A systematic review on relationship between stress and problematic smartphone use

Boon Yew Wong[1], Kee Jiar Yeo[1], Lina Handayani[2]
[1]School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia, Johor Bahru, Malaysia
[2]Faculty of Public Health, Universitas Ahmad Dahlan, Yogyakarta, Indonesia

Article Info	ABSTRACT
	This study systematically reviewed the existing research on relationship between stress and problematic smartphone use. It aimed to provide an aggregative view of the existing research findings on relationship between stress and problematic smartphone use and how these researches are conducted (i.e., research designs, sampling techniques, sample characteristics, measurement scales, data analysis techniques). A thorough literature research in five bibliographic databases (Taylor & Francis, Wiley, SAGE, SpringerLink, ScienceDirect), Google Scholars, and previous review papers has resulted in 35 studies being included in this review. This review has found that the existing empirical evidence generally demonstrated that i) stress can cause problematic smartphone use; ii) the effect of stress on problematic smartphone use is not straightforward but transmitted by other variables (i.e., mediator), and iii) the effect of stress on problematic smartphone use varies as a function of context or individual differences (i.e., moderator). Finally, following a thorough review of their methodological information, this review has also identified the strengths and limitations of the existing studies on relationship between stress and problematic smartphone use, as well as potential directions of research.

Corresponding Author:

Boon Yew Wong
School of Education, Faculty of Social Sciences and Humanities, Universiti Teknologi Malaysia,
Johor Bahru, Johor, Malaysia
Email: boonyew1234@gmail.com

1. INTRODUCTION

Smartphone is a mobile phone equipped with advanced computing capacity. Since its introduction in 2007, smartphone has been an integral part of both personal and work lives. It is not only used for social communication (e.g., phone call, text messaging, or social media), entertainment (e.g., games or youtube), but also many other purposes such as seeking information, online shopping, or learning. On the other hand, given its tiny size, smartphone possesses high portability. It can easily fit into pocket or bag, enabling users to access their smartphone anywhere and anytime [1]. Given the multifunctionality and high accessibility of smartphone, users can easily spend substantial amount of time on smartphone use, which can potentially cause disruption to their work or social obligations and subsequently cause adverse consequences [1]

Despite the recognition that spending too much time on smartphone use can potentially cause disruption to work or social obligations and subsequently cause adverse consequences, many people insist doing it [1]. In the existing literature, one relevant construct is problematic smartphone use, which has been defined as the use or persistent use of smartphone despite the recognition that it can cause daily life disturbances or adverse consequences [2]. Numerous studies have found that problematic smartphone use is highly prevalent across countries especially among adolescents and young adults [3]-[5]. Furthermore,

scholars have revealed that problematic smartphone use is associated with various adverse consequences such as sleep impairments [6], [7], musculoskeletal pain [8], poor physical fitness [9], and poor academic or work performance [10]. Given the prevalence of problematic smartphone use across countries and its associated adverse consequences, scholars have highlighted the need identify the factors that can cause problematic smartphone use [11].

Stress, defined as the negative affective states evoked by perceived inability to cope with life problems or difficulties, has been widely recognized as one of the most significant risk factors leading to problematic smartphone use [12]-[15]. In the existing literature, use and gratification theory (UGT) has been applied to shed light on the link between stress and problematic smartphone use. More specifically, use and gratification theory (UGT) assumes that i) media or technology use is driven by the needs individuals want to gratify (e.g., relaxation, stress relief, socialization), ii) such needs are mainly originated from psychological circumstances (e.g., stress , loneliness), iii) while media or technology use may result in the gratifications of needs, it can also cause unintended negative consequences, and iv) if the use of certain media or technology is found to be effective in gratifying the needs induced by psychological circumstances, individuals tend to repeat or continue using [16].

Based on these assumptions, with regard to the relationship between stress and problematic smartphone use, scholars have argued that when being confronted with life problems or difficulties and feeling psychologically distressed by them, individuals are likely to be motivated to use smartphone or certain smartphone features (e.g., games, watching videos, social media) in order to temporarily flee from the problems or difficulties bothering them and alleviate their associated negative emotions [13], [17]-[20]. While the use of smartphone or certain smartphone features (e.g., games, watching videos, social media) is usually seen as an effective way to temporarily flee from life problems or difficulties and neutralize their associated distress emotions, scholars have pointed out that it does not help in addressing life problems or difficulties. Instead, it draws the attention of individuals away from the problems or difficulties that need to be solved and hinders the development of corresponding solutions, which can potentially lead to problematic outcomes [1], [13], [17]. To illustrate, when being confronted with academic problems (e.g., difficult learning tasks, excessive academic assignments), if students choose to engage in smartphone use for temporary escape but not address the academic problems they are facing, problematic outcomes are likely to follow (e.g., poor academic grades, missing submission deadlines) [12], [18].

Furthermore, scholars have pointed out that, individuals who feel stressed by life problems or difficulties and need temporary escape from the life problems or difficulties bothering them or alleviation of their associated distress emotions may tend to repeat or continue using smartphone or certain smartphone features (e.g., games, social media) if they find that such use can effectively accommodate their need, even they have recognized that it can potentially cause adverse consequences [1], [18]-[20]. Based on these, scholars have argued that individuals who face life problems or difficulties and feeling psychologically distressed are particularly prone to engage in problematic smartphone use [18]-[20]. These are corroborated by numerous empirical studies that have found positive relationship between stress and problematic smartphone use [13]-[15], [17], [19]-[24]. Although numerous studies are conducted to investigate the relationship between stress and problematic smartphone use, scholars have highlighted that these studies are conducted with different research designs (e.g., cross-sectional vs longitudinal), sampling techniques (eg: convenience vs random), sample types (e.g., students vs non-student adults), measures of stress/problematic smartphone use, and data analysis techniques (eg: correlation vs regression or mediation vs moderation) [1], [25]. Furthermore, scholars have also pointed out that their research findings appear to be mixed. More specifically, some studies have found statistically positive relationship between stress and problematic smartphone use whereas others found insignificant relationship [1]. Inspired by these, scholars have argued that, instead of leaving a body of isolated or scattered research findings on relationship between stress and problematic smartphone use, researchers should summarize the existing research findings and how these researches are conducted (i.e., research designs, sampling techniques, sample characteristics, measurement scales, data analysis techniques) [1], [25].

Accordingly, Elhai *et al.* [1], Vahedi and Saiphoo [25], and Sohn *et al.* [26] have recently reviewed the research on relationship between stress and problematic smartphone use. However, these recently published reviews have only covered very limited number of studies on relationship between stress and problematic smartphone use. Specifically, Elhai *et al.* [1] and Vahedi and Saiphoo [25] have each covered only six studies and Sohn *et al.* [26] has covered only five studies on relationship between stress and problematic smartphone use in their reviews. Furthermore, the review conducted by Elhai *et al.* [1] and Vahedi and Saiphoo [25] have only covered studies up to year 2016 and Sohn *et al.* [26] has only covered studies up to year 2017. In this regard, it is worth to note that the literature on relationship between stress and problematic smartphone use has grown rapidly in recent years. As a result, many newer studies studying the relationship between stress and problematic smartphone use are not covered in their review. Inspired by

these, this study systematically reviews the studies on relationship between stress and problematic smartphone use up to the year 2022. The purpose of this systematic review is to provide an aggregative view of the existing empirical evidences on relationship between stress and problematic smartphone use and how the existing researches on relationship between stress and problematic smartphone use are conducted (i.e., research designs, sampling techniques, sample characteristics, measurement scales, data analysis techniques), and identify research gaps that can inform the potential areas for future research.

2. RESEARCH METHOD

This review was conducted according to the step-by-step procedures of Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) as shown in Figure 1. Literature search in this review involved two main stages: i) primary literature search and ii) supplemental literature search. In primary literature search, a literature search is first conducted on March 5, 2022 in five major bibliographic databases (Taylor & Francis, Wiley, SAGE, SpringerLink, and ScienceDirect). In combination with Boolean operators (i.e., AND/OR), the keywords used in the literature search are ("smartphone addiction" OR "problematic smartphone use" OR "excessive smartphone use" OR "smartphone dependence") AND ("stress" OR "stressor" OR "stressful life event"). Furthermore, given the fact that the first smartphone was introduced in 2007, this study only targets those studies published after 2007. Specifically, this study limited its literature search to only studies published in the year 2008 to 2022.

