



## Research article

# Anger and worry are related to problematic smartphone use: A cross-sectional examination of novel psychopathological constructs in a college-aged sample in the United Arab Emirates

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## ABSTRACT

**Introduction:** Problematic smartphone use (PSU) has consistently been shown to be associated with depression and anxiety. However, the association of PSU and psychological constructs beyond these two have rarely been subjected to examination. Worry and anger are transdiagnostic constructs that, given their conceptual similarity with depression and anxiety, may similarly evidence significant relationships with PSU.

**Methods:** To test these hypotheses, a sample of 264 college-aged students were recruited from a university in the United Arab Emirates. The sample ranged in age from 18 to 36 years ( $M = 21.51$ ,  $SD = 2.99$ ). Self-report measures of PSU, worry and anger were administered.

**Results:** Results revealed statistically significant associations with PSU, anger, and worry – these results were evident following correlational as well as regression analyses. Moreover, using a recommended cut-off score from the literature to identify participants scoring beyond the clinical threshold indicative of PSU, worry and anger scores were significantly higher in the clinical sub-group.

**Conclusions:** This study's results lend additional credibility to uses and gratifications theory and compensatory internet use theory as it appears that the excessive use of technologies may indeed serve the purpose of compensating for the management of emotional distress. Results are discussed within the context of these two theories.

## 1. Introduction

The rate of smartphone ownership has risen exponentially in recent years, particularly in first-world countries. Poushter et al. (2018), having analysed data from the Pew Research Centre, report the global prevalence of smartphone ownership to be approximately 59% with the reported prevalence being higher in first-world, industrialised countries (e.g., 77% in the United States). Whilst smartphones may offer its users a great number of benefits, most notably with regard to the improvement of occupational efficiency and productivity as well as providing innovative approaches to the delivery of education and the conduct of business (George and DeCristofaro, 2016; Lee et al., 2017; Li and Lin, 2018; Remon et al., 2017), a plethora of research now suggests that excessive engagement in smartphone use can result in deleterious consequences for its users.

Excessive use of smartphones, often referred to as problematic smartphone use (PSU) in the literature, is conceptualised as overuse of

one's smartphone that results in functional impairment and a range of distressing symptoms (e.g., lack of control, withdrawal, increased tolerance, inability to desist use of the device despite the clear experience of aversive consequences) which closely resemble those experienced by individuals with substance use disorders (Billieux et al., 2015). Notably though, some scholars have questioned the application of addiction nomenclature to individuals' use of technologies (Petry and O'Brien, 2013). This contention has, to some extent, been strengthened by recent findings that individuals appear to develop addictive tendencies, not towards the device itself, which a preponderance of the preceding literature on this subject has contended, but rather the application or feature that the device enables use of, appears to drive its excessive use (Low-e-Calverley and Pontes, 2020). The contentious nature of the PSU construct is further highlighted by the varying descriptions and terminologies used to refer to it; most notably, 'smartphone use disorder' (Peterka-Bonetta et al., 2019), 'problematic mobile phone use' (Vally and El Hichami, 2019), 'compulsive smartphone use' (Chen et al., 2017) and

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'smartphone addiction' (Vally and Alowais, 2020). Given the lack of a recognised diagnostic criteria for PSU, the deployment of varying descriptions is likely to continue. PSU is similar to problematic internet use (Balhara et al., 2019; Vally et al., 2020) and to internet gaming disorder (Stevanovic et al., 2020; Vally, 2020), the latter of which has an established diagnostic criterion captured in the current version of the International Classification of Diseases manual (World Health Organization, 2018).

PSU appears to carry harmful effects for individuals' physical health such as musculoskeletal pain as well as contributing towards injury and/or mortality via an increased number of pedestrian and traffic accidents (Thompson et al., 2013; Xie et al., 2016). Evidence also suggests that it is particularly associated with elevated and deleterious mental health outcomes. Comprehensive systematic reviews and meta-analyses indicate that PSU is consistently associated with psychopathological constructs, most notably depressive symptomatology and elevated anxiety and stress (De-Sola Gutierrez et al., 2016; Elhai et al., 2017; Vahedi and Saiphoo, 2018). The magnitude of the associative relationship with depression appears to be moderate (Elhai et al., 2017) whilst studies of PSU's relationship with anxiety and stress generally report small to moderate associations (Vahedi and Saiphoo, 2018).

