Problematic Smartphone Use and Its Impact on the Psychology of Adolescents in Malaysia

Hazwanim Hashim[1,2], Hizlinda Tohid[1], Teh Rohaila Jamil[1]*, Nik Ruzyanei Nik Jaafar[3] and Shamsul Azhar Shah[4]

[1]Department of Family Medicine, Faculty of Medicine, Universiti Kebangsaan Malaysia, 56000 Cheras, Kuala Lumpur, Malaysia
[2]Kuala Ketil Health Clinic, Ministry of Health, 09300 Baling, Kedah, Malaysia
[3]Department of Psychiatry, Faculty of Medicine, Universiti Kebangsaan Malaysia, 56000 Cheras, Kuala Lumpur, Malaysia
[4]Department of Community Health, Faculty of Medicine, Universiti Kebangsaan Malaysia, 56000 Cheras, Kuala Lumpur, Malaysia

ABSTRACT

This study aims to determine the prevalence of problematic smartphone use (PSU) among secondary school adolescents and to examine its relationship with psychological problems (depression, anxiety, and stress [Model 1], or the number of psychological problems [Model 2]). This cross-sectional study has utilised a self-administered questionnaire assessing the participants' sociodemographic and clinical characteristics, pattern and purpose of usage, presence of PSU (via the Malay-version smartphone addiction scale-short version [SAS-SV]), and presence of psychological problems (via the depression-anxiety-stress scale-21 [DASS-21]). Four hundred and fourteen students aged 15–16 from five national secondary schools in Seremban and smartphone users have been recruited via cluster sampling. Students in remedial or special education classes, previously diagnosed with depression, anxiety or stress and absent on the day of data collection were excluded. The prevalence of PSU, probable depression, anxiety and stress were 43.5%, 31.6%, 48.3% and 26.8%, respectively. Most respondents reported mild to moderate severity for each psychological problem. However, three out of ten respondents had multiple psychological problems. In both multiple logistic regression models, Malay students had higher daily usage, and the higher monthly costs were significantly associated with PSU when other confounding factors were controlled.

A higher number of psychological problems was associated with PSU (adjusted odds ratio: 1.28, 95% confidence interval: 1.06–1.54; p=0.011) but not purpose of usage or individual psychological problem. PSU and psychological problems were prevalent among secondary school adolescents. These findings highlight the complex relationship between PSU and psychological problems that warrant further detailed studies.

INTRODUCTION

Smartphones have become essential tools in daily life as hand-held computers and communication devices with multiple functions. Nevertheless, excessive smartphone use has been prevalent in recent times. This phenomenon, characterised by uncontrolled and pervasive use, reflects other technological and behavioural addictions, such as Internet and gaming addiction (Panova & Carbonell, 2018; Sohn et al., 2019; Yu & Sussman, 2020). Besides losing control, it shares other psychological features of addiction, including tolerance, compulsive and persistent behaviour despite significant negative consequences, functional impairments, craving, and other withdrawal symptoms (Panova & Carbonell, 2018). Thus, many previous studies conceptualised excessive smartphone use as smartphone addiction. However, some experts argue that it is merely problematic or maladaptive smartphone use and not a distinct entity of technological addiction

(Yu & Sussman, 2020). Hence, smartphone addiction (SA) is still not recognised as a mental disorder by the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-5; American Psychiatric Association, 2013). Smartphone addiction is also referred to as problematic smartphone use (PSU), and both terms have been used interchangeably in previous studies (Yu & Sussman, 2020).

Over the past decade, PSU has become more common, especially among adolescents and young adults (Panova & Carbonell, 2018; Sohn et al., 2019; Yu & Sussman, 2020). A study among adolescents in six Asian countries reported smartphone ownership among Malaysian adolescents at 56.7% and social networking as the most common Internet usage (37.9%; Mak et al., 2014). It is postulated that growing up with various high-technology devices has rendered adolescents highly receptive to smartphone overuse (Kwon et al., 2013). According to a systematic review by Sohn et al. (2019) based on 41 studies published between 2011 and 2017, the prevalence of PSU among adolescents and youth ranges mainly between 10% to 30%, with a median prevalence of 23.3%. However, recent studies demonstrated a higher prevalence of 74% among adolescents aged 7–18 years old (Buctot et al., 2020; Coco et al., 2020; Jo et al., 2020). In Malaysia, previous research on PSU showed a prevalence of 15% to 61%, although it mainly involved young adults at tertiary educational centres (Hadi et al., 2019; Ismail et al., 2020; Ithnain et al., 2018; Nasser et al., 2020; Nor et al.,

2020). However, studies on school-going adolescents (under 18 years old) are still lacking.

PSU among adolescents and young adults has been significantly associated with a unique usage pattern and various adverse consequences. Adolescents with PSU overuse smartphones in terms of duration (four hours or more per day) and frequency and involve specific smartphone functions that are primarily used for socialising (social networking), gaming and entertainment with less parental control (Cha & Seo, 2018; Fischer-Grote et al., 2019; Haug et al., 2015). This trend has been associated with significant adverse physical consequences (e.g., wrist pain, neck discomfort, blurred vision, and giddiness), poor academic performance, interpersonal problems, poor sleep and psychological problems such as depression, anxiety and stress (Elhai et al., 2017; Haug et al., 2015; C. Lee & Lee, 2017; Panova & Carbonell, 2018).

Depression, anxiety and stress have been associated with PSU with minor to moderate effects (Elhai et al., 2017; Sohn et al., 2019; Thomée, 2018; Vahedi & Saiphoo, 2018). Many previous studies used a cross-sectional design. Thus, the causal relationship between PSU and psychological problems could not be determined. Some studies have shown a significant association between PSU and psychological problems (Buctot et al., 2020; Hadi et al., 2019; Ikeda & Nakamura, 2014; Ithnain et al., 2018; Kim et al., 2020; Nor et al., 2020). In contrast, other studies showed non-significant relationships between PSU

and psychological problems (Cha & Seo, 2018; Choi et al., 2015; Elhai et al., 2016; Ismail et al., 2020; J. Lee et al., 2018; Thomée, 2018). Similarly, longitudinal studies also demonstrated mixed findings (Coyne et al., 2019, 2020; Jo et al., 2020; Jun, 2016, 2019; Lapierre et al., 2019; Park et al., 2019; Thomée et al., 2011). Only a few studies suggested a bi-directional relationship between PSU and depression (Jun, 2016; Liu et al., 2019; Park et al., 2019), whereas some highlighted that the relationship is mediated by other factors such as proneness to boredom and self-regulation through behavioural activation and emotional suppression (Elhai et al., 2016, 2018). Due to these conflicting results, more studies are required to understand the psychopathological mechanism underlying PSU, especially in multicultural countries such as Malaysia.