Upon completion of literature search on the five bibliographic databases, all identified citations are imported into Endnote X9. Subsequently, the duplicates are electronically identified and removed. After removing duplicates, the titles and abstracts of the identified citations are evaluated to preliminarily determine whether they are suitable to be included in this review. After evaluating the titles and abstracts, the full text of the citations preliminarily deemed suitable for this review are retrieved to further determine whether they are eligible to be included in the final review. Regarding the inclusion criteria, this study only includes studies with the following characteristics: i) written in English, ii) published in peer-reviewed journals, iii) involved standardized (i.e., can be administered across participants in a consistent manner) and quantifiable measure of stress and problematic smartphone use, and iv) reported standardized correlation coefficients (R) and/or beta regression coefficients (β) for the relationship between stress and problematic smartphone use. Furthermore, this study also excludes studies with the following characteristics i) conference papers, ii) review papers iii) incomplete statistical information (e.g., p-value), iv) scales used to measure stress and/or problematic smartphone use are not accessible, and v) considers technostress (a specific type of stress related to information/communication overload caused by high accessibility of smartphone) and its relationship with problematic smartphone use.

Regarding supplemental literature search, with the aim to identify relevant studies that may be overlooked in primary literature search, this study has also conducted a literature search on March 12, 2022 in Google Scholar with the same keywords and screened the reference list of the existing review papers [1], [25], [26]. These studies are subsequently assessed based on the inclusion and exclusion criteria previously highlighted to determine whether they are eligible to be included in the final review. Finally, a set of study characteristics is extracted and inserted in a spreadsheet, which include; i) sample characteristic (sampling techniques, sample type, sample size), ii) location of study, iii) research design (e.g., cross-sectional/longitudinal), iv) stress types studied (e.g., academic/social), stress measures, and the approach to measure stress (e.g., transactional-focused/response-focused/stimulus-focused), v) problematic smartphone use measures, vi) data analysis techniques, and lastly vii) findings/results on relationship between stress and problematic smartphone use as presented in Table 1.
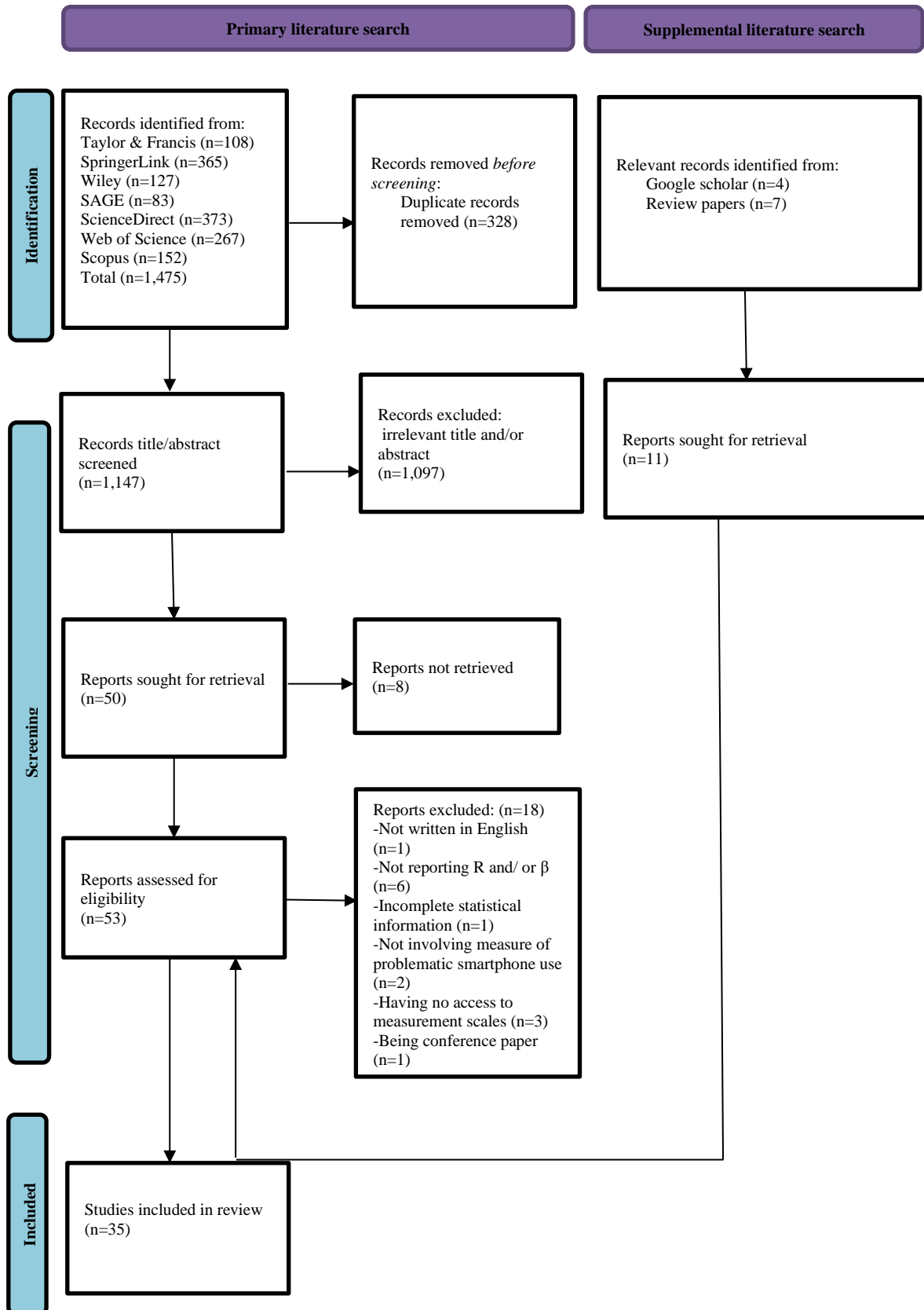
Primary literature search	Supplemental literature search

Identification

Records identified from:
Taylor & Francis (n=108)
SpringerLink (n=365)
Wiley (n=127)
SAGE (n=83)
ScienceDirect (n=373)
Web of Science (n=267)
Scopus (n=152)
Total (n=1,475)

Records removed *before screening*:
Duplicate records removed (n=328)

Relevant records identified from:
Google scholar (n=4)
Review papers (n=7)

Screening

Records title/abstract screened (n=1,147)

Records excluded: irrelevant title and/or abstract (n=1,097)

Reports sought for retrieval (n=11)

Reports sought for retrieval (n=50)

Reports not retrieved (n=8)

Reports assessed for eligibility (n=53)

Reports excluded: (n=18)
-Not written in English (n=1)
-Not reporting R and/ or β (n=6)
-Incomplete statistical information (n=1)
-Not involving measure of problematic smartphone use (n=2)
-Having no access to measurement scales (n=3)
-Being conference paper (n=1)

Included

Studies included in review (n=35)

Figure 1. PRISMA diagram outlining steps involved in literature search

3.   RESULTS
3.1. Preliminary literature research findings

In primary literature search, a total of 1,475 studies are identified from five major bibliographic databases (i.e., Taylor & Francis, Wiley, SAGE, SpringerLink, ScienceDirect). Among these studies, a total of 1,432 studies are excluded from this review for being duplicates (n=328), being not relevant for relationship between stress and problematic smartphone use (n=1,097), and unretrievable full text (n=8). On the other hand, in supplemental literature search, only a total of 11 relevant studies not identified or covered in primary literature search are identified from Google Scholar (n=4) and previous similar review papers [1], [25], [26] (n=7). This has reflected the appropriateness and comprehensiveness of the search strategies in this review's primary literature search. Accordingly, based on the inclusion and exclusion criteria noted in previous section, the full text of a total of 53 studies are thoroughly assessed to determine whether they are eligible to be included in the final review. In this regard, among these studies, a total of 18 studies are excluded for not being written in English (n=1), not reporting correlation coefficients (R) and/or beta regression coefficients (β) for the relationship between stress and problematic smartphone use (n=6), having incomplete statistical information (e.g., p-value) (n=1), not involving measure of problematic smartphone use (n=2), having not accessible measurement scales of stress (n=3), considering technostress (n=1), being conference papers (n=1), and being review papers (n=3). Based on the discussions above, a total of 35 studies are included in the final review as shown in Table 1 (See Appendix) [12], [13], [14], [17]-[24], [27]-[50].