While most studies of PSU have overwhelmingly focused on the assessment of depression and anxiety, more recently, a burgeoning body of research has begun to explore its association with psychopathological constructs beyond the frequently examined depressive and anxious affect. These studies have shown that PSU severity is reliably related to individuals' fear of missing out (Oberst et al., 2017), rumination (Vally et al., 2021), boredom proneness (Elhai et al., 2018a), low self-control (Cho et al., 2017), emotion dysregulation (Elhai et al., 2018b), and behavioural inhibition (Kim et al., 2016).

Additionally, in a recent study, Elhai et al. (2019) explored the applicability of worry and anger, two psychological constructs that they hypothesized may also be positively associated with increasing severity of PSU. They found that both variables were indeed statistically related to PSU at the correlational level. The researchers also reported, following a latent profile analysis, that as scores on the worry and anger measures increased, so too did the likelihood of being placed in increasingly more severe classes of PSU (Elhai et al., 2019).

With the exception of this single exploratory study, worry and anger have received no further empirical scrutiny in relation to PSU severity. This overt omission in the literature is surprising given that a theoretically sound rationale can be posited for the potential relationship between these variables and PSU. Borkovec et al. (1998) defined worry as a persistent and negative verbal thought that is unwanted by the person to whom it appears. Worry and rumination appear to have a number of parallels. Rumination is a construct that has frequently been studied in relation to PSU and consistently found to be significantly related to PSU (Vally et al., 2021). It similarly involves the presence of persistent negative thoughts, that may also be unwanted, but are self-referential in nature (Mennin and Fresco, 2013) and thus both these two constructs can be considered forms of repetitive negative thinking. They also appear to serve a similar purpose, that of enabling the individuals' avoidance of experiencing negative emotion and this typically takes the form of a maladaptive behavioural response (McEvoy et al., 2013; Newman et al., 2013). Given these parallels between worry and rumination, it is likely that worry may also be related to PSU.

Elhai et al. (2019) propose that the arousal symptoms of anxiety are related to the expression of anger. It is recognised that, when faced with a fearful situation, individuals frequently respond by engaging the 'fight or flight response'. When in 'flight', individuals will likely manifest symptoms of anxiety, when engaged in the 'fight' response, anger, aggression, and hostility will likely be manifest (Cassello-Robbins and Barlow, 2016). Given this consideration, it appears that both anxiety and anger (the manifest constructs) are triggered by the same emotive construct, fear. Moreover, the literature indicates that anxiety is often comorbid with anger problems lending additional validity to their proposed

associative relationship (Hawkins and Cogle, 2011). It should also be borne in mind that impulsivity has been shown to be an important risk factor in the development of aggressive tendencies, which one can consider to be the behavioural manifestation of expressive anger (Johnson and Carver, 2016). Impulsivity also has a verifiable relationship with PSU (De-Sola De-Sola Gutierrez et al., 2016; Remon et al., 2017). Thus, elevated levels of anger may indeed be related to PSU severity.

### 1.1. Problematic smartphone use research in the United Arab Emirates

The United Arab Emirates (UAE) is an especially relevant context within which to study PSU. Most of the research relating to this construct originates from European and East Asian contexts whilst researchers have only recently begun to examine the problematic use of technologies in Middle Eastern populations. This burgeoning body of research appears to suggest that technology-based addictions may be a substantial issue for individuals resident in the UAE. Preliminary studies that have examined prevalence rates of problematic internet use (Vally et al., 2020), internet gaming disorder (Vally, 2020), and PSU (Vally and Alowais, 2020; Vally and El Hichami, 2019) in this region have consistently reported that approximately half the sampled individuals appear to exhibit addictive tendencies beyond the accepted clinical thresholds. In addition to seemingly high rates of prevalence, these addictive constructs also appear to be related to other established psychopathological constructs, most notably depression, anxiety, and attention-deficit and hyperactivity symptoms (Vally and Alowais, 2020; Vally and El Hichami, 2019; Vally et al., 2020). However, examination of worry and anger within the context of PSU remains unexplored.

