The Moderating Effect of Mindfulness on the Relationship Between Problematic Smartphone Usage and Depression, Anxiety, and Stress

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ABSTRACT. The purpose of the current study was to investigate mindfulness as a moderator in the relationship between problematic smartphone usage (PSU) and ratings of depression, anxiety, and stress. Participants were 168 undergraduates from a university in southern California, who completed an online survey measuring smartphone addiction, mental health markers, and mindfulness. The current study also investigated the relationship between one’s objective smartphone screen time and ratings of PSU, depression, anxiety, and stress through Pearson’s product-moment correlations and hierarchical regression analyses. Results indicated that, for individuals with high mindfulness, mindfulness significantly moderated the relationship between PSU and anxiety and stress, but not depression. For those high in mindfulness, higher PSU was associated with higher anxiety (B = 0.11, SE = 0.04, 95% CI [0.02, 0.19], p = .02) and stress (B = 0.12, SE = 0.05, 95% CI [-0.08, 0.09], p < .001), an unexpected finding. The relationships between PSU and both anxiety and stress were nonsignificant for those low in mindfulness (p = .80 in both cases). Among the full sample, more objective screen time was associated with more depression (r = .25, p < .001) but was not linked to PSU (r = .13, p = .13). Implications are discussed, as well as limitations and suggestions for future research.

Keywords: problematic smartphone usage, mindfulness, depression, anxiety, stress, screen time, smartphone addiction

Smartphones are widely used across the world and in the United States. Smartphones are most popular among adults aged 18–29, among whom 96% own a smartphone (Pew Research Center, 2021a). Because of the vast prevalence of smartphone use, academics have become increasingly interested in both the positive and negative implications of smartphone use. Smartphones offer the potential to foster relationships through direct communication, to provide efficiency and productivity benefits, and even offer benefits associated with education and entertainment. Research has suggested that the misuse or overuse of smartphones correlates with various aspects of psychological ill-being (Elhai et al., 2018b; Soni et al., 2017). On the other hand, research on mindfulness applications used on smartphones have found positive effects in encouraging autonomous motivation in which an individual engages in behavior consistent with their internal goals and outcomes (Bauer et al., 2017).

Problematic Smartphone Usage
Smartphone misuse is not a formal condition recognized by psychologists or established in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), and so the operational definition has varied in the literature. Several studies have referred to smartphone addiction (Demirici et al., 2015; Liu et al., 2018; Soni et al., 2017; Yang et al., 2019). Smartphone users display some commonalities to other types of addictions, however, it is imperative...
Mindfulness and Problematic Smartphone Usage

Stratton, Krumrei-Mancuso, and Miller-Perrin

(2019) found similar results in a population of smartphone usage group. Volkmer and Lemer high smartphone usage compared to the low scores were higher in the group of students with researchers found that depression and anxiety all be associated with smartphone overuse. These found depression, anxiety, and sleep quality to be correlated with excessive smartphone usage among a sample of 587 Indian students, those with less smartphone usage. In Turkey, Demirci depression, anxiety, and stress compared to those who do not. Other researchers have utilized the Mobile Phone Addiction Index (MPAI; Liu et al., 2018; Yang et al., 2019; Zhang et al., 2020). However, studies using the MPAI have only been conducted using Chinese samples.

Regardless of the definitions and terms used, PSU has been correlated with several negative psychological health outcomes. Soni et al. (2017) divided participants into three groups based on Smartphone Addiction Scale scores and found that, among a sample of 587 Indian students, those with excessive smartphone usage demonstrated higher depression, anxiety, and stress compared to those with less smartphone usage. In Turkey, Demirci et al. (2015) studied 319 university students and found depression, anxiety, and sleep quality to all be associated with smartphone overuse. These researchers found that depression and anxiety scores were higher in the group of students with high smartphone usage compared to the low smartphone usage group. Volkmer and Lemer (2019) found similar results in a population of 461 German-speaking adults who were disproportionately female (71%). The study measured well-being, satisfaction with life, and mindfulness, all of which were negatively correlated with mobile phone usage. However, gender differences were also found suggesting that the relationship between mindfulness, well-being, and mobile phone usage was different between men and women in the sample. These findings point to the importance of controlling for demographic variables, such as gender, in future samples.