Locally, previous studies on PSU and psychological problems and well-being mainly involved students of tertiary institutions with different life challenges compared to secondary school adolescents (Hadi et al., 2019; Ismail et al., 2020; Ithnain et al., 2018; Nasser et al., 2020). However, most research showed a significant association of PSU with depression, anxiety and poorer psychological well-being, except for the study by Ismail et al. (2020). A more recent study by Nor et al. (2020), which examined this relationship among 158 secondary school students aged 13-16, highlighted that higher smartphone use significantly correlated with poorer psychological well-being. Therefore, the

lack of relevant research and the importance of examining the magnitude of PSU and its relationship with psychological problems among secondary school Malaysian adolescents demands more in-depth studies in this area. Accordingly, this study examines the prevalence of PSU among adolescents in Malaysia and its association with depression, anxiety and stress when sociodemographic factors, usage patterns, commonly used functions and parental usage limitations were controlled. Besides assessing the relationship between PSU and each psychological problem, this study also examines the impact of having multiple psychological problems on smartphone use, as these problems could have a cumulative effect. Notably, most adolescents who suffer from psychological problems would have mild to moderate severity (Ismail et al., 2020; Ithnain et al., 2018; Nasser et al., 2020), in which the impairment might not be severe enough to be accounted as a feature of behavioural addiction (Panova & Carbonell, 2018). Usually, behaviour addiction involves pervasive and continuous negative behaviour despite significant impairment (Panova & Carbonell, 2018).

The researchers hypothesised that the higher the number of psychological problems, the greater the impairment and likelihood of adolescents with PSU. The findings of this study would also lend valuable insights into prevention and intervention strategies against PSU by medical professionals and healthcare providers.

METHODS

The researchers conducted a cross-sectional study in Seremban, Negeri Sembilan, Malaysia in two phases between June 2016 and November 2016: (1) Phase 1: Validation of the questionnaire and (2) Phase 2: Main study. All Form 4 students aged 15–16 (equivalent to 10th grade in the USA educational system or Year 11 in the UK educational system) from two schools during Phase 1 and three schools during Phase 2 were invited to participate in this study. Out of 29 schools in the district, five schools were selected by the State Education Department because they were national co-ed secondary day schools located within a 10 to 20 km radius from each other, with a similar population. The State Education Department, Malaysia also determined the year (i.e., grade) of the students involved in the study as they were not facing any significant examinations that year. The inclusion criteria for Phase 1 and Phase 2 studies involved students who used a smartphone, agreed to participate and had written parental consent. Students in remedial or special education classes, previously diagnosed with depression, anxiety or stress, and absent on the day of data collection were excluded.

A smartphone has been operationally defined as a cellular or mobile telephone with an integrated computer function and other features or software applications (e.g., camera, video, email, Internet connection and data plan) different from the conventional mobile telephone. Other telecommunication devices, such as iPads, tablets, and notepads,

were not considered smartphones. Phase 1 of the study involved students recruited from two secondary schools. This phase aims to translate the original English version of the Smartphone Addiction Scale-Short Version for adolescents (SAS-SV) into the Malay language and examine the psychometric properties of the Malay version of the SAS-SV. The original English version of SAS-SV was translated into Malay through the back-to-back-translation process, which involved two independent translators from English to Malay and another two independent translators from Malay to English. These translators were linguistic lecturers or secondary school teachers teaching Bahasa Malaysia or English. The sample size was 143 participants, subject to the item ratio of ten participants per item and considering a 30% drop-out rate. At each translation stage, the translated versions were reviewed and harmonised by a panel of experts (two family medicine specialists and one psychiatrist) after obtaining feedback from the translators. Subsequently, the Malay version of SAS-SV was subjected to face validation involving ten secondary school students, resulting in a minor change by adding a conjunction for Item 2.

The second face validation with another set of ten secondary school students showed good comprehensibility of the final Malay version of SAS-SV. Then, this version was given to 154 students for construct validation and reliability study via test-retest (only involved 20 out of 154 students) and internal consistency testing. The participants involved in Phase 1 of the study were not included in Phase 2. The researchers performed Principal Axis factoring (PAF) with Direct Oblimin rotation for construct validity. The initial exploratory factor analysis resulted in two components with Kaiser-Meyer-Olkin Measure of Sampling Adequacy of 0.818, and the *p*-value for Bartlett's test of sphericity was <0.001. However, the items were forced into one component based on the scree plot and parallel analysis with Monte Carlo PCA. The one-component solution explained a total of 36.4% of the variance.

Meanwhile, Cronbach's alpha of the Malay version of SAS-SV was 0.84. For reliability testing, Spearman's rho correlation between the test and retest scores was 0.95 (*p*<0.001), suggesting a good correlation between the scores. The Wilcoxon Signed-Rank test was insignificant (p=0.118) and indicated no significant difference between the scores.

In Phase 2, the researchers used StatCal EpiInfo version 7 for sample size calculations. The sample size was 384, calculated based on an estimated smartphone addiction prevalence of 50%, 95% confidence interval (CI) and 5% precision. Considering 20% of the non-response rate, 460 students were recruited from three secondary schools. The definition of a smartphone was clearly stated on the first page of the self-administered questionnaire, written in the Malay language and comprised five sections:

1. Sociodemographic data (i.e., gender, ethnicity, monthly family income,

parent/guardian's employment status)

2. Past medical history
3. Patterns of smartphone usage (i.e., smartphone ownership, daily usage time, parental usage limitations, cost of monthly usage, source of money spent on a smartphone, and purpose of usage)
4. PSU using the recently validated Malay version SAS-SV, and
5. Probable depression, anxiety and stress using the Depression, Anxiety and Stress Scale-21 (DASS-21)

The students took less than 10 minutes to complete the questionnaire.

The SAS-SV comprised ten items with a 6-point Likert scale response (strongly disagree to strongly agree). The total score ranged from 10 to 60. The PSU was defined by the cut-off points of 31 or more for male adolescents and 33 or more for female adolescents. Adopted from the original version of the SAS-SV, the cut-off values had good sensitivity (male: 0.87, female: 0.86) and specificity (male: 0.89, female: 0.89) in predicting smartphone addiction (Kwon et al., 2013). The validated self-administered Malay version DASS-21 had three domains (depression, anxiety and stress) used as a screening tool to detect probable depression, anxiety and stress based on symptoms in one week. Each domain of DASS-21 contained seven items with a 4-point Likert scale response indicating the severity of each state. The students assigned scores of 0 (did not apply

to me) to 3 (applied to me most of the time) for each item. Then, the total score for each domain was multiplied by two. The cut-off scores for probable depression, anxiety and stress were ≥10, ≥8 and ≥15, respectively (Musa et al., 2007). In Malaysia, existing adolescent health screening programmes used DASS-21 for secondary school students. The school counsellors routinely screened Form 4 students and reviewed the results to identify students with potential psychological problems according to the standard procedure. Consequently, the counsellors may refer students who need further attention to the school medical team or respective public health clinics.