3.2. Methodological information of the studies reviewed

This section presents the methodological information of the 35 studies included in the current review. As shown in Table 1 (See Appendix), majority of these studies have employed cross-sectional design (n=32) [12], [14], [17]-[22], [24], [27], [28], [30]-[50], which involve one-off data collection and study the relationship between stress and problematic smartphone use at a single point in time [51]. Only a few studies have employed longitudinal design (n=3) [13], [23], [29], which involve multiple waves of data collection and study the relationship between stress and problematic smartphone use at different points in time over a period of time [51]. Most of the studies reviewed are conducted in China (n=17) [12]-[23], [27]-[29], [35], [36], [41], [44], [45], [47]. Although they are relatively scant, some studies are also conducted in other countries such as Korea (n=3) [42], [43], [46], India (n=2) [33], [48], Malaysia (n=2) [14], [24], Turkey (n=2) [38], [39], United States (n=1) [13], Canada (n=1) [34], Netherlands (n=1) [31], Brazil (n=1) [49], Oman (n=1) [40], and Lebanon (n=1) [30]. There are also studies that have not specified the location of studies (n=3) [32], [37], [50].

The studies reviewed have primarily sampled college/university students (n=23) [13], [14], [17], [19], [22], [24], [27]-[30], [33]-[36], [38]-[42], [44], [46]-[48]. Other studies have sampled middle school students (n=2) [12], [23], high school students (n=2) [18], [21], a mix of middle school students and high school students (n=1) [20], and a mix of middle school students, high school students, and college/university students (n=1) [45]. Apart from various student sample sets, some studies have also sampled from general population (n=1) [31], general adults (n=3) [37], [49], [50], generation X and Y adults (1) [32], and patients with schizophrenia (n=1) [43]. The sample size of the studies reviewed are highly varied, which ranges from 96 (n=1) [49] to 5109 samples (n=1) [45]. Of these, majority of the studies reviewed have used 100-500 participants (n=16) [12], [13], [23], [29], [30]-[34], [37], [39], [40], [43], [46], [48], [50]. Other studies reviewed have involved 500-1,000 (n=13) [14], [17], [18], [21], [22], [24], [27], [28], [36], [38], [41], [42], [44], 1,000-2,000 (n=3) [20], [35], [47], and 2,000-3,000 participants (n=1) [19].

Regarding sampling methods, many studies reviewed have regrettably not specified their sampling method (n=15) [12], [19], [20], [21], [22], [24], [31], [32], [34], [38], [42], [43], [46], [49], [50]. Among those studies that have specified their sampling method, the most reported sampling method is convenience sampling (n=15) [13], [17], [18], [23], [27], [28], [29], [33], [35], [36], [37], [39], [40], [47], [48]. The primary consideration of convenience sampling is "the ease with which potential participants can be located or recruited" [52]. Accordingly, the studies employed convenience sampling mainly target potential participants that are easily available or most convenient to access as samples. There are also studies that have employed stratified random sampling (n=2) [30], [41], which is a method that first partition the targeted research population into mutually exclusive stratas. Individual participants are then randomly drawn from each of the stratas [52]. Some studies have also employed cluster sampling (n=3) [14], [44], [45]. This is similar to stratified random sampling where the targeted research population is first partitioned into different discrete clusters or groups. Different from stratified random sampling, cluster sampling does not draw individual participants from each of the clusters or groups. Instead, it targets every case within the selected clusters or groups as samples [52].

Among the studies included in the current review, various measures are employed to measure problematic smartphone use. Of these, the two most employed measures are Leung [53]'s mobile phone addiction index (MPAI) (n=9) [18], [21], [23], [27], [29], [35], [44], [45], [47] and Kwon *et al.* [54]'s

smartphone addiction scale-short version (SAS-SV) (n=9) [19], [20], [24], [28], [30], [33], [41], [48], [49]. Apart from these, other measures used include Kwon *et al.* [55]'s smartphone addiction scale (SAS) (n=3) [38], [40], [43], Su *et al.* [56]'s smartphone addiction scale for college students (SAS-C) (n=3) [17], [22], [36], Kim *et al.* [57]'s smartphone addiction proneness scale (SAPS) (n=4) [13], [14], [42], [46], Hong *et al.* [58]'s mobile phone addiction scale (MPAS) (n=1) [12], Bianchi and Philips [59]'s mobile phone problem use (MPPUS) (n=1) [31], Foerster *et al.* [60]'s 10-item mobile phone problem use scale (MPPUS-10) (n=1) [39], Csibi et al. [61]'s smartphone application-based addiction scale (SABAS) (n=1) [37], Chóliz [62]'s test of mobile dependence (TMD) (n=1) [34], Billieux *et al.* [63]'s problematic mobile phone use questionnaire (PMPUQ) (n=1) [32], and Walsh *et al.* [64]'s mobile phone involvement questionnaire (MPIQ) (n=1) [50].

On the other hand, a large part of the studies reviewed have employed response-focused stress measures (n=17) [14], [19]-[21], [24], [28], [31], [32], [35], [39], [40]-[42], [45], [48], [49], [50]. Such measures typically contain a series of questions centered only on capturing negative psychological/emotional states [65], [66]. The response-focused stress measures employed by the studies reviewed include Lovibond and Lovibond [67]'s 42-item depression, anxiety, stress scale (DASS-42) (n=2) [32], [40], Lovibond and Lovibond [67]'s 21-item depression, anxiety, stress scale (DASS-21) (n=11) [14], [19], [21], [24], [28], [35], [39], [41], [48], [49], [50], Carleton *et al.* [68]'s Brief Fear of Negative Evaluation Scale (n=1) [31], and a few single-item measures (n=3) [20], [42], [45]. Few studies have employed stimulus-focused stress measures (n=2) [23], [29]. Such measures typically contain a checklist of life situations/events that can potentially cause negative emotional states. Respondents would be requested to report; i) which life situations/events listed in the checklist have occurred in their life and ii) to what extent the occurred events have affected their life [65], [66]. The only stimulus-focused stress measure employed by the studies reviewed is Liu *et al.* [69]'s Adolescent self-rating life events checklist.

Apart from response-focused and stimulus-focused stress measures, the vast majority of the studies included in the current review have employed transactional-focused stress measures (n=16) [12], [13], [17], [18], [22], [27], [30], [33], [34], [36], [37], [38], [43], [44], [46], [47]. Typically, such measures do not only contain questions that reflect the level of exposure to a set of potentially stressful life events and their resulting negative emotional/psychological states, but also questions that reflect how individuals perceive the life events/situations they encountered (i.e., whether the life situations/events individuals encountered are perceived as burdensome or threatening and whether they perceive that they have the ability to cope) [65], [66]. The transactional-focused stress measures employed by the studies reviewed include Cohen *et al.* [70]'s 14-item perceived stress scale (PSS-14) (n=6) [17], [27], [36], [44], [46], [47], Cohen and Williamson [71]'s 10-item perceived stress scale (PSS-10) (n=7) [13], [22], [30], [33], [34], [38], [43], Cohen and Williamson [71]'s 4-item Perceived Stress Scale (PSS-4) (n=1) [37], and Liu and Lu [72]'s Academic Stress Questionnaire (n=2) [12], [18].

In addition, most of the studies reviewed have employed global measures of stress (n=28) [13], [14], [17], [19], [21], [22], [24], [27], [28], [30], [32]-[44], [46]-[50]. Such measures contain questions that reflect the overall perception of stress and do not reflect the stress in specific life domain (e.g., academic, social, financial stress). The global measures of stress employed by the studies reviewed include Cohen et al. [70]'s 14-item perceived stress scale (PSS-14) (n=6) [17], [27], [36], [44], [46], [47], Cohen and Williamson [71]'s 10-item perceived stress scale (PSS-10) (n=7) [13], [22], [30], [33], [34], [38], [43], Cohen and Williamson [71]'s 4-item perceived stress scale (PSS-4) (n=1) [37], Lovibond and Lovibond [67]'s 42-item Depression, Anxiety, Stress Scale (DASS-42) (n=2) [32], [40], Lovibond and Lovibond [67]'s 21-item Depression, Anxiety, Stress Scale (DASS-21) (n=11) [14], [19], [21], [24], [28], [35], [39], [41], [48], [49], [50], and single-item measure (n=1) [42]. On the other hand, some studies reviewed have employed domain-specific measures of stress (n=7) [12], [18], [20], [23], [29], [31], [45]. Such measures contain questions that reflect the stress in specific domain of life (e.g., academic, social stress). Among the studies reviewed, Liu and Lu [72]'s Academic Stress Questionnaire (n=2) [12], [18] and a few single-item measures (n=2) [20], [45] are employed to measure academic stress. Carleton *et al.* [68]'s Brief Fear of Negative Evaluation Scale (n=1) [31] is employed to measure social stress. Liu *et al.* [69]'s Adolescent Self-Rating Life Events Checklist (n=2) [23], [29] is employed to reflect stress elicited by interpersonal relationship, study pressure, change for adaptation, and punishment.