In the United States, Elhai et al. (2018b) also found that increased smartphone use was related to increased levels of specific types of psychopathology, such as depression symptoms and maladaptive emotion regulation skills among an undergraduate sample of 68 undergraduate students. This study was notable for its use of a smartphone application called “Moment,” which aimed to measure participants’ objective screen time. These researchers asked students to download the app, which measured their screen time during 1 week. Results indicated that depression and expressive suppression of emotions accounted for significant variability in students’ smartphone use, which was objectively measured by their screen time. Similarly, Liu et al. (2019) conducted a study of nearly 12,000 Chinese adolescents and found an association between the total duration of one’s mobile phone use and users’ depressive symptoms. However, this study relied entirely on self-reported screen time, which asked participants how many hours they spend on their phones each day. This is likely an inaccurate measure of one’s actual smartphone use. Despite the fact that most studies on PSU have been cross-sectional and/or correlational, the quantity of research and the overlapping, consistent conclusions of researchers point to a connection between negative psychological effects and mobile phone use that is well-studied and established.

Factors Related to PSU

To understand the potential for poor outcomes associated with PSU, some researchers have begun to investigate factors that may mediate or moderate the relationship between PSU and negative psychological outcomes. However, different researchers have proposed that the relationship between one’s psychological state and PSU works in different directions. Some studies have suggested that one’s psychological state may work to shape their PSU, despite being cross-sectional. For example, Liu et al. (2019) found that self-control partially mediated...
the association between perceived stress and mobile phone addiction. Kim et al. (2015) pointed out that face-to-face communication may have a moderating role between the use of mobile phones and the development of problematic use of mobile phones.

Other studies have suggested that PSU may shape one’s psychological state. In 2017, Bauer et al. investigated the relationship between smartphone usage and autonomous motivations, defined as engaging in a behavior consistent with a person’s intrinsic goals or desired outcomes and emanating from the self. The researchers investigated autonomous motivation and mindfulness among 211 participants, aged 16–42. They found that mindfulness while using instant messaging was positively related to users’ well-being. Further, mindfulness was related to more autonomous motivations for using one’s mobile phone. The relationship between participants’ day-to-day mindfulness and positive affect from instant messaging was fully mediated by a more autonomous motivation to use instant messaging. These studies are important because they point to underlying risk factors that may be related to smartphone use and have implications for methods to protect against the negative outcomes of PSU.

Mindfulness as a Relevant Factor
Perhaps one of the most promising factors impacting PSU and psychological outcomes could be mindfulness, as discussed by Yang et al. (2019). Mindfulness is defined as a receptive state of mind in which one’s attention, informed by a sensitive awareness of what is occurring in the present, simply observes what is taking place (Brown & Ryan, 2003). Yang et al. (2019) pointed out that mindfulness could be a moderating factor with regard to mobile phone addiction and depression and anxiety because of a combination of several theories, including the mindfulness stress-buffering hypothesis and the reperceiving model of mindfulness. The mindfulness stress-buffering hypothesis posits that mindfulness can mitigate the detrimental impacts of stress on mental health outcomes. This hypothesis was described in detail by Creswell and Lindsey (2014), who stated that mindfulness mitigates stress appraisals and reduces stress reactivity responses, and that these stress reduction effects explain how mindfulness affects health outcomes. The second hypothesis, the reperceiving model of mindfulness, states that higher levels of trait mindfulness may make it easier to develop the capability of reperceiving stressful experiences, resulting in less psychological distress in response to negative experiences. Within the lens of smartphone use, more mindfulness may make it easier for a user to reperceive problematic aspects of their smartphone use (e.g., when they feel impatient or anxious when they are not holding their smartphones).

Mindfulness has been studied in relation to mobile phone use, but there are varying perspectives on the direction of the relationship between mindfulness and mobile phone use; different studies have suggested that the relationship operates in different directions. Elhai et al. (2018a) found that mindfulness mediated the relationship between depression and anxiety sensitivity with PSU, measured after 1 month. This research, which examined 261 college students, found that depression, anxiety sensitivity, and mindfulness were correlated with each other. This study assessed the undergraduate students two times, 1 month apart, using a model where depression and anxiety predicted mindfulness, in turn predicting severity of PSU after the 1 month interval. The researchers suggested that mindfulness can buffer the impact of anxious and depressive psychopathology on behavioral addictions, such as smartphone use. This mediation suggests that it is mindfulness that buffers one’s depression and anxiety, therefore reducing PSU.

Other research has suggested that this relationship may work in another direction, where mindfulness works to reduce PSU, thus reducing depression and anxiety. Apaolaza et al. (2019) provided a potential process explanation for the beneficial effect of mindfulness on the stress derived from mobile social media use. The researchers found that mindfulness has a beneficial effect on compulsive smartphone social networking site (SNS) use, stating that mindfulness decreases the likelihood of developing problematic mobile social media use. The study, which examined 346 undergraduate students in China, found that stress derived from compulsive mobile SNSs was lower in individuals higher in mindfulness. This relationship was mediated by positive effects on self-esteem, negative effects on social anxiety, and, in turn, reduced compulsive mobile SNS use. The process presented by Apaolaza et al. would suggest that mindfulness decreases compulsive mobile use. This study used the social media site WhatsApp to measure compulsive use. However, the use of WhatsApp may or may not be considered a social media site in the United States, where social media use primarily includes sites such as Facebook, Instagram, and Twitter, where a defining feature includes posts to public
audiences. These applications offer different uses from the limited direct messaging functioning of applications such as WhatsApp. Because different smartphone applications are different in nature, this study may not be generalizable to a United States population where WhatsApp is used by a much smaller percent of adults than other social media sites (Pew Research Center, 2021b), or to the misuse of smartphones in general.