Ethical Considerations

All respondents provided verbal consent and written consent from their parents. Ethical clearance was sought from the Research Ethics Committee of University Kebangsaan Malaysia, the Ministry of Education Malaysia, and the Negeri Sembilan State Education Department. Further, the researchers obtained permission to conduct the study at the schools from the respective school principals. Consent to use SAS-SV and the Malay version DASS-21 was obtained from the authors (Kwon et al., 2013; Musa et al., 2007). Specific authorisation to translate SAS-SV into the Malay language and validate the Malay version of SAS-SV was also acquired from the original author (Kwon et al., 2013). Since the screening for probable depression, anxiety and stress was conducted among the respondents, the respective school

counsellors assessed and observed those with potential psychological problems per routine practice.

Statistical Analysis

The researchers analysed the data collected with the IBM SPSS Statistics version 23. This study's dependent variable was PSU, and all other variables that could influence smartphone use were independent. Descriptive statistics were performed on all variables. Simple logistic regression (SLR) was performed to identify independent variables with a *p* value of <0.25, which was subsequently subjected to the multiple logistic regression (MLR) analysis. The variables with clinical significance were also included in the MLR. The primary aim of the MLR is to determine factors independently associated with PSU after other variables in the model were controlled. Since there are overlapping primary independent variables, namely, the number of psychological problems and specific psychological problems (probable depression, anxiety and stress), two models of MLR were performed. Model 1 examined the association of PSU with specific psychological problems (probable depression, anxiety and stress) when sociodemographic factors, usage patterns, usage purpose, and parental usage limitations were controlled. In contrast, Model 2 assessed the association of PSU with the number of psychological problems when similar confounding factors were adjusted. The association was significant at a *p* value of <0.05.

RESULTS

Characteristics of Smartphone Users and Patterns of Usage

Out of 598 Form Four students from three national secondary schools, 141 students were excluded from the study because they were from remedial or special education classes (108 students), previously diagnosed with stress (3 students) and absent on the day of data collection (30 students; Figure 1). Four hundred fifty-seven students fulfilled the study criteria and returned the parental consent form during the data collection day. This study recorded a response rate of 96.0%, as 18 students did not complete the questionnaire. Further, 94.3% of 439 students were smartphone users (414 students).

Among 414 smartphone users, the majority were females (62.1%), Malays (69.8%), had at least one parent or guardian unemployed (65.5%) and came from families who earned ≤RM 4000 (~USD 930) a month (78.3%; Table 1). Most of them had no past medical history (90.3%).

Table 2 shows the pattern and purpose of smartphone use. In this study, four in five adolescents had self-owned smartphones (82.9%) and spent <RM50 per month for smartphone usage (85.7%), and most students used money from others to pay for the expenditure (63.5%). The median (IQR) duration of smartphone use in a day was 4.0 (4.0) hours (minimum: one hour, maximum: 13 hours). About two-thirds (42.8%) of them did not receive parental limitations on smartphone usage. In addition, the top two smartphone functions that adolescents
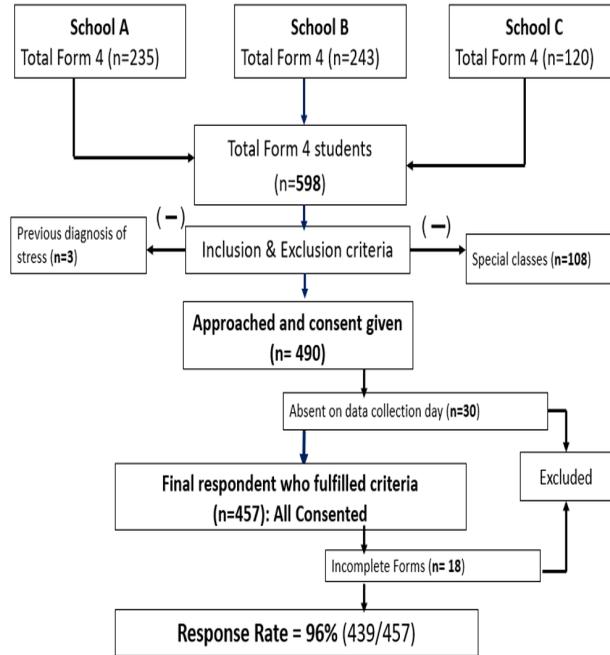
Figure 1. Sampling flowchart

Table 1

Sociodemographic and clinical characteristics of smartphone users (N=414)

Variables	Overall		Smartphone overused		Crude OR[a] 95% CI	*p* value[a]
	n (%) or Median (IQR)	SAS-SV§ Score Median (IQR)	Yes# *n* (%) or Median (IQR)	No *n* (%) or Median (IQR)		
Gender						
Male	157 (37.9)	29.0 (11.0)	68 (43.3)	89 (56.7)	1	
Female	257 (62.1)	31.0 (13.0)	112 (43.6)	145 (56.4)	1.01 (0.68-1.51)	0.957
Race						
Non-Malay	125 (30.2)	27.0 (8.0)	33 (26.4)	92 (73.6)	1	
Malay	289 (69.8)	32.0 (12.0)	147 (50.9)	142 (49.1)	2.89 (1.82-4.57)	<0.001*
Monthly family income						
<RM2000	177 (42.8)	30.0 (14.0)	82 (46.3)	95 (53.7)		
RM2000-RM4000	147 (35.5)	31.0 (13.0)	66 (44.9)	81 (55.1)	0.94 (0.61-1.47)	0.797

Table 1 *(Continue)*

Variables	Overall		Smartphone overused		Crude OR[a] 95% CI	*p* value[a]
	n (%) or Median (IQR)	SAS-SV§ Score Median (IQR)	Yes# *n* (%) or Median (IQR)	No *n* (%) or Median (IQR)		
Monthly family income						
>RM4000	90 (21.7)	28.5 (10.0)	32 (35.6)	58 (64.4)	0.64 (0.38-1.08)	0.094
Parents' status of employment						
At least one parent/guardian is unemployed	271 (65.5)	30.0 (13.0)	118 (43.5)	153 (56.5)	1	
Both parents/ guardians are employed	143 (34.5)	31.0 (12.0)	62 (43.4)	81 (56.6)	0.99 (0.66-1.49)	0.971
Past medical history						
No	374 (90.3)	30.0 (12.0)	162 (43.3)	212 (56.7)	1	
Yes	40 (9.7)	30.5 (18.0)	18 (45.0)	22 (55.0)	1.07 (0.56-2.06)	0.838
Possible depression						
No	283 (68.4)	28.0 (11.0)	107 (37.8)	176 (62.2)	1	
Yes	131 (31.6)	34.0 (12.0)	73 (55.7)	58 (44.3)	2.07 (1.36-3.15)	0.001*
Possible anxiety						
No	214 (51.7)	28.5 (12.0)	84 (39.3)	130 (60.7)	1	
Yes	200 (48.3)	31.5 (13.0)	96 (48.0)	104 (52.0)	1.43 (0.97-2.11)	0.073
Possible stress						
No	303 (73.2)	29.0 (11.0)	118 (38.9)	185 (61.1)	1	
Yes	111 (26.8)	34.0 (13.0)	62 (55.9)	49 (44.1)	1.98 (1.28-3.08)	0.002*
Number of psychological problems	1.0 (2.0)		1.0 (3.0)	1.0 (2.0)	1.34 (1.13-1.59)	0.001*

Note. §SAS-SV: smartphone addiction scale-short version (range of total score: 10-60, midpoint: 35); #Cut-off point score for smartphone addiction: ≥ 31 (male), ≥ 33 (female); [a]: Simple logistic regression; *Significance: $p<0.05$

primarily used were for (1) socialising and communication, including social networking (95.4%), and (2) entertainment, including gaming, listening to music and watching videos (91.3%).