A number of hypotheses have been proposed that attempt to explain why technology-based addictions may be so prevalent in this location. First, the socio-economic context of this country is such that the rapid development of the country has been accompanied by commensurate advancements in the country's infrastructure, including in the telecommunications sector, increased economic prosperity, and an overt focus, directed by the government, towards technological advancement and the study of science and technology. This has seen an increased focus on the use of mobile devices to fulfil a variety of purposes, an enhanced fascination with technology, particularly amongst youth and young adults, and increased rates of smartphone ownership (Vally and Alowais, 2020; Vally and El Hichami, 2019; Vally et al., 2021). Therefore, given this context, focused study of the potential deleterious consequences of this overt focus on technology, and use of the devices that facilitate engagement with technological advancements, is especially relevant and timely.

### 1.2. Theoretical framework

Compensatory Internet Use Theory (CIUT) proposes that individuals engage in use of the internet (and by extension, internet-enabled devices) as a means of, primarily, diminishing their experience of distressing emotive states, and secondarily, to satisfy social needs that may be unmet in the real world (Kardefelt-Winther, 2014). Thus, the use of internet-enabled devices such as smartphones may potentially serve as an adaptive coping mechanism for individuals during times of distress. However, a beneficial effect is only likely when this engagement is minimal. Where this use strays into excessive levels, and functional impairment ensues, dependency and a range of deleterious mental health outcomes may occur (Kardefelt-Winther, 2014). This theory has been subjected to extensive empirical study and generated substantial evidence in support of its contention regarding the relationship between psychopathology and PSU (Elhai et al., 2018a; Long et al., 2016; Vally et al., 2020; Wang et al., 2015).

Additionally, Uses and Gratifications Theory (UGT) (Blumler, 1979) may be relevant in examining the association between worry and anger and PSU; specifically, the proposition that habit formation (e.g., habitually checking one's smartphone for notifications) may be reinforced by the gratification felt when receiving a smartphone notification. Thus, it is

a plausible hypothesis that the alleviation in emotional distress and expanded social connectedness experienced by users of smartphones may also serve a similarly reinforcing effect thus elevating the likelihood of continued and increased duration of use.

### 1.3. Aims and hypotheses

**Hypothesis 1 (H1).** Smartphone addiction, as assessed using a valid and reliable assessment measure, will be highly prevalent in this sample. Moreover, it is hypothesized that, when using the recommended cut-off score indicative of problematic/ addictive smartphone use, approximately half of the sample will fall above this threshold.

**Hypothesis 2 (H2).** Worry severity should be positively associated with PSU severity.

**Hypothesis 3 (H3).** Anger severity should be positively related with PSU severity.

## 2. Methodology

### 2.1. Participants and procedure

Ethical approval for the conduct of this study was obtained from the Social Sciences Research Ethics Committee at the author's institution. All procedures were conducted in accordance with the 1964 Declaration of Helsinki and its later amendments.

This study was conducted during the Fall semester of the 2019/2020 academic year. Participant recruitment was conducted on the campus of the author's institution, a large government-funded university in the UAE. Announcements advertising the study were made in lectures for psychology and general education courses during the first two weeks of the semester. Notices about the study were also posted on physical campus notice boards and on social media accounts that are typically used by the student population of this institution. Participants who elected to participate were provided with an electronic link. This could be used to access an online-administered survey which, when accessed, presented brief background information about the study, informed participants of their rights, the investigator's responsibilities, and provided the research team's contact details. An informed consent form was presented and proceeding ahead to commence the survey was taken as indicative of the provision of informed consent.

The potential sampling frame, encompassing all students registered for the targeted courses during the respective semester, totalled approximately 750 students. The final sample comprised of 264 participants who accessed and completed the online survey, a response rate of approximately 35%. The sample's age ranged from 18-36 years ( $M = 21.51$ ,  $SD = 2.99$ ), with the vast majority being 18–25 years old ( $n = 240$ , 92.0%). Years of schooling averaged 14.25 years ( $SD = 2.11$ ). A majority of participants were women ( $n = 170$ , 65.1%). Most were not in a relationship at the time of the study ( $n = 245$ , 93.9%). With regard to the cultural and demographic profile of the participants, all participants were Emirati (citizens of the United Arab Emirates), Muslim in terms of religious orientation, and bilingual (both Arabic and English). English is the official language of instruction at this institution and, as such, all assessment measures were administered in English.