Yang et al. (2019) also found that mindfulness moderated the relationship between mobile phone addiction and its negative effects in a similar way. The study examined 1,258 Chinese high school students and found that the associations between mobile phone addiction and anxiety/depression were weaker among adolescents with higher levels of mindfulness compared to those with lower levels of mindfulness. This study further investigated the relationship suggested by Apaolaza et al. (2019) that mindfulness may lead to less PSU, however, it used a Chinese sample. American and Chinese students likely do not use their smartphones in the same ways. Therefore, it would be valuable to extend this research to examine the effects of mindfulness on PSU in a sample of American undergraduate students. Data from Pew Research (2019) suggested that smartphones are more popular among adults aged 18–29 than any other age bracket, and that college-educated adults displayed a greater percentage of using smartphones than any other education bracket. This points to a need to study moderating factors of PSU, such as mindfulness, among a sample of U.S. undergraduate students.

**Purpose of the Current Study**

The purpose of the current study was to evaluate the moderating effect of mindfulness between PSU and depression, anxiety, and stress ratings among a sample of US college students. We hypothesized that one’s PSU would be positively correlated with one’s ratings of depression, anxiety, and stress, and negatively correlated with mindfulness (Hypothesis 1). Further, we expected that mindfulness would moderate the associations between PSU and depression, anxiety, and stress, such that participants with higher mindfulness scores would demonstrate weaker associations between PSU and depression, anxiety, and stress (Hypothesis 2). In other words, we examined mindfulness as a moderating factor (Baron & Kenny, 1986). We also hypothesized that objective daily average smartphone screen time would be positively correlated with ratings of PSU, and depression, anxiety, and stress (Hypothesis 3).

**Method**

**Participants**

This study included a convenience sample of 168 undergraduate students enrolled in foundational psychology courses at a small, private, liberal-arts university in Southern California. Participants ranged in age from 18 to 25 years ($M_{age} = 19.18, SD = 1.36$). Participants who did not answer at least 95% of items on the survey were excluded from data analysis ($n = 7$). To minimize the effects of selection bias and maximize power, four participants who skipped only one item on a scale were retained in the analyses, and missing data were replaced with each participant’s mean value for other responses on the scale.$^1$

Among the final sample, 63.7% identified as women, 35.7% men, 0.6% gender nonconforming. The ethnicity of participants was similar to the population of the college. The most common race reported was White (54.8%), followed by 13.1% Asian, 11.3% Multiracial, 8.9% Latinx, 7.1% Asian American, and 4.8% African American. Approximately 92% of the sample reported using an Apple iPhone, and 100% of the sample reported using a smartphone in their day-to-day life.

**Procedure**

Participants were recruited using an online research participation management system, and data were collected through an online survey. Before beginning the survey, each participant was presented with an informed consent form, and the study was approved by the university’s Institutional Research Review Board (Protocol # 20-04-1351). Participants received one research participation credit toward the four total credits required for their psychology course.

Participants completed the survey online, which required approximately 10 minutes. Participants completed the following scales: Smartphone Addiction Scale-Short Version (Kwon et al., 2013), Mindful Attention Awareness Scale (Brown & Ryan, 2003), and the Depression Anxiety Stress Scale-21 (DASS-21; Lovibond & Lovibond, 1995).

The questionnaire was partially counterbalanced to control for order effects. Half of the participants were randomly assigned to a survey, which presented the DASS-21 first, followed by the Mindful Attention Awareness Scale, while the other half of participants completed the scales in

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$^1$ Analysis was also conducted excluding the four participants, and the significance of results did not change, thus we proceeded with our method.
the reverse order. The Smartphone Addiction Scale was presented third in both versions of the survey in order to prevent completion of this scale from influencing responses on the other measures. The final items on the questionnaire included demographic information and items that addressed participants’ daily average smartphone screen time. Participants were presented with directions on how to locate their daily average screen time in their iPhone settings. From there, participants were asked to self-report their daily average smartphone screen time. Next, an item asked participants to upload a screenshot of their daily average smartphone screen time. This item assessed the validity of participants’ survey responses by collecting the average daily screen time measured by their smartphone.