With regard to the statistical test of direct relationship between stress and problematic smartphone use, some studies reviewed have conducted correlation analysis (n=12) [14], [22], [30], [34], [39], [40], [41], [43], [45], [48], [49], [50], a statistical test that quantifies the direction and strength of the relationship between two variables (i.e., stress and problematic smartphone use) [73]. Other studies reviewed have conducted regression analysis (n=3) [32], [38], [42], a statistical test that quantifies the amount by which the value of outcome variable changes when the value of predicting variable changes [73]. There are also studies that have employed both of them (n=20) [12], [13], [17]-[21], [23], [24], [27], [28], [29], [31], [33], [35],

[36], [37], [44], [46], [47]. Apart from examining the direct relationship, some studies reviewed have conducted mediation analysis (n=7) [12], [18], [19], [20], [23], [29], [41], a statistical method that identifies the variable that transmits the effect of one variable (e.g., stress) to another variable (e.g., problematic smartphone use) [74]. Some studies reviewed have also conducted moderation analysis (n=1) [36], a statistical method that identifies the variable that can change the direction or the magnitude of relationship between two other variables (e.g., stress and problematic smartphone use) [74]. There are also studies that have conducted both mediation and moderation analysis (n=5) [13], [21], [27], [28], [47].

In addition, some studies have moved beyond simple mediation/moderation analysis. Specifically, they have conducted moderated mediation analysis (n=6) [12], [13] [18], [20], [21], [27]. This is a statistical method that integrates mediation and moderation analysis, which enables researchers to examine whether the indirect effect of predicting variable on the ultimate outcome variable vias intervening variable vary as a function of contexts or individual differences [74]. Lastly, some studies reviewed have also conducted serial mediation analysis (n=1) [19]. Similar to simple mediation analysis, serial mediation analysis is a statistical method that identifies the variables that transmit the effect of one variable (e.g., stress) to another variable (e.g., problematic smartphone use). What differentiate serial mediation from simple mediation is that it does not only involve one intervening variable. Instead, it aims to examine whether two or more intervening variables sequentially transmit the effect of predicting variable to the ultimate outcome variable [74]. Taken together, the 35 studies included in the current review have employed various statistical techniques to study the relationship between stress and problematic smartphone use such as correlation/regression analysis, simple mediation/moderation analysis, moderated mediation analysis, and serial mediation analysis. The findings of the studies included in the current review on the relationship between stress and problematic smartphone use are presented and discussed in the following section.

3.3. Relationship between stress and problematic smartphone use: direct, mediated, and moderated

Among the 35 studies included in the current review, regardless of the used research designs, measures of stress/problematic smartphone use, and sample types, the relationship between stress and problematic smartphone use are considerably consistently found to be statistically significant and positive. Specifically, the studies conducted correlation analysis have all found positive relationship between stress and problematic smartphone use (n=32) [12], [13], [14], [17]-[24], [27]-[31], [33], [34]-[37], [39]-[41], [43]-[50]. On the other hand, among the studies reviewed, most of the studies conducted regression analysis have found that stress has positive effect on problematic smartphone use (n=19) [12], [13], [17]-[19], [21], [24], [27], [31]-[33], [35]-[38], [42], [44], [46], [47]. However, interestingly, a few studies conducted regression analysis have also found that stress does not have statistically significant effect on problematic smartphone use (n=4) [20], [23], [28], [29].

Furthermore, despite the fairly consistent empirical support for the positive relationship between stress and problematic smartphone use, scholars have explicitly highlighted that i) the relationship between stress and problematic smartphone use is not direct but mediated by other variables and ii) stress does not always cause problematic smartphone use and it is contingent upon contexts or individual differences [2]. These notions are corroborated by the studies that have found mediated and/or moderated relationship between stress and problematic smartphone use [12], [13], [18]-[23], [27], [28], [36], [41], [47]. To illustrate, some selected empirical evidence for mediated and/or moderated relationship between stress and problematic smartphone use obtained from the studies included in the current review are presented in the following paragraphs. Zhao *et al.* [29] has found that the relationship between stress and problematic smartphone use is mediated by depression, sleeping quality, and suicidal ideation. He *et al.* [36] has found that the relationship between perceived stress and problematic smartphone use is negatively moderated by psychological resilience. Yang *et al.* [19] has found that fear of missing out (FOMO) and smartphone use frequency (SUF) sequentially mediated the relationship between stress and problematic smartphone use. Wang *et al.* [27] has demonstrated that negative emotions mediated the relationship between perceived stress and problematic smartphone use and the indirect effect of perceived stress on problematic smartphone use through negative emotions is negatively moderated by psychological capital. Xu *et al.* [12] has found that the relationship between academic stress and problematic smartphone use is mediated by depression and the indirect effect of academic stress on problematic smartphone use through depression is negatively moderated by problem-focused coping style. Wang *et al.* [18] has found that psychological distress mediated the relationship between academic stress and problematic smartphone use and the indirect effect of academic stress on problematic smartphone use through psychological distress is negatively moderated by academic resilience. Lastly, Shen *et al.* [20] has found that the relationship between academic stress and problematic smartphone use is mediated by depression and the indirect effect of academic stress on problematic smartphone use through depression varies across three different usage types (utilitarian, hedonic, social).

4.   DISCUSSION

The literature search for the current review has finally resulted in 35 studies meeting the inclusion criteria. The rapid growth of literature on relationship between stress and problematic smartphone use in recent years can be reflected by comparing the number of studies included in the current review (n=35) to the number of studies included in previous similar reviews such as Elhai et al. [1] (n=6), Vahedi and Saiphoo [25] (n=6), and Sohn *et al.* [26] (n=5). As discussed in previous section, in line with similar reviews on direct relationship between stress and problematic smartphone use [1], [25], [26], this study has found that the existing empirical evidences on direct relationship between stress and problematic smartphone use generally demonstrated that stress can cause problematic smartphone use. Apart from the direct relationship, this study has also found that the effect of stress on problematic smartphone use is not straightforward but transmitted by other variables, and the effect of stress on problematic smartphone use vary as a function of context or individual differences [20], [21], [27], [41]. These differentiate this review from the previous similar reviews that have only examined the direct relationship between stress and problematic smartphone use [1], [25], [26].

Among the studies included in the current review, this study has identified a few positive trends. Firstly, majority of the existing studies on relationship between stress and problematic smartphone use have employed well-validated instruments to measure stress and problematic smartphone use. This practice is something worth to be retained and adhered by future studies on the relationship between stress and problematic smartphone use. Secondly, as discussed previously, the existing studies have strived to do more than just identifying the direct effect of stress on problematic smartphone use. With the aim to identify the i) generative mechanisms by which stress causes problematic smartphone use and ii) circumstances under which stress causes or does not cause problematic smartphone use (e.g., individual differences/contexts), these studies have also devoted attention to identify the factors that can mediate or moderate the relationship between stress and problematic smartphone use [12], [20], [21], [23], [27], [36], [41], [47]. These have been argued to be particularly relevant to intervening (i.e., reduce/block) the effect of stress on problematic smartphone use. Accordingly, in line with Elhai *et al.* [1], Shen *et al.* [20], Wang et al. [27], Zhao *et al.* [29], Hao *et al.* [41], this study argues that future research should continue this research trajectory through identifying other potential factors that can mediate or moderate the relationship between stress and problematic smartphone use.

On the other hand, among the existing studies on relationship between stress and problematic smartphone use, this review has also identified a few areas that can be improved upon. Firstly, majority of these studies are cross-sectional in nature, thus making it difficult to infer the causal direction of the association between stress and problematic smartphone use. Specifically, with only cross-sectional data, it would not be possible to definitively determine that whether it is problematic smartphone use causes increased level of stress or increased level of stress cause problematic smartphone use. Scholars have argued that causality necessitates a time-order [51], [75]. Accordingly, in order to determine whether it is problematic smartphone use causes increased level of stress or increased level of stress cause problematic smartphone use, it is necessary to determine whether the occurrence of problematic smartphone use precedes or follows the increased level of stress. In this regard, Johnson [75] has explicitly pointed out that longitudinal designs with data collected at multiple points in time over a period of time "allow for a determination of the timing of events and, therefore, can discern something about the order of effects". Building on these, in line with Elhai *et al.* [1], Zhao *et al.* [13], Shen *et al.* [20], Xie *et al.* [23], Wang *et al.* [27], Peng *et al.* [28], and Vujić and Szabo [37], this review argues that more longitudinal investigations should be conducted to provide support for the notion that stress can cause problematic smartphone use.