### 2.2. Instruments

#### 2.2.1. Demographic questionnaire

Participants provided responses to the following items: age, gender, years of schooling, and relationship status.

#### 2.2.2. Frequency of smartphone use

Participants were presented with a list of features/functions of smartphones and asked to rate how often they used each function using a

Likert scale that ranged from 1 (Never) to 6 (Very often). The following functions were presented: text messaging, emails, social networking sites, internet browsing, games, music, pictures and videos, books and magazines, and maps/navigation.

#### 2.2.3. Smartphone Addiction Scale-Short Version (SAS-SV)

The SAS-SV (Kwon et al., 2013a) was used to measure PSU severity. It is a self-report measure that assessed the various components of PSU severity, namely, health and social impairment, withdrawal, and tolerance. Kwon et al. (2013a) initially developed the original version of the SAS by producing a list of items that were derived from problematic internet use measures and adapted these to refer specifically to PSU. The original measure was then refined via psychometric analysis to produce the abbreviated version which has been shown to converge well with the original SAS (Kwon et al., 2013b). The SAS-SV consists of 10 items to which participants respond using a 6-point Likert scale (1 = Strongly disagree to 6 = Strongly agree). The SAS-SV is a highly reliable and valid measure of PSU (Kwon et al., 2013a). Internal consistency in the present sample was adequate (Cronbach's  $\alpha = .73$ ).

#### 2.2.4. Penn State Worry Questionnaire-abbreviated version (PSWQ-A)

The PSWQ-A (Hopko et al., 2003) is a self-report measure of individuals' degree of worry and their perceived ability to control their experienced worry. The questionnaire comprises eight items to which participants provide responses prompted by the following statement: "Enter the response that best describes how typical or characteristic each item is of you." Possible responses range from 1 ("not at all typical") to 5 ("very typical"). The PSWQ-A has been demonstrated to be a reliable measure as its scores appear highly correlated with that of other measures of anxiety and worry (Kertz et al., 2014). Internal consistency in the present sample was high ( $\alpha = .88$ ). A total score for the PSWQ-A is derived by summing the scores of the eight items (Hopko et al., 2003).

#### 2.2.5. Dimensions of anger Reactions-5 (DAR-5) scale

The DAR-5 (Forbes et al., 2004) is an abbreviated, 5-item version of the original DAR scale which was developed as a measure of individuals' anger reactions. Participants provide responses to the five items by responding to the following prompting statement: "Thinking over the past four weeks, indicate the option that best describes the amount of time you felt that way." Possible responses range from 1 ("none or almost none of the time") to 5 ("all or almost all of the time"). The DAR-5 measure has been shown to be reliable and valid (Forbes et al., 2014a, 2014b). In the present sample, reliability was satisfactory (Cronbach's  $\alpha = .70$ ). Scores for the five items are tallied to derive a total score for the scale (Forbes et al., 2004).

### 2.3. Data analysis

The data distributions for the primary variables were examined for normality by generating skewness and kurtosis values. These ranged from  $-.430$  to  $.497$  and were interpreted as indicative of normal data distributions and thus parametric tests were used in all ensuing analyses. Descriptive statistics for all the primary study variables were computed using means and standard deviations, including each item of the SAS-SV. While an overall continuous score was generated for the SAS-SV, a recommendation from the literature was also followed regarding the optimal cut-off score, that which is indicative of PSU (Kwon et al., 2013a). The cut-off score was used to create an additional dichotomous variable that separated participants into two categories, those who produced an overall score above or below the cut-off. Worry and anger scores were then compared between these two stratified groups using t-tests. Gender differences were also examined across all study variables using t-tests.