**Measures**

**Problematic Smartphone Usage**

Participants’ PSU was assessed using the 10-item Smartphone Addiction Scale-Short Version (Kwon et al., 2013). Example items included, “Based on your current situation, to what extent do you agree with the following statements?” “Using my smartphone longer than I had intended,” “Having my smartphone in my mind even when I am not using it,” and “Feeling impatient and fretful when I am not holding my smartphone.” Items were rated on a Likert-type scale ranging from 1 (strongly disagree) to 6 (strongly agree), which measured health and social impairment from smartphone use, as well as symptoms of tolerance and withdrawal. The total score was calculated by summing the responses to all items and scores can range from 10–60. Higher scores represent greater tendencies toward smartphone addiction. Cronbach’s alpha was reported by the test developers to be .91, using adolescent school-aged children in South Korea (Kwon et al., 2013). Internal consistency reliability for the current sample using Cronbach’s alpha was .83.

**Dispositional Mindfulness**

Participants’ dispositional mindfulness was assessed using the 15-item Mindful Attention Awareness Scale (Brown & Ryan, 2003). Items included statements such as “I find myself doing things without paying attention,” “I snack without being aware that I’m eating,” and “I forget a person’s name almost as soon as I’ve been told it for the first time.” Items were rated on a Likert-type scale ranging from 1 (almost always) to 6 (almost never). Total scores were calculated by computing the mean score for all items, which can range from 1–6, with higher scores representing higher dispositional mindfulness. Cronbach’s alpha was reported by the test developers at .87, using an adult population (Brown & Ryan, 2003). In the current sample, internal consistency reliability using Cronbach’s alpha was .85.

**Psychological Functioning**

The psychological functioning of participants was evaluated using the DASS-21 (Lovibond & Lovibond, 1995). The DASS-21 is a set of three scales designed to measure depression, anxiety, and stress. The instructions asked respondents to indicate “how much each statement applied to you over the past week.” Items were rated on a Likert-type scale, ranging from 0 (did not apply to me at all) to 3 (applied to me very much, or most of the time).

The DASS-21 included three subscales with 7 items each. The Depression subscale included items such as “I couldn’t seem to experience any positive feeling at all” and measured components such as dysphoria, hopelessness, devaluation of life, self-deprecation, lack of interest/involvement, anhedonia and inertia. The Anxiety subscale included items such as “I felt I was close to panic” and measured autonomic arousal, skeletal muscle effects, situational anxiety, and subjective experience of anxious affect. The Stress subscale included items such as “I found it difficult to relax” and measured difficulty relaxing, nervous arousal, and being easily upset/agitated, irritable/over-reactive and impatient.

Scores on the DASS-21 included three separate scores for the three subscales: Depression, Anxiety, and Stress, which were calculated by summing the responses for the 7 applicable items. Internal consistency of the DASS-21 was evaluated by the test authors and was strong: (Depression \( \alpha = .91 \); Anxiety \( \alpha = .84 \); Stress \( \alpha = .90 \); Lovibond & Lovibond, 1995). The DASS-21 Anxiety subscale is generally highly correlated with the Beck Anxiety Scale \( (r = .81) \), and the Depression subscale is strongly correlated with the Beck Depression Scale \( (r = .74) \), suggesting good validity of these subscales (Lovibond & Lovibond, 1995). In the current sample, internal consistency reliability using Cronbach’s alpha was found to be .88 for DASS-21 Depression, .77 for DASS-21 Anxiety, and .79 for DASS-21 Stress subscales.

**Demographic Questionnaire and Validity Checks**

Demographic information was collected including age, sex, ethnicity, and socioeconomic status. Two
items on the demographic questionnaire also asked respondents to indicate if they owned and operated a smartphone: “Do you own a personal smartphone that is used in your day-to-day life?” If this question was answered affirmatively, the next question asked was: “Do you own an iPhone that is used in your day-to-day life?”

The last section of the demographic questionnaire concerned participants’ smartphone screen-time report, measured by the smartphone company on every iPhone and Android, the self-report of daily average smartphone screen time, and a validity question. An item instructed respondents as follows: “For the next item, you will be asked to utilize data from your phone’s Screen Time Report. Please go to your phone settings and scroll to ‘Screen Time.’” After participants checked a box indicating that this step had been completed, an item asked respondents: “What is your daily average screen time?” This value is calculated by phone manufacturers by averaging the user’s daily screen time over the past week. Respondents reported this number with an open-ended text response. The next item on the questionnaire requested that respondents upload a screenshot of their screen-time report, which we used to verify the self-reported responses. The final item on the questionnaire asked respondents to indicate whether their responses should be used for research purposes. The item read: “Did you answer each item honest and thoughtfully?” with two options: “Yes, my responses are valid” or “No, my responses should be thrown out.” This item was used to ensure the validity of participants’ responses.