Table 2

Pattern and purpose of smartphone usage (N=414)

Variables	Overall		Smartphone overused		Crude OR[a] 95% CI	*p* value[a]
	n (%) or Median (IQR)	SAS-SV§ Score Median (IQR)	Yes# *n* (%) or Median (IQR)	No *n* (%) or Median (IQR)		
Smartphone ownership						
Owned by others	71 (17.1)	26.0 (14.0)	22 (31.0)	49 (69.0)	1	
Self-owned	343 (82.9)	31.0 (11.0)	158 (46.1)	185 (53.9)	1.90 (1.10-3.28)	0.021*
Daily usage (hours/day)	4.0 (4.0)	N/A	6.0 (4.0)	4.0 (3.0)	1.22 (1.14-1.31)	<0.001*
Limitations on usage by parents/ guardian						
Yes	237 (57.2)	28.0 (13.0)	90 (38.0)	147 (62.0)	1	
No	177 (42.8)	32.0 (12.0)	90 (50.8)	87 (49.2)	1.69 (1.14-2.51)	0.009*
Cost of monthly usage						
<RM50	355 (85.7)	29.0 (12.0)	147 (41.4)	208 (58.6)	1	
≥RM50	59 (14.3)	33.0 (13.0)	33 (55.9)	26 (44.1)	1.80 (1.03-3.13)	0.039*
Source of money spent on smartphone						
Others	263 (63.5)	29.0 (13.0)	103 (39.2)	160 (60.8)	1	
Own money	151 (36.5)	32.0 (12.0)	77 (51.0)	74 (49.0)	1.62 (1.08-2.42)	0.020*
Mostly used for entertainment (gaming, listening to music and watching videos)						
No	36 (8.7)	27.0 (16.0)	13 (36.1)	23 (63.9)	1	

Table 2 *(Continue)*

Variables	Overall		Smartphone overused		Crude OR[a] 95% CI	*p* value[a]
	n (%) or Median (IQR)	SAS-SV§ Score Median (IQR)	Yes# *n* (%) or Median (IQR)	No *n* (%) or Median (IQR)		
Mostly used for entertainment (gaming, listening to music and watching videos)						
Yes	378 (91.3)	30.0 (12.0)	211 (55.8)	167 (44.2)	1.40 (0.69-2.85)	0.352
Mostly used for socialising and communication						
No	19 (4.6)	20.0 (9.0)	4 (21.1)	15 (78.9)	1	
Yes	395 (95.4)	30.0 (12.0)	176 (44.6)	219 (55.4)	3.01 (0.98-9.24)	0.054
Mostly used for photography and videography/graphics						
No	140 (33.8)	28.0 (13.0)	51 (36.4)	89 (63.6)	1	
Yes	274 (66.2)	31.0 (12.0)	129 (47.1)	145 (52.9)	1.55 (1.02-2.36)	0.039*
Mostly used for web browsing for information						
No	149 (36.0)	30.0 (14.0)	65 (43.6)	84 (56.4)	1	
Yes	265 (64.0)	30.0 (12.0)	115 (43.4)	150 (56.6)	0.99 (0.66-1.49)	0.964

Note. §SAS-SV: smartphone addiction scale-short version (range of total score: 10-60, midpoint: 35); #Cut-off point score for smartphone addiction: ≥31 (male), ≥33 (female); [a]: Simple logistic regression; *Significance: $p<0.05$; N/A: Not applicable

Probable depression, anxiety and stress among adolescent smartphone users were prevalent at 31.6%, 48.3% and 26.8%, respectively (Table 1). Most of them suffered psychological problems with mild to moderate severity (Figure 3). Almost three in five adolescents (232/414) had at least one psychological problem, 13.0% (54/414) had two psychological problems, and 18.8% (78/414) had three psychological problems (Figure 2).
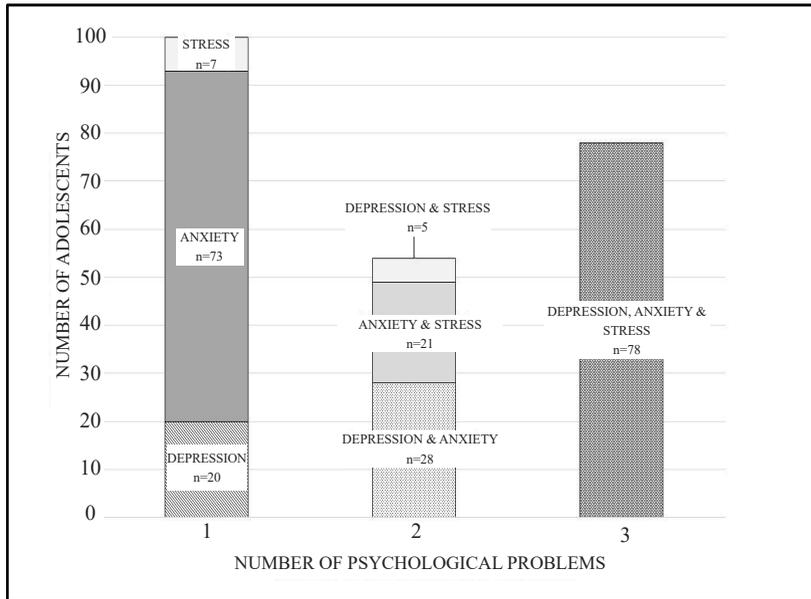
Figure 2. Psychological problems of adolescent smartphone users (*n*=232)
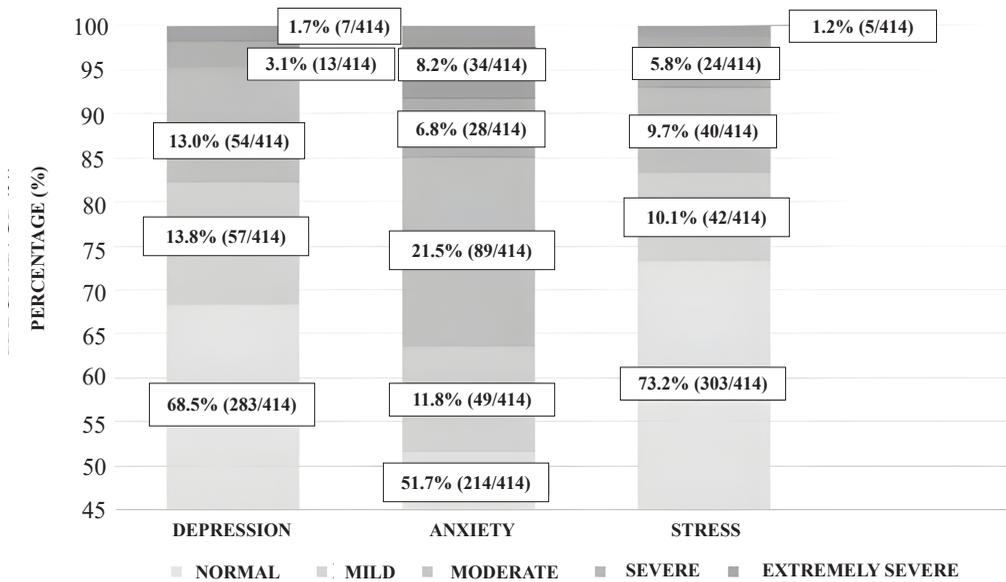
Figure 3. Prevalence of psychological problems and severity among adolescents (N=414)