In examining the association between PSU and worry and anger, bivariate correlations were first computed as preliminary analyses of the examined relationships, which are expressed using Pearson's  $r$  and its

corresponding p-values. Two sets of regression analyses were then conducted. In the first, a hierarchical linear regression was conducted in which two sets of predictor variables were specified (gender was included in step 1 and the two psychopathology variables – anger and worry – were included in step 2) to examine whether these significantly predicted overall SAS-SV scores (measured as a continuous variable). In the second regression, a binomial logistic regression was employed using the complete set of predictor variables, but on this occasion, the categorical SAS-SV score was specified as the dependent variable. This enabled examination of the predictive association of the specified variables with PSU in the clinical/problematic range. Significance levels for all analyses were set  $p < .05$ .

### 3. Results

#### 3.1. Descriptive results and subgroup analyses

Participants provided affirmative responses to all of the presented smartphone functions, however, use of social networking sites (38.3%), internet browsing (30.7%) and text messaging (29.5%) were reported as the most frequently used functions. Table 1 illustrates the reported frequencies and corresponding percentages for the nine smartphone functions.

The sample produced a mean score of 33.98 (SD = 8.70) on the SAS-SV. Item 1 (“I miss planned work due to smartphone use”) was most frequently endorsed by this sample while item 7 (“I will never give up using my smartphone even when my daily life is already greatly affected by it”) produced the lowest mean score. When Kwon et al.’s (2013a) conservative cut-off score was used to stratify the sample into two groups, approximately half of the sample (n = 140, 53%) scored above the cut-off score indicative of PSU. Mean SAS-SV scores differed substantially between these two stratified groups and the comparison was highly significant ( $t(262) = -19.97, p < .001$ ). Table 2 displays the results of these subgroup analyses of PSU prevalence in the sample. Moreover, individuals who scored above the cut-off also produced higher mean scores on the anger and worry measures compared to those who scored below the cut-off. Comparisons were highly significant for both variables ( $p < .001$ ).

Gender differences across the scales were also examined and results demonstrated that differences were evident for scores on the SAS-SV and the DAR-5 scales. Specifically, women scored higher, compared to men, on the SAS-SV as well as on the DAR-5. Table 1 illustrates descriptive statistics and the results of these tests of significance for the stratified SAS-SV groups.

#### 3.2. Regression results

The results of preliminary bivariate correlations indicated statistically significant correlations across all the examined variables. SAS-SV scores were positively and significantly associated with both anger ( $r = .43, p <$

$.001$ ) and worry ( $r = .27, p < .001$ ). Moreover, SAS-SV scores were also significantly associated with both age ( $r = .24, p < .001$ ) and sex ( $r = .18, p = .003$ ) but not with relationship status ( $r = .09, p > .05$ ). Following computation of the hierarchical linear regression in which age was inserted in step 1 and anger and worry were included in step 2, the prespecified model was significant at step 1 with age significantly predicting PSU ( $F(1, 263) = 16.512, p < .001, R^2 = .059$ ). Step 2 was similarly significant ( $F(3, 263) = 23.816, p < .001, \Delta R^2 = .156$ ), however, the change in variance was entirely accounted for by anger which emerged as a significant predictor of SAS-SV ( $p < .001$ ). Worry was not significantly associated with SAS-SV scores. The results of these analyses are illustrated in Table 3.

A second regression analysis was conducted, on this occasion a binomial logistic regression, in which the same predictor variables were used (i.e., gender, sex, worry, and anger) to determine their potential association with PSU scores in the clinical range (i.e., scores above the cut-off score indicative of problematic levels of smartphone use). To execute this analysis, the dichotomous categorical variable that was created by using Kwon et al.’s (2013a) recommended cut-off score was included as the dependent variable in the analysis. The overall model with the inserted predictor variables was statistically significant,  $\chi^2(4) = 59.619, p < .001$ , Nagelkerke  $R^2 = .27$ , and the following variables emerged as significantly associated with scoring above the clinical cut-off score: gender ( $p < .001$ ), age ( $p < .001$ ), and worry ( $p < .05$ ). The results of this logistic regression analysis are illustrated in Table 4.

### 4. Discussion

This study sought to assess the prevalence of PSU in a sample of young adults’ resident in the UAE. It also examined the association of PSU with two primary psychopathological constructs, worry and anger, as these have rarely been subjected to examination.