### TABLE 1

<table>
<thead>
<tr>
<th>Scale</th>
<th>M</th>
<th>SD</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PSU</td>
<td>30.08</td>
<td>8.70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2. Depression</td>
<td>6.29</td>
<td>4.69</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Anxiety</td>
<td>5.16</td>
<td>3.91</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>4. Stress</td>
<td>8.15</td>
<td>4.14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Mindfulness</td>
<td>3.61</td>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Obs ST</td>
<td>311.31</td>
<td>144.41</td>
<td>.13</td>
<td>.25</td>
<td>.13</td>
<td>.08</td>
<td>.01</td>
<td>.06</td>
<td>.21</td>
</tr>
<tr>
<td>8. ST Diff</td>
<td>−5.35</td>
<td>38.50</td>
<td>.58</td>
<td>−14</td>
<td>−01</td>
<td>−08</td>
<td>−04</td>
<td>.06</td>
<td>.21</td>
</tr>
</tbody>
</table>

Note: PSU = problematic smartphone usage; Self-report ST = self-report screen time; Obj ST = objective screen time; ST Diff = difference between objective and self-reported screen time.

Results

### Preliminary Analyses

Based on previous literature (Salari et al., 2020), we included gender as a control variable in analyses including measures of stress. Indeed, a *t* test conducted with the current sample indicated significant gender differences in ratings of stress (*t* = 2.22, *df* = 165, *p* = .04), with women (M = 8.66, SD = 3.85) reporting more stress than men (M = 7.27, SD = 4.52). Men and women did not differ on ratings of PSU (t = 1.58, df = 165, p = .12), depression (t = 1.33, df = 165, p = .18), anxiety (t = 1.69, df = 165, p = .09), or mindfulness (t = −1.47, df = 165, p = .14).

We also examined the relationship between age and our variables of interest. Age was not significantly correlated with PSU (r = −0.05, *p* = .50), depression (r = −0.05, *p* = .56), anxiety (r = .00, *p* = .98), stress (r = .01, *p* = .93), or mindfulness (r = −0.07, *p* = .37). Means and standard deviations for all dependent measures are displayed in Table 1.

We conducted 10 one-way ANOVAs to determine if group differences existed on the variables of interest based on ethnicity or income. Five one-way ANOVAs found no significant group differences based on ethnicity for ratings of PSU, F(5, 162) = 0.98, *p* = .43, η² = .03, depression, F(5, 162) = 1.21, *p* = .31, η² = .04, anxiety, F(5, 162) = 0.37, *p* = .87, η² = .01, stress, F(5, 162) = 0.45, *p* = .82, η² = .01, or mindfulness, F(5, 162) = 0.66, *p* = .66, η² = .01, scores. A second series of five one-way ANOVAs found no significant group differences based on income for ratings of PSU, F(6, 161) = 0.58, *p* = .75, η² = .02, depression, F(6, 161) = 1.62, *p* = .15, η² = .06, anxiety, F(6, 161) = 0.65, *p* = .69, η² = .02, stress, F(6, 161) = 0.64, *p* = .70, η² = .02, or mindfulness, F(6, 161) = 0.20, *p* = .98, η² = .01, scores.

### Primary Analyses

#### Hypothesis 1: Factors Related to PSU

To examine the relationships between all variables, we conducted Pearson product moment correlations. PSU was significantly positively correlated with depression (r = .28, *p* < .001), anxiety (r = .24, *p* < .001), and stress (r = .27, *p* < .001). PSU was significantly negatively correlated with mindfulness (r = −.32, *p* < .001; see Table 1).

#### Hypothesis 2: Mindfulness as a Moderator Between PSU and Depression, Anxiety, and Stress

We conducted three hierarchical regression analyses to examine whether mindfulness would
moderate links between PSU and depression, anxiety, and stress. The results of these analyses are displayed in Table 2.

We conducted a hierarchical regression analysis to examine the moderating effect of mindfulness in the relationship between PSU and depression scores. In Step 1, we entered PSU, which accounted for 7.6% of the variance in ratings of depression. In the second step, mindfulness was added to the model and accounted for 14.3% of the variance in ratings of depression. In the third step, the interaction between mindfulness and PSU was not a significant predictor of depression scores.

We conducted a hierarchical regression analysis to examine the moderating effect of mindfulness in the relationship between PSU and anxiety scores. PSU was entered in Step 1, accounting for 5.6% of the variance in ratings of anxiety. In Step 2, we entered mindfulness, which accounted for 17.1% of the variance in anxiety. In the third and final step, mindfulness significantly moderated links between PSU and anxiety, accounting for 2.0% of the variance. Post-hoc probing demonstrated that there was a positive relationship between PSU and anxiety for individuals high in mindfulness (1 SD above the mean; $B = 0.11, SE = 0.04, 95\% CI [0.02, 0.19], p = .02$), but no relationship between PSU and anxiety for those low in mindfulness (1 SD below the mean; $B = -0.01, SE = 0.04, 95\% CI [-0.09, 0.07], p = .80$). Results of the post-hoc probing are displayed in Figure 1.