Problematic Smartphone Use, Its Usage Pattern and Associated Factors

Table 2 shows the difference in the pattern and purpose of smartphone use between regular users and those with PSU. The prevalence of PSU was 43.5% (234/414). Compared to regular users, more adolescents with PSU had self-owned smartphones

(PSU: 46.1% *versus* Non-PSU: 31.0%, p=0.021) and used their own money to pay for monthly usage costs (PSU: 51.0% *versus* Non-PSU: 39.2%, p=0.020). Those with PSU recorded more prolonged daily usage (PSU: Median 6.0 (IQR 4.0) hours *versus* Non-PSU: Median 4.0 (IQR 3.0) hours, *p*=<0.001). More adolescents with PSU spent ≥RM50 a month on usage (PSU: 46.1% *versus* Non-PSU: 31.0%, p=0.039) and had no parental limitations on their usage (PSU: 50.8% *versus* Non-PSU: 38.0%, p=0.009). Meanwhile, only one smartphone function significantly differed between regular and problematic smartphone users. More adolescents with PSU used smartphones for photography and videography/graphics (PSU: 47.1% *versus* Non-PSU: 36.4%, p=0.039) compared to regular users.

Based on SLR, the following factors were included in both models of MLR: ethnicity (*p*<0.001), smartphone ownership (p=0.021), daily usage (*p*<0.001), parental usage limitations (p=0.009), cost of monthly usage (p=0.039), source of money spent on smartphones (p=0.020), and primary use for photography and videography/graphics (p=0.039; Tables 1 and 2). Even though other purposes of smartphone use were not statistically significant, they were still included in both models of MLR due to their clinical importance in influencing smartphone use.

In both MLR models (Tables 3 and 4), Malay ethnicity, higher daily usage and monthly usage costs of ≥RM50 were significantly associated with PSU. Both models did not show the significance of any smartphone function in influencing excessive smartphone use. In Model 1 (Table 3), the MLR showed that Malay adolescents had 2.53 times the odds of using smartphones excessively than non-Malays (*p*<0.001). An hour increase in smartphone use raised the odds for adolescents with PSU by 1.15 (*p*<0.001), and those who spent ≥RM50 a month on usage had 1.98 risks of having PSU than those who spent lesser (p=0.031). No specific psychological problems (depression, anxiety or stress) were significantly associated with PSU. Model 2 (Table 4) shows that Malay adolescents had 2.54 times the odds of having PSU than non-Malays (*p*<0.001). An hour increase in usage raised the odds for adolescents with PSU by 1.15 (*p*<0.001), and those with monthly usage costs of ≥RM50 had twice the risk of having PSU than those with <RM50 monthly usage costs (p=0.029). The number of psychological problems suffered by the adolescents was significantly associated with PSU (p=0.011). With an increase of one psychological problem, the odds for PSU increased by 1.28. The variance explained by Model 1 and Model 2 was 22% and 21%, respectively.

DISCUSSION

This study aims to determine the prevalence of PSU among secondary school adolescents and examine the relationship between PSU and psychological problems. Simultaneously, the researchers assessed the respondents' usage patterns and purpose. Most adolescents own smartphones,

Table 3

Model 1 multiple logistic regression: Factors associated with smartphone overuse (N=414)

Variables	β	S.E.	Wald Statistic (df)	Adjusted OR[a] (95% CI)	*p* value
Race					
Malay [Ref.: Non-Malay]	0.93	0.26	12.69 (1)	2.53 (1.52-4.23)	**<0.001***
Monthly family income					
RM2001-RM4000 [Ref.: ≤RM2000]	-0.11	0.25	0.21 (1)	0.89 (0.55-1.46)	0.649
>RM4000 [Ref.: ≤RM2000]	-0.50	0.30	2.76 (1)	0.61 (0.34-1.09)	0.097
Smartphone ownership					
Self-owned [Ref.: Owned by others]	0.19	0.33	0.31 (1)	1.20 (0.63-2.31)	0.577
Daily usage (hours/day)	0.14	0.04	12.77 (1)	1.15 (1.07-1.24)	**<0.001***
Limitations on usage by parents/guardian					
No [Ref.: Yes]	0.24	0.23	1.14 (1)	1.27 (0.82-1.98)	0.286
Cost of monthly usage					
≥RM50 [Ref.: <RM50]	0.69	0.32	4.65 (1)	1.98 (1.06-3.70)	**0.031***
Source of money spent on smartphone					
Own money [Ref.: Others]	0.25	0.24	1.10 (1)	1.28 (0.81-2.03)	0.295
Mostly used for entertainment					
Yes [Ref.: No]	0.09	0.41	0.05 (1)	1.10 (0.49-2.44)	0.823
Mostly used for socialising and communication					
Yes [Ref.: No]	0.53	0.63	0.71 (1)	1.70 (0.50-5.79)	0.398
Mostly used for photography and videography/graphics					
Yes [Ref.: No]	0.22	0.25	0.81 (1)	1.25 (0.77-2.04)	0.369

Table 3 *(Continue)*

Variables	β	S.E.	Wald Statistic (df)	Adjusted OR[a] (95% CI)	*p* value
Mostly used for web browsing for information					
Yes [Ref.: No]	-0.28	0.24	1.31 (1)	0.76 (0.47-1.22)	0.252
Possible depression					
Yes [Ref.: No]	0.49	0.29	2.80 (1)	1.63 (0.92-2.90)	0.094
Possible anxiety					
Yes [Ref.: No]	-0.16	0.26	0.36 (1)	0.85 (0.51-1.43)	0.547
Possible stress					
Yes [Ref.: No]	0.42	0.31	1.81 (1)	1.52 (0.83-2.82)	0.178