H1 predicted that PSU would be highly prevalent in this sample, a hypothesis that was informed both by previous investigations of similar constructs in samples of similarly aged individuals in this same region of the world. In confirmation of H1, results revealed that addictive tendencies towards smartphones were highly prevalent in this sample, approximately half of the sample produced mean scores above the recommended cut-off indicative of addictive/problematic use. While this determination may, at first glance, appear to be elevated, and it certainly is higher than the rates typically observed in European and Far East Asian samples (Chen et al., 2017; Kim et al., 2016; Long et al., 2016), there is evidence from elsewhere in the Arabic-speaking world of prevalence rates within a similar range. Sfendla et al. (2018) recruited a sample from the Moroccan general population, and also having employed the SAS-SV, similarly found that 55.8% were classified as excessive users with the symptoms of tolerance and preoccupation appearing to be especially problematic. Moreover, a recent collection of research studies relating to the excessive use of technologies in the UAE points to particularly high rates of prevalence and this finding appears to hold in relation to a range

**Table 1.** Frequency of smartphone use stratified by features and functions.

Frequency of Smartphone Use	1	2	3	4	5	6
Text Messaging	6 (2.3)	21 (8.0)	61 (23.1)	55 (20.8)	43 (16.3)	78 (29.5)
Emails	0 (0)	66 (25.0)	71 (26.9)	54 (20.5)	41 (15.5)	32 (12.1)
SNS	12 (4.5)	15 (5.7)	28 (10.6)	53 (20.1)	55 (20.8)	101 (38.3)
Internet Browsing	3 (1.1)	24 (9.1)	36 (13.6)	57 (21.6)	63 (23.9)	81 (30.7)
Games	33 (12.5)	62 (23.5)	60 (22.7)	39 (14.8)	44 (16.7)	26 (9.8)
Music	12 (4.5)	26 (9.8)	73 (27.7)	60 (22.7)	32 (12.1)	61 (23.1)
Pictures and Videos	9 (3.4)	53 (20.1)	39 (14.8)	49 (18.6)	47 (17.8)	67 (25.4)
Books/Magazines	7 (2.7)	35 (13.3)	58 (22.0)	52 (19.7)	40 (15.2)	72 (27.3)
Maps/Navigation	33 (12.5)	79 (29.9)	70 (26.5)	36 (13.6)	29 (11.0)	17 (6.4)

Note. Data are count (%) out of a total of 264 responses. Responses provided on a Likert scale with 1 = Never and 6 = Very Often. SNS = social networking sites.



**Table 2.** Prevalence of PSU and subgroup analyses.

Instrument	Total Sample (n = 264)	Males (n = 94)	Females (n = 170)	t-value (n = 124)	Below Cut-off (n = 140)	Above Cut-off	t-value
SAS-SV	33.98 (8.70)	31.84 (8.39)	35.17 (8.67)	-3.022*	26.81 (5.62)	40.34 (5.38)	-19.97**
PSWQ	22.56 (7.28)	21.46 (6.87)	23.16 (7.44)	-1.833	20.52 (7.64)	24.36 (6.45)	-4.437**
DAR-5	12.12 (4.13)	11.40 (4.26)	12.51 (4.01)	-2.100*	10.95 (4.05)	13.15 (3.93)	-4.471**

Note. PSU = problematic smartphone use, SAS-SV = Smartphone Addiction Scale – Short Version, PSWQ = Penn State Worry Questionnaire, DAR-5 = Dimensions of Anger Reactions Scale. Data are mean and standard deviation. \*\*p < .001, \*p < .05.

**Table 3.** Linear Regression Results (Overall SAS-SV scores).

Model		B	SE	$\beta$	t	R <sup>2</sup>
1	Age	-0.71	.174	-.243	-4.06**	.059
2	DAR-5	.762	.135	.362	5.64**	.216
	PSWQ	.083	.076	.070	1.09	

Note. B = Unstandardized coefficient, SE = standard error,  $\beta$  = standardized coefficient, Dependent variable = problematic smartphone use (SAS-SV), PSWQ = Penn State Worry Questionnaire, DAR-5 = Dimensions of Anger Reactions Scale. \*\*p < .001.