We conducted a hierarchical regression analysis to examine the moderating effect of mindfulness in the relationship between PSU and stress scores, while controlling for gender. The control variable of gender was entered in the first step, because previous research and our preliminary analyses found significant differences between men and women on ratings of stress. Gender accounted for 2.3% of the variance in ratings of stress. Step 2 included PSU, accounting for 6.4% of the variance in ratings of stress. Mindfulness accounted for 15.9% of the variance in ratings of stress in Step 3. In Step 4, mindfulness significantly moderated links between PSU and stress, accounting for 1.8% of the variance. While controlling for gender, post-hoc probing found that the relationship between PSU and stress was significant for individuals high in mindfulness (1 SD above the mean; $B = 0.12, SE = 0.05, 95\% CI [0.03, 0.21], p < .001$), but not for those low in mindfulness (1 SD below the mean; $B = .01, SE = 0.04, 95\% CI [-0.08, 0.09], p = .80$). Results of the post-hoc probing are displayed in Figure 2.

**Hypothesis 3: Screen-Time Analyses**

Screen-time ratings demonstrated few correlations to the other variables. Objective daily average screen time was not significantly correlated with

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**TABLE 2**

<table>
<thead>
<tr>
<th>Hierarchical Regression Analyses Examining Predictions of Depression, Anxiety, and Stress</th>
<th>$B(SE)$</th>
<th>95%CI</th>
<th>$\beta$</th>
<th>$\Delta R^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Depression</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 1</td>
<td>.08**</td>
<td>0.15 (0.04)</td>
<td>0.07, 0.23</td>
<td>.28</td>
</tr>
<tr>
<td>PSU</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>.14**</td>
<td>0.08 (0.04)</td>
<td>0.00, 0.16</td>
<td>.15</td>
</tr>
<tr>
<td>Mindfulness</td>
<td>−2.48 (0.45)</td>
<td>−3.38, −1.59</td>
<td>−.40</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td></td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSU*Mindfulness</td>
<td>0.03 (0.05)</td>
<td>0.00, 0.12</td>
<td>.04</td>
<td></td>
</tr>
<tr>
<td><strong>Anxiety</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 1</td>
<td>.06**</td>
<td>0.11 (0.03)</td>
<td>0.04, 0.17</td>
<td>.24</td>
</tr>
<tr>
<td>PSU</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>.17**</td>
<td>0.05 (0.03)</td>
<td>−0.02, 0.11</td>
<td>.10</td>
</tr>
<tr>
<td>Mindfulness</td>
<td>−2.27 (0.38)</td>
<td>−3.01, −1.53</td>
<td>−.44</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td></td>
<td>0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSU*Mindfulness</td>
<td>0.05 (0.03)</td>
<td>−0.02, 0.11</td>
<td>.11</td>
<td></td>
</tr>
<tr>
<td><strong>Stress</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 1</td>
<td></td>
<td>−1.12 (0.57)</td>
<td>−2.25, 0.01</td>
<td>−.15</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 2</td>
<td>.06**</td>
<td>−0.85 (0.56)</td>
<td>−1.96, 0.25</td>
<td>−.12</td>
</tr>
<tr>
<td>PSU</td>
<td>0.12 (0.04)</td>
<td>0.05, 0.20</td>
<td>.26</td>
<td></td>
</tr>
<tr>
<td>Step 3</td>
<td></td>
<td>.16**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>−0.60 (0.51)</td>
<td>−1.61, 0.41</td>
<td>−.08</td>
<td></td>
</tr>
<tr>
<td>PSU</td>
<td>0.06 (0.03)</td>
<td>−0.01, 0.13</td>
<td>.13</td>
<td></td>
</tr>
<tr>
<td>Mindfulness</td>
<td>−2.31 (0.39)</td>
<td>−3.09, −1.54</td>
<td>−.43</td>
<td></td>
</tr>
<tr>
<td>Step 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>−0.49 (0.51)</td>
<td>−1.49, 0.52</td>
<td>−.07</td>
<td></td>
</tr>
<tr>
<td>PSU</td>
<td>0.06 (0.03)</td>
<td>−0.00, 0.13</td>
<td>.14</td>
<td></td>
</tr>
<tr>
<td>Mindfulness</td>
<td>−2.30 (0.39)</td>
<td>−3.07, −1.53</td>
<td>−.42</td>
<td></td>
</tr>
<tr>
<td><strong>PSU*Mindfulness</strong></td>
<td>0.08 (0.04)</td>
<td>0.00, 0.16</td>
<td>.14</td>
<td></td>
</tr>
</tbody>
</table>

Note. PSU = problematic smartphone usage; PSU*Mindfulness = interaction between problematic smartphone usage and mindfulness. $p < .05$, $*p < .001$. 