Note. [a]Multiple logistic regression: Enter mode; Negekerke R^2=0.22; *Significance: *p*<0.05

Table 4

Model 2 multiple logistic regression: Factors associated with smartphone overuse (N=414)

Variables	β	S.E.	Wald Statistic (df)	Adjusted OR[a] (95% CI)	*p* value
Race					
Malay [Ref.: Non-Malay]	0.93	0.26	12.89 (1)	2.54 (1.53-4.22)	**<0.001***
Monthly family income					
RM2001-RM4000 [Ref.: ≤RM2000]	-0.09	0.25	0.13 (1)	0.91 (0.56-1.49)	0.718
>RM4000 [Ref.: ≤RM2000]	-0.47	0.30	2.51 (1)	0.63 (0.35-1.12)	0.113
Smartphone ownership					
Self-owned [Ref.: Owned by others]	0.20	0.33	0.38 (1)	1.23 (0.64-2.34)	0.536
Daily usage (hours/day)	0.14	0.04	12.31 (1)	1.15 (1.06-1.24)	**<0.001***
Limitations on usage by parents/guardian					
No [Ref.: Yes]	0.27	0.23	1.44 (1)	1.31 (0.84-2.03)	0.231

Table 4 *(Continue)*

Variables	β	S.E.	Wald Statistic (df)	Adjusted OR[a] (95% CI)	*p* value
Cost of monthly usage					
≥RM50 [Ref.: <RM50]	0.69	0.32	4.78 (1)	2.00 (1.07-3.72)	**0.029***
Source of money spent on smartphone					
Own money [Ref.: Others]	0.27	0.23	1.35 (1)	1.31 (0.83-2.08)	0.246
Mostly used for entertainment					
Yes [Ref.: No]	0.06	0.41	0.02 (1)	1.06 (0.48-2.36)	0.884
Mostly used for socialising and communication					
Yes [Ref.: No]	0.51	0.63	0.66 (1)	1.67 (0.49-5.72)	0.415
Mostly used for photography and videography/graphics					
Yes [Ref.: No]	0.21	0.25	0.71 (1)	1.23 (0.76-2.00)	0.400
Mostly used for web browsing for information					
Yes [Ref.: No]	-0.32	0.24	1.74 (1)	0.73 (0.46-1.77)	0.187
Number of psychological problems	0.24	0.10	6.40 (1)	1.28 (1.06-1.54)	0.011*

Note. [a]Multiple logistic regression: Enter mode; Negekerke R^2=0.21; *Significance: $p<0.05$

although many depend on others to support their usage costs. Many adolescents spent about <RM50 (<USD12) a month, deemed affordable by them and their families. The average daily use of smartphones is four hours, lower than that of Malaysian undergraduates with five to eight hours of daily use (Hadi et al., 2019; Ismail et al., 2020; Nasser et al., 2020). Most adolescents use smartphones for socialising, communication and entertainment, with no significant difference between regular and problematic users. In contrast, adolescents in Switzerland spend one to two hours daily on their smartphones, although the most common smartphone function is still social networking (Haug et al., 2015). This finding indicates the fundamental smartphone function that suits the daily needs of adolescents.

In this study, two in five adolescents had PSU, with an average daily usage of six hours. This finding is comparable to recent studies among adolescents aged 7–18 (Coco et al., 2020; Nor et al., 2020). Many problematic users spent ≥RM50 (≥USD12) a month of their own money on smartphone usage. The results show a significant association between higher monthly usage cost and PSU, which was not found in most other studies. A study in Spain found a positive association between family economy, intensive phone use and cell phone dependence, measured by the frequency of usage and monthly phone bill (Sánchez-Martínez & Otero, 2009). The lack of similar findings from other studies may be due to the non-inclusion of monthly costs and differing costs of smartphone use in other countries. None of the usage patterns and purposes significantly influenced PSU when other confounding factors were controlled, except for high daily usage time and monthly usage costs. The findings highlight that excessive use is a salient feature of behavioural addiction supported in previous studies (Buctot et al., 2020; Cha & Seo, 2018; Fischer-Grote et al., 2019; Haug et al., 2015; C. Lee & Lee, 2017). Moreover, the findings in the present study did not support previous studies that postulate PSU as an addiction to the functions offered by smartphones (Fischer-Grote et al., 2019; Panova & Carbonell, 2018; Yu & Sussman, 2020). Smartphone addiction is regarded as a subset of technological addiction, and smartphones only act as a medium that facilitates such addiction (Fischer-Grote et

al., 2019; Panova & Carbonell, 2018; Yu & Sussman, 2020).

Further findings show that psychological problems are common among secondary school students in this study. The prevalence of depression (31.6%), anxiety (48.3%) and stress (26.8%) were higher than the national prevalence (Institute for Public Health [IPH], 2017). In the National Health and Morbidity Survey (IPH, 2017) that utilised DASS-21, the prevalence of depression, anxiety and stress among Malaysian adolescents aged 13 to 17 were 18.3%, 39.7% and 9.6%, respectively. This research also indicates that three in ten adolescents had multiple psychological problems. These findings were alarming, but the reasons for these prevalent psychological problems remain unanswered as the study did not examine risk factors for the psychological problems. However, this study demonstrates non-significant associations of PSU with each of the psychological problems when other confounding factors are controlled. This finding differs from other studies which found a significant association between PSU and psychological problems (Buctot et al., 2020; Elhai et al., 2018; Hadi et al., 2019; Haug et al., 2015; Ikeda & Nakamura, 2014; Ithnain et al., 2018; Kim et al., 2020; Nasser et al., 2020; Nor et al., 2020).

As PSU may indicate overused of specific functions of the smartphone, such as the internet or social media use, the non-significant finding of PSU and psychological problems also differs from previous studies on Internet addiction, sleep disturbances and psychological problems

such as depression and anxiety (Ho et al., 2014; Zhang et al., 2017). Interestingly, the number of psychological problems suffered by adolescents was significantly and independently associated with PSU. Those with more psychological problems were more likely to have PSU. This finding shows that adolescents with multiple psychological problems are more vulnerable to PSU and may have to utilise their smartphones as a coping mechanism. This previous finding also suggests that the relationship between PSU and psychological problems is more complex and cannot be simply explained by depression, anxiety or stress. Instead, it is multifaceted beyond the usual causal relationships where psychological problems are postulated as risk factors or consequences of PSU (Coyne et al., 2020; Jo et al., 2020; Jun, 2016, 2019; Lapierre et al., 2019; Liu et al., 2019; Park et al., 2019; Thomée et al., 2011).

