–365. doi:10.2165/00023210-200822050-00001

Shensa, A., Escobar-Viera, C. G., Sidani, J. E., Bowman, N. D., Marshal, M. P., & Primack, B. A. (2017). Problematic social media use and depressive symptoms among U.S. young adults: A nationally-representative study. *Social Science & Medicine, 182*, 150–157. doi:10.1016/j.socscimed.2017.03.061

Shi, J. Q., & Niu, Q. K. (2010). SNSs usage among Chinese Internet users: An empirical study. In B. K. Wiederhold, G. Riva, & S. I. Kim (Eds.), *Annual review of cybertherapy and telemedicine 2010: Advanced technologies in behavioral, social and neurosciences* (Vol. 154, pp. 150–154). Washington, DC: ISO Press.

Song, Y., Huang, Y., Liu, D., Kwan, J. S. H., Zhang, F., Sham, P. C., & Tang, S. W. (2008). Depression in college: Depressive symptoms and personality factors in Beijing and Hong Kong college freshmen. *Comprehensive Psychiatry, 49*(5), 496–502. doi:10.1016/j.comppsych.2008.02.005

Taylor, D. J., Lishstein, K. L., & Durrence, H. H. (2003). Insomnia as a health risk factor. *Behavioral Sleep Medicine, 1*(4), 227–247. doi:10.1027/15402010BSM0104_5

Thapar, A., Collishaw, S., Pine, D. S., & Thapar, A. K. (2012). Depression in adolescence. *Lancet, 379*(9820), 1056–1067. doi:10.1016/S0140-6736(11)60871-4

Thapar, A., Collishaw, S., Potter, R., & Thapar, A. K. (2010). Managing and preventing depression in adolescents. *BMJ, 340*, C209. doi:10.1136/bmj.c209

Tsai, P. S., Wang, S. Y., Wang, M. Y., Su, C. T., Yang, T. T., Huang, C. J., & Fang, S. C. (2005). Psychometric evaluation of the Chinese version of the Pittsburgh Sleep Quality Index (CPSQI) in primary insomnia and control subjects. *Quality of Life Research, 14*(8), 1943–1952. doi:10.1007/s11136-005-4346-x

Tsitsika, A., Janikian, M., Schoenmakers, T. M., Tzavela, E. C., Ollafsson, K., Wójcik, S., Florian Macarie, G., Tzavara, C., & Richardson, C. (2014). Internet addictive behavior in adolescence: A cross-sectional study in seven European countries. *Cyberpsychology, Behavior, and Social Networking, 17*(8), 528–535. doi:10.1089/cyber.2013.0382

Van den Bulck, J. (2004). Television viewing, computer game playing, and Internet use and self-reported time to bed and time out of bed in secondary-school children. *Sleep, 27*(1), 101–104. doi:10.1093/sleep/27.1.101

Vernon, L., Modecki, K. L., & Barber, B. L. (2017). Tracking effects of problematic social networking on adolescent psychopathology: The mediating role of sleep disruptions. *Journal of Clinical Child and Adolescent Psychology, 46*(2), 269–283. doi:10.1080/15374416.2016.1188702

Wang, J. L., Jackson, L. A., Gaskin, J., & Wang, H. Z. (2014). The effects of social networking site (SNS) use on college students’ friendship and well-being. *Computers in Human Behavior, 37*, 229–236. doi:10.1016/j.chb.2014.04.051

Wolniczak, I., Cáceres-DelAgula, J. A., Palma-Ardiles, G., Arroyo, K. J., Solis-Visscher, R., Paredes-Yauri, S., Mego-Aquije, K., & Bernabe-Ortiz, A. (2013). Association between Facebook dependence and poor sleep quality: A study in a sample of undergraduate students in Peru. *PLoS One, 8*(3), e59087. doi:10.1371/journal.pone.0059087

Wu, A. M., Li, J., Lau, J. T., Mo, P. K., & Lau, M. M. (2016). Potential impact of Internet addiction and protective psychosocial factors onto depression among Hong Kong Chinese adolescents – Direct, mediation and moderation effects. *Comprehensive Psychiatry, 70*, 41–52. doi:10.1016/j.comppsych.2016.06.011

Xu, Z., Su, H., Zou, Y., Chen, J., Wu, J., & Chang, W. (2012). Sleep quality of Chinese adolescents: Distribution and its associated factors. *Journal of Paediatrics and Child Health, 48*(2), 138–145. doi:10.1111/j.1440-1754.2011.02065.x
Yaghjyan, L., Arao, R., Brokamp, C., O’Meara, E. S., Sprague, B. L., Ghita, G., & Ryan, P. (2017). Association between air pollution and mammographic breast density in the Breast Cancer Surveillance Consortium. Breast Cancer Research, 19(1), 36. doi:10.1186/s13058-017-0828-3

Yang, L., Sun, L., Zhang, Z., Sun, Y., Wu, H., & Ye, D. (2014). Internet addiction, adolescent depression, and the mediating role of life events: Finding from a sample of Chinese adolescents. International Journal of Psychology, 49(5), 342–347. doi:10.1002/ijop.12063

Yoo, Y.-S., Cho, O.-H., & Cha, K.-S. (2014). Associations between overuse of the Internet and mental health in adolescents. Nursing & Health Sciences, 16(2), 193–200. doi:10.1111/nhs.12086

Young, K. S. (1998). Internet addiction: The emergence of a new clinical disorder. CyberPsychology & Behavior, 1(3), 237–244. doi:10.1089/cpb.1998.1.237

Zhang, J., Wu, Z., Fang, G., Li, J., Han, B., & Chen, Z. (2010). Development of the Chinese age norms of CES-D in urban area. Chinese Mental Health Journal, 24(2), 139–135. doi:10.3969/j.issn.1000-6729.2010.02.015

Zhou, H. Q., Shi, W. B., Wang, X. F., Yao, M., Cheng, G. Y., Chen, P. Y., & Li, D. G. (2012). An epidemiological study of sleep quality in adolescents in South China: A school-based study. Child: Care, Health and Development, 38(4), 581–587. doi:10.1111/j.1365-2214.2011.01300.x

Zhou, S. X. (2010). Gratifications, loneliness, leisure boredom and self-esteem as predictors of SNS-game addiction and usage pattern among Chinese college students. Hong Kong: The Chinese University of Hong Kong.