---
PSU ($r = .13, p = .13$), anxiety ($r = .13, p = .13$), or stress ($r = .08, p = .35$). Objective daily screen time was significantly positively correlated with depression ($r = .25, p < .001$) and self-report screen time ($r = .96, p < .001$).

The difference between participants’ self-reported screen time and objective daily screen time was calculated by subtracting the self-report screen time from the objective daily screen-time measure, in order to calculate a measure of screen-time underestimation. Of the 132 participants who reported both measures of screen time, the mean difference was only $–5.35$ minutes ($SD = 8.50$) per day. A paired-samples $t$ test indicated that there was no significant difference between the measure of objective daily screen time ($M = 311.31, SE = 12.57$) and self-reported screen time ($M = 305.96, SE = 12.31$), $t = –1.60, df = 131, p = .11$.

A regression analysis was conducted to investigate the predictive power of objective daily screen time in predicting ratings of PSU. In the analysis, objective daily screen time was not a significant predictor of PSU, $F(1, 131) = 2.36, B = 0.01, CI [0.00, 0.02], p = .13$.

**Discussion**

The current study examined the moderating effect of mindfulness in the relationship between PSU and the mental health indicators of depression, anxiety, and stress scores.

**Factors Related to PSU**

Our first hypothesis that PSU would be positively associated with depression, anxiety, and stress, and negatively associated with mindfulness was supported. PSU was associated with higher levels of depression, anxiety, and stress, accounting for between 5.6 and 7.6% of the variance in these outcomes. This suggests that, on average, as PSU increased, so did participants’ levels of depression, anxiety, and stress. These findings support previous research on the negative psychological outcomes associated with PSU (Apoalaza et al., 2019; Demirci et. al., 2015; Soni et al., 2017; Yang et al., 2019). However, longitudinal research is needed to establish directionality among these variables. If it is found that PSU leads to mental health concerns, this highlights the importance of developing interventions to address PSU, which may in turn decrease negative effects such as anxiety, depression, or stress.

We observed a significant negative correlation between PSU and mindfulness. In general, greater levels of PSU were related to lower levels of mindfulness. This supports previous research that has begun to investigate the relationship between PSU and mindfulness (Bauer et al., 2017; Elhai et al., 2018a; Volkmer & Lerner, 2019; Yang et al., 2019; Zhang et al., 2020). It is possible that mindfulness might be a mitigating factor that protects individuals from developing PSU. On the other hand, PSU may decrease one’s sense of mindfulness. Longitudinal research is needed to determine the direction of this relationship.

**Mindfulness as a Moderator Between PSU and Depression, Anxiety, and Stress**

Our second hypothesis that participants who were higher in mindfulness would display weaker associations between PSU and depression, anxiety, and stress than those with lower levels of mindfulness
was not supported. In fact, we found the opposite. Mindfulness moderated the relationship between PSU and anxiety and stress, with post-hoc probing indicating that, for those high in mindfulness, more PSU was associated with higher anxiety and stress. For those low in mindfulness, there was no association between PSU and anxiety and stress. Mindfulness did not moderate the relationship between PSU and depression.

These findings might be due to the fact that individuals higher in mindfulness could be more mindful of the general impacts of their own PSU, which causes the individual greater anxiety and stress. PSU may be more detrimental for those high in mindfulness because it goes against their typical identity as a person who typically displays high levels of attentive awareness. Those low in mindfulness may not demonstrate a significant link between PSU and anxiety and stress because they are not attentive to their excess PSU or because their smartphone use habits may not clash with their values as it does for the high mindfulness group.

The moderating effect of mindfulness on the relationship between PSU and anxiety contradicts previous research by Yang et al. (2019), as the moderation relationships worked in opposite directions. Yang et al. (2019) found that the relationship between PSU and anxiety was weaker among those high in mindfulness because it goes against their typical identity as a person who typically displays high levels of attentive awareness. Those low in mindfulness may not demonstrate a significant link between PSU and anxiety and stress because they are not attentive to their excess PSU or because their smartphone use habits may not clash with their values as it does for the high mindfulness group.