The significant association between PSU and the number of psychological problems found in this study suggests that users with multiple psychological problems could excessively use smartphones to relieve boredom as an escape mechanism or deviation from real-life problems to suppress their emotions (Elhai et al., 2016, 2018). Since most adolescents have psychological problems with mild to moderate severity, it is postulated that the problems might not be highly severe to cause significant anhedonia, virtual social withdrawal and reduced smartphone use. Without an active coping mechanism, this maladaptive behaviour may, in turn, worsen their problems as

PSU could lead to sleep deprivation, loneliness, interpersonal problems and poor school outcomes (Jun, 2019; Lapierre et al., 2019; C. Lee & Lee, 2017; Liu et al., 2019; Thomée et al., 2011). Therefore, the underlying psychopathological mechanism that explains the relationship between PSU and psychological problems among adolescents requires further exploration in future studies.

Since this study is one of the first in Malaysia to assess PSU and its relationship with psychological problems among secondary school adolescents, the findings provide valuable insight into curbing smartphone addiction among adolescents. Another strength of this study is the validated SAS-SV questionnaire utilised in many other studies worldwide. The Malay version of SAS-SV was validated among secondary school adolescents and thus can be used in future research to identify individuals at high risk for PSU.

Nevertheless, this study has several limitations. It is cross-sectional in design and involves 15 to 16-year-olds adolescents from national schools. Thus, the findings are not generally applicable to all Malaysian adolescents. Due to the complexity of the relationship between the variables, a mixed-method design is more appropriate for a qualitative and quantitative study of PSU. Future studies should also include multiple factors that simultaneously influence PSU and psychological problems to provide an understanding of the interconnection between the factors.

CONCLUSION

The problematic smartphone uses, and psychological problems are prevalent among secondary school adolescents. A substantial proportion of them suffered not from one but multiple psychological problems. The significant factors associated with PSU indicate excessive and pervasive smartphone use despite having multiple psychological problems. None of the smartphone functions had a significant association with PSU. The conflicting findings also show a non-significant association of PSU with psychological problems (depression, anxiety, or stress). However, a significant association with the number of psychological problems suggest a complex relationship between these entities that require further studies. Nevertheless, the prevalence of PSU and psychological problems among adolescents indicate the need for screening programmes to identify those at risk for appropriate intervention.

ACKNOWLEDGEMENT

REFERENCES

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). American Psychiatric Publishing, Inc. https://doi.org/10.1176/appi.books.9780890425596

Buctot, D. B., Kim, N., & Kim, J. J. (2020). Factors associated with smartphone addiction prevalence and its predictive capacity for health-related quality of life among Filipino adolescents. *Children and Youth Services Review*, *110,* Article 104758. https://doi.org/10.1016/j.childyouth.2020.104758

Cha, S. S., & Seo, B. K. (2018). Smartphone use and smartphone addiction in middle school students in Korea: Prevalence, social networking service, and game use. *Health Psychology Open*, *5*(1). https://doi.org/10.1177/2055102918755046

Choi, S. W., Kim, D. J., Choi, J. S., Ahn, H., Choi, E. J., Song, W. Y., Kim, S., & Youn, H. (2015). Comparison of risk and protective factors associated with smartphone addiction and Internet addiction. *Journal of Behavioral Addictions*, *4*(4), 308-314. https://doi.org/10.1556/2006.4.2015.043

Coco, G. L., Salerno, L., Franchina, V., La Tona, A., Di Blasi, M., & Giordano, C. (2020). Examining bi-directionality between fear of missing out and problematic smartphone use. A two-wave panel study among adolescents. *Addictive Behaviors*, *106,* Article 106360. https://doi.org/10.1016/j.addbeh.2020.106360

Coyne, S. M., Rogers, A. A., Zurcher, J. D., Stockdale, L., & McCall, B. (2020). Does time spent using social media impact mental health?: An eight year longitudinal study. *Computers in Human Behavior*, *104,* Article 106160. https://doi.org/10.1016/j.chb.2019.106160

Coyne, S. M., Stockdale, L., & Summers, K. (2019). Problematic cell phone use, depression, anxiety, and self-regulation: Evidence from a three year longitudinal study from adolescence to emerging adulthood. *Computers in Human Behavior*, *96*, 78-84. https://doi.org/10.1016/J.CHB.2019.02.014

Elhai, J. D., Dvorak, R. D., Levine, J. C., & Hall, B. J. (2017). Problematic smartphone use: A conceptual overview and systematic review of relations with anxiety and depression psychopathology. *Journal of Affective Disorders*, *207*, 251-259. https://doi.org/10.1016/j.jad.2016.08.030

Elhai, J. D., Levine, J. C., Dvorak, R. D., & Hall, B. J. (2016). Fear of missing out, need for touch, anxiety and depression are related to problematic smartphone use. *Computers in Human Behavior*, *63*, 509-516. https://doi.org/10.1016/j.chb.2016.05.079

Elhai, J. D., Vasquez, J. K., Lustgarten, S. D., Levine, J. C., & Hall, B. J. (2018). Proneness to boredom mediates relationships between problematic smartphone use with depression and anxiety severity. *Social Science Computer Review*, *36*(6), 707-720. https://doi.org/10.1177/0894439317741087

Fischer-Grote, L., Kothgassner, O. D., & Felnhofer, A. (2019). Risk factors for problematic smartphone use in children and adolescents: A review of existing literature. *Neuropsychiatrie*, *33*(4), 179-190. https://doi.org/10.1007/s40211-019-00319-8

Hadi, A. A., Nawawi, H. M. M., Shamsuri, N., Rahim, N. N., & Pasi, N. (2019). Smartphone addiction and its relationship with psychological health among students of a medical school in East Coast Malaysia. *Asian Journal of Pharmaceutical and Clinical Research*, *12*(8), 257-260. https://doi.org/10.22159/ajpcr.2019.v12i18.34396

Haug, S., Castro, R. P., Kwon, M., Filler, A., Kowatsch, T., & Schaub, M. P. (2015). Smartphone use and smartphone addiction among young people in Switzerland. *Journal of Behavioral Addictions*, *4*(4), 299-307. https://doi.org/10.1556/2006.4.2015.037

Ho, R. C., Zhang, M. W., Tsang, T. Y., Toh, A. H., Pan, F., Lu, Y., Cheng, C., Yip, P. S., Lam, L. T.,

Lai, C. M., Watanabe, H., & Mak, K. K. (2014). The association between Internet addiction and psychiatric co-morbidity: A meta-analysis. *BMC Psychiatry*, *14*, Article 183. https://doi.org/10.1186/1471-244X-14-183

Ikeda, K., & Nakamura, K. (2014). Association between mobile phone use and depressed mood in Japanese adolescents: A cross-sectional study. *Environmental Health and Preventive Medicine*, *19*(3), 187-193. https://doi.org/10.1007%2Fs12199-013-0373-3

Institute for Public Health. (2017). *National health and morbidity survey 2017 (NHMS 2017): Adolescent mental health (DASS-21).* Ministry of Health Malaysia.