**Table 4.** Logistic Regression Results (SAS-SV scores stratified by cut-off).

	B	SE	Wald	Sig.
Gender	1.156	.328	12.448	<.001
Age	.344	.072	22.836	<.001
DAR-5	.055	.040	1.868	.172
PSWQ	.052	.023	5.195	.023
Nagelkerke R <sup>2</sup>	.270			

Note. B = Unstandardized coefficient, SE = standard error, Dependent variable = problematic smartphone use (categorized SAS-SV scores by cut-off), PSWQ = Penn State Worry Questionnaire, DAR-5 = Dimensions of Anger Reactions Scale.

of potential sources of problematic use, namely, problematic use of the internet (Vally et al., 2020), internet gaming (Vally, 2020), as well as excessive use of social media platforms (Vally and D'Souza, 2019). Young adults are the most prolific users of smartphones as they serve a great variety of purposes that range from academic functions to entertainment and the facilitation of social connectedness (i.e., text messaging and social media use).

The present data also supported H2, specifically, that worry was positively associated with PSU severity. This was the case both at the correlational level as well as when the sample was stratified using the cut-off score for the SAS-SV - worry was also substantially more prevalent amongst individuals who scored above the cut-off. These results appear to suggest, in concurrence with the propositions of UGT, that worry may be a factor in determining individual variation in the severity of PSU. Moreover, this also fits with previous findings of a demonstrated relationship between rumination and PSU severity, which is especially relevant when one considers that both worry and rumination are conceptually similar in that both constructs form part of a broader category of negative and repetitive thinking (Elhai et al., 2019). This study's finding provides substantiating evidence in support of CIUT, specifically that smartphone use enables its users to attain social connectedness, compensating for a lack thereof in their real-world lives, and to attain escapism from their experienced difficulties (Karddefelt-Winther, 2014). Therefore, those who tend to ruminate or experience excessive worry about their lives may divert their attention towards virtual realms as a means of emotion regulation. Elhai et al. (2019) also suggest that such individuals may engage in excessive reassurance-seeking behaviour by excessively and repeatedly checking their mobile devices for notifications. This serves the function of alleviating their experienced distress and, if successful in attaining this effect, the checking behaviour is likely to be reinforced as the individual comes

to rely upon this method for alleviating their negative emotional states. Of particular relevance to contextualizing this study's finding is recent evidence which suggests that the association between repetitive negative thinking and PSU may in fact be mediated by mental disengagement (Khoo and Yang, 2021). These authors found that individuals who ruminate tended to resort to playing games or browsing websites on their mobile devices in an attempt to disengage from negative thoughts. Ruminators and worriers may also use their mobile devices for adaptive purposes – to search the world wide web and gather information related to their worries so as to better cope with their experienced difficulties. These proposed functions served by excessive engagement in smartphone use, for which there is some empirical evidence, underscore the theoretical contentions of CIUT (Karddefelt-Winther, 2014).

H3 was also supported by this study's findings. Anger was positively related to PSU severity, both following correlational analyses and when subjected to regression analyses. While anger has rarely been studied in relation to PSU, the current finding should be unsurprising when considering that anxiety - a psychological construct that has consistently been found to be related to PSU - and anger are intricately related concepts (De-Sola De-Sola Gutierrez et al., 2016; Elhai et al., 2018a; Vahedi and Saiphoo, 2018). Research demonstrates that the presence of aggressive tendencies, more specifically indirect aggression, are one of the strongest predictors of anxiety difficulties amongst adolescents (Chung et al., 2019). This is significant in relation to the present study given Crick et al.'s (1999) finding that this form of anger results in damage to the individual's social relationships rather than externalised physical damage to their others. It is therefore plausible that individuals who are prone to manifesting indirect forms of anger and suffer the loss of significant interpersonal relationships as a result thereof, may redirect their attention towards online forms of interaction in pursuit of new relationships or perhaps in search of information related to their relational difficulties. Researchers have also reported that anger appears to be related to the experience of academic pressure (Cooley et al., 2017). This is highly relevant to an adolescent and young adult population, a developmental stage of life in which a number of crises and stressors converge to create immense stress and, invariably, precipitate unfavourable emotional responses such as anxiety or indeed aggression. PSU may therefore be a behavioural response to this psycho-emotional turmoil or a manifested coping strategy. The causative relationship between these constructs remains unclear at present but it appears likely that they are not unidirectional (Chung et al., 2019). Previous research has also found that anger is reliably associated with impulsivity (Johnson and Carver, 2016). This is relevant given that impulsivity is implicated as a potential causal mechanism in the development of PSU (Billieux et al., 2015).