In addition to the notion that stress can cause problematic smartphone use, interestingly, some scholars have argued that the relationship between stress and problematic smartphone use can potentially be bi-directional, whereby increased level of stress drives problematic smartphone use and problematic smartphone use further increase the level of stress [1], [30]. For examples, with the aim to temporarily escape from the problems bothering them (e.g., academic problems) and alleviate its associated distress emotions, individuals who face stress may be driven to engage in problematic smartphone use. However, problematic smartphone use can cause various adverse consequences such as inability to accomplish academic/work tasks and poor relationship with family members/friends. These adverse consequences caused by problematic smartphone use may further reduce individual's perceived control over their life circumstances and thus increase the level of perceived stress [13], [30]. In order to empirically support the bi-directional relationship between stress and problematic smartphone use, longitudinal evidence is deemed necessary [1], [13]. However, in line with Elhai *et al.* [1], Zhao and Lapierre [13], and Vahedi and Saiphoo [25], this review has found that longitudinal evidence that can prove bi-directional relationship between stress and problematic smartphone is thus far considerably scant in the existing literature. Accordingly, this review argues that more

longitudinal evidences are needed to further verify the bi-directional relationship between stress and problematic smartphone use.

Secondly, the generalizability of the existing empirical evidence on relationship between stress and problematic smartphone use is limited due to the interplay of two factors. Firstly, the samples used by most of the studies are unitary, whereby they have drawn samples only from a specific group of population (e.g., high school students or college students). Secondly, majority of the studies have employed convenience sampling. In this regard, scholars have explicitly highlighted that i) research findings are generalizable to the targeted population only if the samples are representative of the targeted population, and ii) samples can be representative only if they are randomly drawn from the targeted population [52]. Accordingly, scholars have argued that convenience sampling will not be able to yield a representative set of samples because it only selects the sampling units that can be easily accessed and therefore studies employed convenience sampling has been argued to be unable to generate findings that are generalizable to the targeted population [52]. Inspired by these, in line with Elhai *et al.* [1], Xu *et al.* [12], Yang *et al.* [19], Wang *et al.* [27], Shen *et al.* [20], Peng *et al.* [28], Vujić and Szabo [37], and Zhang *et al.* [45], this review argues that drawing a more representative set of samples through employing random sampling and samples with more diversified backgrounds is advisable for the future studies on relationship between stress and problematic smartphone use.

Thirdly, as highlighted in previous section, the vast majority of the existing studies on relationship between stress and problematic smartphone use have focused on capturing an overall perception of stress. A major weakness of this approach is that it does not identify the stress stemming from specific domains of life (e.g., academic, social, financial). As a result, the life domains that can be targeted by interventions for problematic smartphone use are not specified and vague [76]. Accordingly, instead of an overall perception of stress, this review argues that future studies on relationship between stress and problematic smartphone use should pay more attention to domain-specific stress (e.g., academic, social, financial) because it highlights the specific life domains that can be targeted by the interventions aimed to reduce the likelihood of problematic smartphone use.

Lastly, it is also worth to point out that a large number of existing studies on relationship between stress and problematic smartphone use have either employed stimulus-focused or response-focused stress measures. These approaches to measure stress have respectively focused only on reflecting whether and the extent to which individuals are exposed to a set of life events that can potentially cause negative emotional/psychological states and whether and the extent to which individuals feel emotionally/psychologically distressed [66]. However, scholars have explicitly pointed out that researchers studying stress should not only consider the life events/situations that happen to individuals and their resulting negative emotions/psychological states. In order to more comprehensively or better reflect stress construct, they should also consider how individuals perceive the life events/situations they encountered (i.e., whether they think the life events they encountered are burdensome/threatening and whether they think they have ability to handle or cope with these life events) [66]. These have potentially explained why majority of the existing studies on relationship between stress and problematic smartphone use have employed transactional-focused stress measures, which contain questions reflecting not only i) whether and the extent to which individuals are exposed to life events that can cause negative emotional/psychological states, ii) whether and the extent to which individuals feel emotionally/psychologically distressed but also iii) how individuals perceive the life events/situations they encountered (i.e., whether they think the life events they encountered are burdensome/threatening and whether they think they have ability to handle or cope with these life events) [66]. Since scholars have repeatedly highlighted that transactional-focused stress measures can better or more comprehensively reflect stress construct [65], [66], this study argues that sticking to transactional-focused stress measures (e.g., perceived stress scale) is highly advisable for future studies that aim to examine the relationship between stress and problematic smartphone use.

5. CONCLUSION

This study has provided an aggregative view of the existing empirical evidences on relationship between stress and problematic smartphone use and how the existing researches on relationship between stress and problematic smartphone use are conducted (i.e., research designs, sampling techniques, sample characteristics, measurement scales, data analysis techniques). Building on these, among the existing studies on relationship between stress and problematic smartphone use, this study has identified some areas worth to be retained or further explored by future studies and highlighted areas that can be improved upon. These are expected to shed light on the potential areas worth to be addressed by future studies on relationship between stress and problematic smartphone use.

Despite the contribution to the literature on relationship between stress and problematic smartphone use, this review has some limitations worth to be highlighted. Firstly, this study has considered only research

papers written in English and thus it can potentially miss out on some valuable research papers related to the relationship between stress and problematic smartphone use but written in other languages (e.g., Korean/Chinese). Secondly, the literature searches in five major bibliographic databases (i.e., Taylor & Francis, Wiley, SAGE, SpringerLink, ScienceDirect) and Google Scholar are executed with only a set of predetermined keywords: ("smartphone addiction" OR "problematic smartphone use" OR "excessive smartphone use" OR "smartphone dependence") AND ("stress" OR "stressor" OR "stressful life event"). In such case, the search results may not be exhaustive, and some eligible researches can potentially be not covered. This situation is particularly salient for literature search in Google Scholar because its policy only allows researchers to examine the first 1,000 search results. In this study, the keywords used have generated approximately 10,000 search results in Google Scholar. Accordingly, it is foreseeable that some eligible researches can potentially be overlooked.

REFERENCES

[1]   J. D. Elhai, R. D. Dvorak, J. C. Levine, and B. J. Hall, "Problematic smartphone use: A conceptual overview and systematic review of relations with anxiety and depression psychopathology," *Journal of Affective Disorders,* vol. 207, pp. 251-259, Jan. 2017, doi: 10.1016/j.jad.2016.08.030.

[2]   J. D. Elhai, J. C. Levine, and B. J. Hall, "The relationship between anxiety symptom severity and problematic smartphone use: A review of the literature and conceptual frameworks," *Journal of Anxiety Disorders,* vol. 62, pp. 45-52, Mar. 2019, doi: 10.1016/j.janxdis.2018.11.005.

[3]   B. Chen, F. Liu, S. Ding, X. Ying, L. Wang, and Y. Wen, "Gender differences in factors associated with smartphone addiction: a cross-sectional study among medical college students," *BMC Psychiatry,* vol. 17, no. 1, pp. 341, Oct. 2017, doi: 10.1186/s12888-017-1503-z.

[4]   Z. Yang, K. Asbury, and M. D. Griffiths, "An exploration of problematic smartphone use among chinese university students: associations with academic anxiety, academic procrastination, self-regulation and subjective wellbeing," *The International Journal of Mental Health & Addiction,* vol. 17, no. 3, pp. 596-614, Jun. 2019, doi: 10.1007/s11469-018-9961-1.

[5]   M. Forster *et al.*, "Can Adverse Childhood Experiences Heighten Risk for Problematic Internet and Smartphone Use? Findings from a College Sample," *International Journal of Environmental Research and Public Health,* vol. 18, no. 11, pp. 5978, June. 2021, doi: 10.3390/ijerph18115978..

[6]   M. X. Zhang and A. M. S. Wu, "Effects of smartphone addiction on sleep quality among Chinese university students: The mediating role of self-regulation and bedtime procrastination," *Addictive Behaviors,* vol. 111, pp. 106552, Dec. 2020, doi: 10.1016/j.addbeh.2020.106552.