The current study also failed to replicate a finding of Yang et al. (2019) that mindfulness moderated the relationship between PSU and depression. Data from the current study did not support the moderating power of mindfulness in analyses examining depression. The differing results between the two studies could be due to the fact that students in a Chinese sample and in a U.S. sample use their smartphones differently. A study by Xu and Mocarski (2014) showed that students’ social media usage reflected their cultural values. It could similarly be true that cultural pressure shapes the way that a person perceives their excessive smartphone use. Perhaps in American culture, a person’s mindful awareness of their PSU causes greater anxiety because of cultural pressure to minimize screen time.

**Links Between Screen Time and PSU**

Our research also investigated the relationship of screen time to PSU. We found that objective daily screen time was not a significant predictor of PSU. This supports findings by Elhai et al. (2018b), who measured smartphone screen time over the course of one week.

The paired-samples t test did not indicate significant differences between objective and self-reported screen time, which implies that overall, the sample was fairly accurate in estimating their screen time. This challenges previous assertions by Elhai et al. (2018b) that self-report has consistently been found to be an inaccurate measure of objective screen time. Our study suggests that there are specific methods that can be used to achieve fairly accurate self-report data of screen time. Specifically, in the current study, we directed participants on how to find an objective measure of their daily screen time before self-reporting the value, which is a unique approach from other studies (e.g., Liu et al., 2017). The overall findings of the current study regarding screen time suggest that what matters more in developing PSU is not how much time an individual uses their phone, but rather, how the individual uses their phone. There are likely individual differences in how people use their phones, such that some people may have high screen time but may not demonstrate PSU due to the nature of their smartphone usage. Perhaps some people engage in self-improvement or meaningful relational activities through their smartphones, or work or engage in school activities from their smartphones, all of which may increase their screen time without increasing PSU.

**Limitations**

The current findings were likely influenced by the study’s timing, which occurred during the COVID-19 lockdown. The university where data were collected had transitioned from in-person classes to online classes prior to data collection, thus all participants were taking online classes. It is possible that at least some participants in the study had greater objective screen time during the study period than during normal circumstances due to circumstances of the lockdown, which required greater reliance on technology. Some participants might have relied on their smartphones for online classes, which would add hours of screen time each day that would not have been the case during normal circumstances. Outside of lockdown, when classes and work responsibilities take place in-person and not online, the time spent on daily responsibilities (such as work and school) would be separate from screen time, as opposed to the current circumstances which may require smartphone use for those same responsibilities.

In addition to increasing one’s total screen time, it is also likely that participants were using...
their smartphones in generally different ways during these circumstances than before the COVID-19 pandemic. Individuals likely became more reliant on their smartphones for not only work or school, but also connectedness, entertainment, and productivity. This difference would be especially prevalent among a college student population. The primary limitation then is the vast variability in what students are doing on their smartphones that is classified as problematic. Is a student using their smartphone problematically to post on social media? Or is that student online shopping, gaming, or messaging? Smartphone use is both subjective and diverse.

Limitations also surround the generalizability of the current sample, all of whom attended the same private, Christian university. It is possible that the university’s generally safe campus, religious affiliations, and temperate climate each play a role in shaping not only students’ general smartphone usage but also mental health correlates. Because of how many factors can shape students’ mental health ratings, we cannot assume the observed relationships between mindfulness, smartphone usage, and depression, anxiety, or stress would generalize to other populations.

Future Research

Future research should consider replicating the current study during normal circumstances, outside of the COVID-19 pandemic, to investigate the generalizability of the results. Research should aim to evaluate a sample with greater demographic diversity, in terms of both ethnicity and socioeconomic status. Research may benefit from a more specific measure of objective screen time that would offer insights beyond the total average minutes spent on one’s phone each day. For example, an objective measure of screen time that indicates the time spent within each smartphone application, such as email, video chat, and social media platforms could help provide valuable insight into the relationship between screen-time ratings and PSU, as well as its negative implications. Overall, future research should consider the mechanisms behind PSU in order to further the theoretical and conceptual understanding of the condition. This insight may give way to more precise definitions and measures of PSU.

The current study is unique in the finding that PSU might lead to greater anxiety and stress among individuals high in mindfulness, but not among those low in mindfulness. It is likely, though, that the relationship between PSU and anxiety and stress is bidirectional, as evidenced by existing research (Elhai et al., 2018b). Future research should consider an experimental approach to provide greater insight into causality.

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Salari, N., Hosseinian-Far, A., Jalali, R., Vaisi-Raygani, A., Rasoulopoor, S., Mohammadi, M., Rasoulopoor, S., & Khalede-Paveh, B. (2020). Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic. Individuals likely became more reliant on their smartphones for not only work or school, but also connectedness, entertainment, and productivity. This difference would be especially prevalent among a college student population. The primary limitation then is the vast variability in what students are doing on their smartphones that is classified as problematic. Is a student using their smartphone problematically to post on social media? Or is that student online shopping, gaming, or messaging? Smartphone use is both subjective and diverse.

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