Additional analyses showed that PSU severity was significantly associated with both age and gender, specifically younger participants and women demonstrated statistically significant associations both in bivariate correlations and when included in regression analyses. The literature is generally equivocal in this regard. While some of the literature has found significant associations (Wang et al., 2015), as is the case for the current study, others have not (van Deursen et al., 2015). Thus, this potential association remains unclear. The association of PSU with relationship status also appears similarly unclear. The correlation of SAS-SV scores with relationship status in this study was not significant. However, it is a plausible hypothesis that individuals in a

relationship may have less time to divert towards excessive use of devices or indeed may be less likely to require this form of disengagement or emotion regulation as the social support provided by a relationship may already satisfy this need. This hypothesis naturally assumes that one's relationship is a healthy and adaptive form of support. If this were not the case, the relationship with the development of PSU may potentially be inverted. This is a hypothetical contention at this point for which empirical support is needed. In relation to the significant association with age, it should be borne in mind that this study exclusively sampled college-aged students thus rendering a limited sample in terms of age. This decision was guided by the desire to investigate the research questions in a population in which prevalence tends to be high, however, the secondary result of this is that it does not allow for a reliable examination of the association of age with PSU. A sample with a much wider age range would, more reliably, allow for examination of this issue.

#### 4.1. Limitations of the study

In addition to the limited age range of the sample, this study is also limited in a number of other respects. First, the proposed hypotheses were not pre-registered, and this is therefore an acknowledged limitation of the study's design. Second, the student sample limits generalizability of the study's results – the obtained results may not necessarily hold for participants of varying ages, socio-economic status, or educational levels. This should be borne in mind when cautiously interpreting the results. Additionally, this study employed the use of self-report measures which are open to reporting bias, both as a result of social desirability or indeed capacity for recall. Diagnostic measures (e.g., structured clinical interviews) of the primary study variables would circumvent this issue. Objective measures of smartphone use/overuse have also been used in some studies and may provide a more reliable measure of PSU than individuals' self-report. The cross-sectional nature of this study precludes firm conclusions about the causal nature of these variables. While worry and anger may appear to be associated with PSU, longitudinal studies are required to determine the casual pathways between these psychopathological variables.

Two additional issues may, potentially, have impacted the seemingly elevated rate of clinically significant PSU. Given that participants were invited to participate following publicly placed advertisements and invitations, self-selection bias may have resulted in a preponderance of individuals for whom PSU was of interest. Additionally, the sample comprised of a significant proportion of female participants (64%), for whom previous research has demonstrated PSU may be especially problematic in comparison to their male counterparts. This disproportionate representation of females may similarly have inadvertently elevated the proportion scoring above the clinical cut-off score. A further limitation of the study's design is its lack of assessment of participants' pre-morbid affective state. Research has demonstrated that variations in participants' subjective mood as a result of seasonality (Tonetti et al., 2007) or circadian functions (Adan, 1993), for example, may introduce a degree of nuanced variation in the association between the examined variables. Future studies of the relationship between mood and PSU may wish to consider assessing, either objectively or through subjective self-report, the extent to which participant mood or affective state results from these constructs and this would likely require a longitudinal design to observe the variation in mood across time.

#### 5. Conclusion

This study demonstrates that the study of psychopathological variables that are transdiagnostic in nature – those commonly occurring across a number of discrete diagnoses – may be worthwhile foci in furthering our understanding of PSU, in particular, and of technology-based addictions more generally. Understanding the phenomenology of these novel diagnostic constructs are important as we consider

formulating their diagnostic criteria for inclusion in future iterations of diagnostic manuals.

#### Declarations

##### Author contribution statement

Zahir Vally: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

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##### Data availability statement

Data will be made available on request.

##### Declaration of interest's statement

The author declares no conflicts of interest.

##### Additional information

No additional information is available for this paper.

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