[7]   S. Y. Sohn, L. Krasnoff, P. Rees, N. J. Kalk, and B. Carter, "The Association Between Smartphone Addiction and Sleep: A UK Cross-Sectional Study of Young Adults," *Frontiers in Psychiatry,* vol. 12, art no. 659288, Mar. 2021, doi: 10.3389/fpsyt.2021.629407.

[8]   A. M. Alsalameh, M. J. Harisi, M. A. Alduayji, A. A. Almutham, and F. M. Mahmood, "Evaluating the relationship between smartphone addiction/overuse and musculoskeletal pain among medical students at Qassim University," *Journal of Family Medicine and Primary Care,* vol. 8, no. 9, pp. 2953-2959, Sep. 2019, doi: 10.4103/jfmpc.jfmpc_665_19.

[9]   S.-E. Kim, J.-W. Kim, and Y.-S. Jee, "Relationship between smartphone addiction and physical activity in Chinese international students in Korea," *Journal of Behavioral Addictions,* vol. 4, no. 3, pp. 200-205, Sep. 2015, doi: 10.1556/2006.4.2015.028.

[10] É. Duke and C. Montag, "Smartphone addiction, daily interruptions and self-reported productivity," *Addictive Behaviors Reports,* vol. 6, pp. 90-95, Dec. 2017, doi: 10.1016/j.abrep.2017.07.002.

[11] P. A. Busch and S. McCarthy, "Antecedents and consequences of problematic smartphone use: A systematic literature review of an emerging research area," *Computers in Human Behavior,* vol. 114, pp. 106414, Jan. 2021, doi: 10.1016/j.chb.2020.106414.

[12] T.-T. Xu *et al.*, "The relationship between academic stress and adolescents' problematic smartphone usage," *Addiction Research & Theory,* vol. 27, no. 2, pp. 162-169, Mar. 2019, doi: 10.1080/16066359.2018.1488967.

[13] P. Zhao and M. A. Lapierre, "Stress, dependency, and depression: An examination of the reinforcement effects of problematic smartphone use on perceived stress and later depression," *Cyberpsychology,* vol. 14, no. 4, pp. art no. 3, Nov. 2020, doi: 10.5817/CP2020-4-3.

[14] W. S. Wan Ismail *et al.*, "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,* vol. 56, no. 4, pp. 949-955, May. 2020, doi: 10.1111/ppc.12517.

[15] A. Winkler, F. Jeromin, B. K. Doering, and A. Barke, "Problematic smartphone use has detrimental effects on mental health and somatic symptoms in a heterogeneous sample of German adults," *Computers in Human Behavior,* vol. 113, pp. 106500, Dec. 2020, doi: 10.1016/j.chb.2020.106500.

[16] E. Katz, J. G. Blumler, and M. Gurevitch, "Uses and gratifications research," *The public opinion quarterly,* vol. 37, no. 4, pp. 509-523, Jan. 1973, doi: 10.1086/268109.

[17] J.-L. Wang, H.-Z. Wang, J. Gaskin, and L.-H. Wang, "The role of stress and motivation in problematic smartphone use among college students," *Computers in Human Behavior,* vol. 53, pp. 181-188, Dec. 2015, doi: 10.1016/j.chb.2015.07.005.

[18] J.-L. Wang, D. H. Rost, R.-J. Qiao, and R. Monk, "Academic stress and smartphone dependence among Chinese adolescents: A moderated mediation model," *Children and Youth Services Review,* vol. 118, pp. 105029, Nov. 2020, doi: 10.1016/j.childyouth.2020.105029.

[19] H. Yang, B. Liu, and J. Fang, "Stress and problematic smartphone use severity: smartphone use frequency and fear of missing out as mediators," *Frontiers in Psychiatry,* vol. 12, art no. 659288, Jun. 2021, doi: 10.3389/fpsyt.2021.659288.

[20] B. Shen, F. Wang, S. J. Sun, and Y. Liu, "Chinese Adolescents' Academic Stress and Smartphone Addiction: A Moderated-Mediation Model," *Journal of Broadcasting & Electronic Media,* vol. 65, no. 5, pp. 724-740, Jan. 2022, doi: 10.1080/08838151.2021.2014842.

[21] Q. Q. Liu, D. J. Zhang, X. J. Yang, C. Y. Zhang, C. Y. Fan, and Z. K. Zhou, "Perceived stress and mobile phone addiction in Chinese adolescents: A moderated mediation model," *Computers in Human Behavior,* vol. 87, pp. 247-253, Oct. 2018, doi: 10.1016/j.chb.2018.06.006.

[22] X. Shen and J.-L. Wang, "Loneliness and excessive smartphone use among Chinese college students: Moderated mediation effect of perceived stressed and motivation," *Computers in Human Behavior,* vol. 95, pp. 31-36, Jun. 2019, doi: 10.1016/j.chb.2019.01.012.

[23] J.-Q. Xie, M. A. Zimmerman, D. H. Rost, X.-Q. Yin, and J.-L. Wang, "Stressful life events and problematic smartphone usage among Chinese boarding-school adolescents: a moderated mediation model of peer support and depressive symptoms," *Addiction Research & Theory,* vol. 28, no. 6, pp. 493-500, Dec. 2020, doi: 10.1080/16066359.2019.1692824.

[24] L. Y.-C. Lei, M. A.-A. Ismail, J. A.-M. Mohammad, and M. S. B. Yusoff, "The relationship of smartphone addiction with psychological distress and neuroticism among university medical students," *BMC Psychology,* vol. 8, no. 1, pp. 1-9, Sep. 2020, doi: 10.1186/s40359-020-00466-6.

[25] Z. Vahedi and A. Saiphoo, "The association between smartphone use, stress, and anxiety: A meta-analytic review," *Stress Health,* vol. 34, no. 3, pp. 347-358, Apr. 2018, doi:10.1002/smi.2805.

[26] S. Y. Sohn, P. Rees, B. Wildridge, N. J. Kalk, and B. Carter, "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," *BMC Psychiatry,* vol. 19, art no. 356, Nov. 2019, doi: 10.1186/s12888-019-2350-x.

[27] W. Wang *et al.*, "Perceived Stress and Smartphone Addiction in Medical College Students: The Mediating Role of Negative Emotions and the Moderating Role of Psychological Capital," *Frontiers in Psychology,* vol. 12, art no. 660234, Jul. 2021, doi: 10.3389/fpsyg.2021.660234.

[28] Y. Peng, H. L. Zhou, B. Zhang, H. L. Mao, R. T. Hu, and H. B. Jiang, "Perceived stress and mobile phone addiction among college students during the 2019 coronavirus disease: The mediating roles of rumination and the moderating role of self-control," *Personality and Individual Differences,* vol. 185, art no. 111222, Feb. 2022, doi: 10.1016/j.paid.2021.111222.

[29] C. Zhao *et al.*, "Longitudinal effects of stressful life events on problematic smartphone use and the mediating roles of mental health problems in chinese undergraduate students," *Frontiers in Public Health,* vol. 9, art no. 752210, Dec. 2021, doi: 10.3389/fpubh.2021.752210.

[30] M. Samaha and N. S. Hawi, "Relationships among smartphone addiction, stress, academic performance, and satisfaction with life," *Computers in Human Behavior,* vol. 75, pp. 1016-1016, Oct. 2017, doi: 10.1016/j.chb.2016.12.001.

[31] A. van Deursen, C. L. Bolle, S. M. Hegner, and P. A. M. Kommers, "Modeling habitual and addictive smartphone behavior The role of smartphone usage types, emotional intelligence, social stress, self-regulation, age, and gender," *Computers in Human Behavior,* vol. 45, pp. 411-420, Apr. 2015, doi: 10.1016/j.chb.2014.12.039.

[32] D. J. Kuss, E. Kanjo, M. Crook-Rumsey, F. Kibowski, G. Y. Wang, and A. Sumich, "Problematic mobile phone use and addiction across generations: The roles of psychopathological symptoms and smartphone use," *Journal of Technology in Behavioral Science,* vol. 3, no. 3, pp. 141-149, Jan. 2018, doi: 10.1007/s41347-017-0041-3.

[33] S. Dharmadhikari, S. Harshe, and P. Bhide, "Prevalence and correlates of excessive smartphone use among medical students: A cross-sectional study," *Indian Journal of Psychological Medicine,* vol. 41, no. 6, pp. 549-555, Nov. 2019, doi: 10.4103/IJPSYM.IJPSYM_75_19.