Ismail, W. S., Sim, S. T., Tan, K. A., Bahar, N., Ibrahim, N., Mahadevan, R., Jaafar, N. R. N., Baharudin, A., & Aziz, M. A. (2020). The relations of Internet and smartphone addictions to depression, anxiety, stress, and suicidality among public university students in Klang Valley, Malaysia. *Perspectives in Psychiatric Care*, *56*(4), 949-955. https://doi.org/10.1111/ppc.12517

Ithnain, N., Ghazali, S. E., & Jaafar, N. (2018). Relationship between smartphone addiction with anxiety and depression among undergraduate students in Malaysia. *International Journal of Health Sciences and Research*, *8*(1), 163-171.

Jo, Y. S., Bhang, S. Y., Choi, J. S., Lee, H. K., Lee, S. Y., & Kweon, Y. S. (2020). Internet, gaming, and smartphone usage patterns of children and adolescents in Korea: A c-CURE clinical cohort study. *Journal of Behavioral Addictions*, *9*(2), 420-432. https://doi.org/10.1556/2006.2020.00022

Jun, S. (2016). The reciprocal longitudinal relationships between mobile phone addiction and depressive symptoms among Korean adolescents. *Computers in Human Behavior*, *58*, 179-186. https://doi.org/10.1016/j.chb.2015.12.061

Jun, S. (2019). Longitudinal influences of depressive moods on problematic mobile phone use and negative school outcomes among Korean adolescents. *School Psychology International*, *40*(3), 294-308. https://doi.org/10.1177/0143034319830452

Kim, H., Cho, M. K., Ko, H., Yoo, J. E., & Song, Y. M. (2020). Association between smartphone usage and mental health in South Korean adolescents: The 2017 Korea youth risk behavior web-based survey. *Korean Journal of Family Medicine*, *41*, 98-104. https://doi.org/10.4082/kjfm.18.0108

Kwon, M., Lee, J. Y., Won, W. Y., Park, J. W., Min, J. A., Hahn, C., Gu, X., Choi, J. H., & Kim, D. J. (2013). Development and validation of a smartphone addiction scale (SAS). *Plos One*, *8*(2), Article e56936. https://doi.org/10.1371/journal.pone.0056936

Lapierre, M. A., Zhao, P., & Custer, B. E. (2019). Short-term longitudinal relationships between smartphone use/dependency and psychological well-being among late adolescents. *Journal of Adolescent Health*, *65*(5), 607-612. https://doi.org/10.1016/j.jadohealth.2019.06.001

Lee, C., & Lee, S. K. (2017). Prevalence and predictors of smartphone addiction proneness among Korean adolescents. *Children and Youth Services Review*, *77*, 10-17. https://doi.org/10.1016/j.childyouth.2017.04.002

Lee, J., Sung, M. J., Song, S. H., Lee, Y. M., Lee, J. J., Cho, S. M., Park, M. K., & Shin, Y. M. (2018). Psychological factors associated with smartphone addiction in South Korean adolescents. *The Journal of Early Adolescence*, *38*(3), 288-302. https://doi.org/10.1177/0272431616670751

Liu, S., Wing, Y. K., Hao, Y., Li, W., Zhang, J., & Zhang, B. (2019). The associations of long-time mobile phone use with sleep disturbances and mental distress in technical college students: A prospective cohort study. *Sleep*, *42*(2), Article zsy213. https://doi.org/10.1093/sleep/zsy213

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. https://doi.org/10.1089/cyber.2014.0139

Nor, H. A. M., Bashir, N. F. J. M., & Mokhtar, D. M. M. (2020). Relation between smartphone addiction, sleep quality and psychological health among adolescents in Malaysia. *International Journal of Psychosocial Rehabilitation*, *24*(4), 4288-4298. https://doi.org/10.37200/IJPR/V24I4/PR201535

Musa, R., Fadzil, M. A., & Zain, Z. (2007). Translation, validation and psychometric properties of Bahasa Malaysia version of the Depression, Anxiety and Stress Scales (DASS). *ASEAN Journal of Psychiatry*, *8*(2), 82-89.

Nasser, N. S., Loh, J. L., Rashid, A. A., Sharifat, H., Ahmad, U., Ibrahim, B., Mustafa, S., Hoo, F. K., Ching, S. M., & Suppiah, S. S. (2020). A survey on smartphone dependence and psychological effects among undergraduate students in a Malaysian University. *Medical Journal of Malaysia*, *75*(4), 356-362. https://doi.org/10.1186/s12888-016-1083-3

Panova, T., & Carbonell, X. (2018). Is smartphone addiction really an addiction? *Journal of Behavioral Addictions*, *7*(2), 252-259. https://doi.org/10.1556/2006.7.2018.49

Park, S. Y., Yang, S., Shin, C. S., Jang, H., & Park, S. Y. (2019). Long-term symptoms of mobile phone use on mobile phone addiction and depression among Korean adolescents. *International Journal of Environmental Research and Public Health*, *16*(19), Article 3584. https://doi.org/10.3390/ijerph16193584

Sánchez-Martínez, M., & Otero, A. (2009). Factors associated with cell phone use in adolescents in the community of Madrid (Spain). *Cyberpsychology,*

Behavior and Social Networking, *12*(2), 131-137. https://doi.org/10.1089/cpb.2008.0164

Sohn, S., Rees, P., Wildridge, B., Kalk, N. J., & Carter, B. (2019). Prevalence of problematic smartphone usage and associated mental health outcomes amongst children and young people: A systematic review, meta-analysis and GRADE of the evidence. *BioMed Central Psychiatry*, *19*, Article 356. https://doi.org/10.1186/s12888-019-2350-x

Thomée, S. (2018). Mobile phone use and mental health. A review of the research that takes a psychological perspective on exposure. *International Journal of Environmental Research and Public Health*, *15*(12), Article 2692. https://doi.org/10.3390/ijerph15122692

Thomée, S., Härenstam, A., & Hagberg, M. (2011). Mobile phone use and stress, sleep disturbances, and symptoms of depression among young adults - a prospective cohort study. *BioMed Central Public Health*, *11*, Article 66. https://doi.org/10.1186/1471-2458-11-66

Vahedi, Z., & Saiphoo, A. (2018). The association between smartphone use, stress, and anxiety: A meta-analytic review. *Stress Health*, *34*(3), 347-358. https://doi.org/10.1002/smi.2805

Yu, S., & Sussman, S. (2020). Does smartphone addiction fall on a continuum of addictive behaviors? *International Journal of Environmental Research and Public Health*, *17*(2), Article 422. https://doi.org/10.3390/ijerph17020422

Zhang, M., Tran, B. X., Huong, L. T., Hinh, N. D., Nguyen, H., Tho, T. D., Latkin, C., & Ho, R. (2017). Internet addiction and sleep quality among Vietnamese youths. *Asian Journal of Psychiatry*, *28*, 15-20. https://doi.org/10.1016/j.ajp.2017.03.025