[34] E. A. Flynn, É. R. Thériault, and S. R. Williams, "The use of smartphones to cope with stress in university students: Helpful or harmful?," *Journal of Technology in Behavioral Science,* vol. 5, no. 2, pp. 171-177, Jan. 2020, doi: 10.1007/s41347-019-00125-7.

[35] X. F. Yang, P. C. Wang, and P. Hu, "Trait Procrastination and Mobile Phone Addiction Among Chinese College Students: A Moderated Mediation Model of Stress and Gender," *Frontiers in Psychology,* vol. 11, art no. 614660, Dec. 2020, doi: 10.3389/fpsyg.2020.614660.

[36] D. He, X. Shen, and Q.-Q. Liu, "The relationship between upward social comparison on SNSs and excessive smartphone use: A moderated mediation analysis," *Children and Youth Services Review,* vol. 116, pp. 105232, Sep. 2020, doi: 10.1016/j.childyouth.2020.105232.

[37] A. Vujić and A. Szabo, "Hedonic use, stress, and life satisfaction as predictors of smartphone addiction," *Addictive Behaviors Reports,* vol. 15, art no. 100411, Jan. 2022, doi: 10.1016/j.abrep.2022.100411.

[38] Ş. Gökçearslan, Ç. Uluyol, and S. Şahin, "Smartphone addiction, cyberloafing, stress and social support among university students: A path analysis," *Children and Youth Services Review,* vol. 91, pp. 47-54, Aug. 2018, doi: 10.1016/j.childyouth.2018.05.036.

[39] N. Atış Akyol, D. Atalan Ergin, A. K. Krettmann, and C. A. Essau, "Is the relationship between problematic mobile phone use and mental health problems mediated by fear of missing out and escapism?," *Addictive Behaviors Reports,* vol. 14, art no. 100384, Dec. 2021, doi: 10.1016/j.abrep.2021.100384.

[40] N. Al Battashi, O. Al Omari, M. Sawalha, S. Al Maktoumi, A. Alsuleitini, and M. Al Qadire, "The Relationship between smartphone use, insomnia, stress, and anxiety among university students: a cross-sectional study," *Clinical Nursing Research,* vol. 30, no. 6, pp. 734-740, Jul. 2020, doi: 10.1177/1054773820983161.

[41] Z. Hao, L. Jin, J. Huang, and H. Wu, "Stress, academic burnout, smartphone use types and problematic smartphone use: The moderation effects of resilience," *Journal of Psychiatric Research,* vol. 150, pp. 324-331, Jun. 2022, doi: 10.1016/j.jpsychires.2022.03.019.

[42] H.-J. Kim, J.-Y. Min, H.-J. Kim, and K.-B. Min, "Association between psychological and self-assessed health status and smartphone overuse among Korean college students," *Journal of Mental Health,* vol. 28, no. 1, pp. 11-16, Sep. 2017, doi: 10.1080/09638237.2017.1370641.

[43] J.-Y. Lee *et al.*, "Problematic smartphone use and related factors in young patients with schizophrenia," *Asia-Pacific Psychiatry,* vol. 11, no. 3, p. e12357, May. 2019, doi: 10.1111/appy.12357.

[44] A. Mehmood *et al.*, "Exploration of Psychological Mechanism of Smartphone Addiction Among International Students of China by Selecting the Framework of the I-PACE Model," *Frontiers in Psychology,* vol. 12, art no. 758610, Nov. 2021, doi: 10.3389/fpsyg.2021.758610.

[45] X. Zhang *et al.*, "Perceived Academic Stress and Depression: The Mediation Role of Mobile Phone Addiction and Sleep Quality," *Front. Public Health,* vol. 10, art no. 760387, Jan. 2022, doi: 10.3389/fpubh.2022.760387.

[46] K. S. Paek, "The factors related to the smartphone addiction of undergraduate students," *Medico-Legal Update,* vol. 19, no. 1, pp. 732-737, Jun 2019, doi: 10.5958/0974-1283.2019.00128.2.

[47] C. Zhao *et al.*, "Effects of online social support and perceived social support on the relationship between perceived stress and problematic smartphone usage among Chinese undergraduates," *Psychology Research and Behavior Management,* vol. 14, pp. 529-539, May. 2021, doi: 10.2147/PRBM.S302551.

[48] S. T. Choksi and N. Patel, "A study to find out the correlation of mobile phone addiction with anxiety, depression, stress and sleep quality in the college students of surat city," *International Journal of Current Research and Review,* vol. 13, no. 8, pp. 137-142, Arp. 2021, doi: 10.31782/IJCRR.2021.13812.

[49]   L. J. F. S. Júnior, C. H. T. Ribeiro, L. de Sousa Fortes, B. T. Barbosa, and L. V. da Silva Neto, "Smartphone addiction is associated with symptoms of anxiety, depression, stress, tension, confusion, and insomnia: A cross-sectional and comparative study with physically and non-physically active adults in self-isolation during the COVID-19 pandemic," *Salud Mental,* vol. 44, no. 4, pp. 193-200, Jan. 2021, doi: 10.17711/SM.0185-3325.2021.025.

[50]   J. Harwood, J. J. Dooley, A. J. Scott, and R. Joiner, "Constantly connected–The effects of smart-devices on mental health," *Computers in Human Behavior,* vol. 34, pp. 267-272, May. 2014, doi: 10.1016/j.chb.2014.02.006.

[51]   M. Saunders, P. Lewis, and A. Thornhill, *Research methods for business students* 7th edition ed. England: Pearson, 2015.

[52]   M. Sarstedt, P. Bengart, A. M. Shaltoni, and S. Lehmann, "The use of sampling methods in advertising research: A gap between theory and practice," *International Journal of Advertising,* vol. 37, no. 4, pp. 650-663, Jul. 2018, doi: 10.1080/02650487.2017.1348329.

[53]   L. Leung, "Linking psychological attributes to addiction and improper use of the mobile phone among adolescents in Hong Kong," *Journal of Children and Media,* vol. 2, no. 2, pp. 93-113, Jun. 2008, doi: 10.1080/17482790802078565.

[54]   M. Kwon, D.-J. Kim, H. Cho, and S. Yang, "The smartphone addiction scale: development and validation of a short version for adolescents," *PLoS One,* vol. 8, no. 12, pp. e83558, Dec. 2013, doi: 10.1371/journal.pone.0083558.

[55]   M. Kwon *et al.*, "Development and validation of a smartphone addiction scale (SAS)," *PLoS One,* vol. 8, no. 2, pp. e56936, Feb. 2013, doi: 10.1371/journal.pone.0056936.

[56]   S. Su, T. Pan, X. Liu, X. Chen, Y. Wang, and M. Li, "Development of the smartphone addiction scale for college students," *Chinese Mental Health Journal,* vol. 28, no. 5, pp. 392-397, 2014.

[57]   D. Kim, Y. Lee, J. Lee, J. K. Nam, and Y. Chung, "Development of Korean smartphone addiction proneness scale for youth," *PLoS One,* vol. 9, no. 5, pp. e97920, May. 2014, doi: 10.1371/journal.pone.0097920.

[58]   F.-Y. Hong, S.-I. Chiu, and D.-H. Huang, "A model of the relationship between psychological characteristics, mobile phone addiction and use of mobile phones by Taiwanese university female students," *Computers in Human Behavior,* vol. 28, no. 6, pp. 2152-2159, Nov. 2012, doi: 10.1016/j.chb.2012.06.020.

[59]   A. Bianchi and J. G. Phillips, "Psychological predictors of problem mobile phone use," *Cyberpsychology & behavior,* vol. 8, no. 1, pp. 39-51, Feb. 2005, doi: 10.1089/cpb.2005.8.39.

[60]   M. Foerster, K. Roser, A. Schoeni, and M. Röösli, "Problematic mobile phone use in adolescents: derivation of a short scale MPPUS-10," *International Journal of Public Health,* vol. 60, no. 2, pp. 277-286, Feb. 2015, doi: 10.1007/s00038-015-0660-4.

[61]   S. Csibi, M. D. Griffiths, B. Cook, Z. Demetrovics, and A. Szabo, "The psychometric properties of the smartphone application-based addiction scale (SABAS)," *International Journal of Mental Health and Addiction,* vol. 16, no. 2, pp. 393-403, Apr. 2018, doi: 10.1007/s11469-017-9787-2.

[62]   M. Choliz, "Mobile-phone addiction in adolescence: the test of mobile phone dependence (TMD)," *Progress in Health Sciences,* vol. 2, no. 1, pp. 33-44, June. 2012.

[63]   J. Billieux, M. Van der Linden, and L. Rochat, "The role of impulsivity in actual and problematic use of the mobile phone," *Applied Cognitive Psychology: The Official Journal of the Society for Applied Research in Memory and Cognition,* vol. 22, no. 9, pp. 1195-1210, Jan. 2008, doi: 10.1002/acp.1429.

[64]   S. P. Walsh, K. M. White, S. Cox, and R. M. Young, "Keeping in constant touch: The predictors of young Australians' mobile phone involvement," *Computers in Human Behavior,* vol. 27, no. 1, pp. 333-342, Jan. 2011, doi: 10.1016/j.chb.2010.08.011.

[65]   D. Putwain, "Researching academic stress and anxiety in students: some methodological considerations," *British Educational Research Journal,* vol. 33, no. 2, pp. 207-219, Mar. 2007, doi: 10.1080/01411920701208258.

[66]   P. J. Dewe, M. P. O'Driscoll, and C. L. Cooper, "Theories of Psychological Stress at Work," in *Handbook of Occupational Health and Wellness*, R. J. Gatchel and I. Z. Schultz Eds. Boston, MA: Springer US, Nov. 2012, pp. 23-38, doi: 10.1007/978-1-4614-4839-6_2.

[67]   P. F. Lovibond and S. H. Lovibond, "The structure of negative emotional states: Comparison of the Depression Anxiety Stress Scales (DASS) with the Beck Depression and Anxiety Inventories," *Behaviour research and therapy,* vol. 33, no. 3, pp. 335-343, Mar. 1995, doi: 10.1016/0005-7967(94)00075-U.

[68]   R. N. Carleton, D. R. McCreary, P. J. Norton, and G. J. Asmundson, "Brief fear of negative evaluation scale—revised," *Depression and Anxiety,* vol. 23, no. 5, pp. 297-303, May. 2006, doi: 10.1002/da.20142.

[69]   X. Liu *et al.*, "The Adolescent Self-Rating Life Events Checklist and its reliability and validity," *Chinese Journal of Clinical Psychology,* vol. 5, no. 1, pp. 34-36, 1997.

[70]   S. Cohen, T. Kamarck, and R. Mermelstein, "A global measure of perceived stress," *Journal of Health and Social Behavior,* vol. 24, no. 4, pp. 385-396, Dec. 1983, doi: 10.2307/2136404.

[71]   S. Cohen and G. Williamson, "Perceived stress in a probability sample of the Measuring Stress in Psychiatric and Physical Disorders 23 United States," *The Social Psychology of Health,* pp. 31-67, 1998.

[72]   Y. Liu and Z. Lu, "Chinese high school students' academic stress and depressive symptoms: Gender and school climate as moderators," *Stress Health,* vol. 28, no. 4, pp. 340-346, Oct. 2012, doi: 10.1002/smi.2418.

[73]   J. F. Hair, W. C. Black, B. J. Babin, R. E. Anderson, and R. Tatham, *Multivariate Data Analysis*. Upper Saddle River, New Jersey: Pearson Education, 2010.

[74]   A. F. Hayes and N. J. Rockwood, "Conditional process analysis: Concepts, computation, and advances in the modeling of the contingencies of mechanisms," *American Behavioral Scientist,* vol. 64, no. 1, pp. 19-54, Jan. 2020, doi: 10.1177/0002764219859633.

[75]   S. L. Johnson, "A question of time: Cross-sectional versus longitudinal study designs," *Pediatrics,* vol. 31, pp. 250-251, Jun. 2010, doi: 10.1542/pir.31-6-250.

[76]   H. M. Stallman and C. P. Hurst, "The university stress scale: measuring domains and extent of stress in university students," *Australian Psychologist,* vol. 51, no. 2, pp. 128-134, Apr. 2016, doi: 10.1111/ap.12127.

BIOGRAPHIES OF AUTHORS

Boon Yew Wong 🆔 🇬 SC Ⓟ is a PhD student at Universiti Teknologi Malaysia. His current research focuses on educational psychology, cyberpsychology, and addictive behavior. He can be contacted at email: boonyew1234@gmail.com.

Kee Jiar Yeo 🆔 🇬 SC Ⓟ is a Professor of Educational Psychology attached to the School of Education, Universiti Teknologi Malaysia. She has over 30 years of experience as an academic in various educational institutions. Her expertise and interest in research include educational psychology, early childhood education, educational assessment, and special education. Her involvement in conferences, publication and consultations centred on these disciplines. She can be contacted at email: kjyeo@utm.my.

Lina Handayani 🆔 🇬 SC Ⓟ is currently senior lecturer in Public Health Department, Faculty of Public Health, Universitas Ahmad Dahlan. She graduated her Ph.D of Educational Psychology from Universiti Teknologi Malaysia. She is interested in area of Health Education and Promotion. She can be contacted at email: lina.handayani@ikm.uad.ac.id.

APPENDIX

Table 1. Study characteristics and findings (*Continue*)

Authors	Research design	Sampling method	Sample characteristic	Stress type/measure /perspective	Problematic smartphone use measure	Analysis	Relationship between stress and problematic smartphone use
[12]	Cross-sectional	Not specified	316 middle school students in China	Domain specific: Academic stress/Academic Stress Questionnaire/Transactional-focused	MPAS	Correlation, Regression, Mediation, Moderated Mediation	-Correlation analysis has shown that academic stress is significantly and positively corelated with problematic smartphone use (R=0.465, p<0.01) -Regression analysis has shown that academic stress is significantly and positively related to problematic smartphone use (β=0.378, p<0.001). -Mediation analysis has shown that depression mediated the relationship between academic stress and problematic smartphone use

Table 1. Study characteristics and findings (*Continue*)

Authors	Research design	Sampling method	Sample characteristic	Stress type/measure /perspective	Problematic smartphone use measure	Analysis	Relationship between stress and problematic smartphone use
							(β=0.071, 95% CI [0.026:0.137]). -Moderated mediation analysis has shown that indirect effect of academic stress on problematic smartphone use through depression is negatively moderated by problem-focused coping (indirect effect in low problem-focused coping group β=0.094, 95% CI [0.033:0.177]; average group β=0.071, CI [0.024:0.135]; high group β=0.049. CI [0.013:0.108]).
[13]	Longitudinal	Convenience sampling	222 college students in United States	General life stress/PSS-10/Transactional-focused	SAPS	Correlation, Regression, Mediation, Moderation, Moderated Mediation	-Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.382. p<0.001). -Regression analysis has shown that stress is significantly and positively related to problematic smartphone use (β=0.191 p<0.01). -Moderation analysis has shown that social support does not moderate the relationship between stress and problematic smartphone use (β= -0.042, p>0.05). -Mediation analysis and Moderated Mediation analysis have shown that: A) Person-to-person smartphone use does not mediate the relationship between stress and problematic smartphone use (indirect effect at low level of social support β=-0.018, 95% CI [-0.066:0.016]; medium β=-0.015, 95% CI [-0.058:0.012]; high β=-0.014, 95% CI [-0.061:0.012]). B) Mass media smartphone use does not mediate the relationship between stress and problematic smartphone use (indirect effect at low level of social support β=-0.002, 95% CI [-

Table 1. Study characteristics and findings (*Continue*)

Authors	Research design	Sampling method	Sample characteristic	Stress type/measure /perspective	Problematic smartphone use measure	Analysis	Relationship between stress and problematic smartphone use
							0.021:0.015]; medium β=-0.001, 95% CI [-0.017:0.012]; high β=-0.001, 95% CI [-0.018:0.013]). C) Indirect effect of stress on problematic smartphone use through social networking smartphone use is negatively moderated by social support. Specifically, social networking smartphone use mediated the relationship between stress and problematic smartphone use for individuals having low and medium level of social support but not for those having high level of social support (indirect effect at low level of social support β=0.101, 95% CI [0.028:0.212]; medium β=0.064, 95% CI [0.017:0.135]; high β=0.036, 95% CI [-0.004:0.097])
[14]	Cross-sectional	Multi-stage cluster sampling	525 university students in Malaysia	General life stress/Stress subscale of DASS-21/Response-focused	SAPS	Correlation	-Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.35, p<0.001).
[17]	Cross-sectional	Convenience sampling	600 college students in China	General life stress/PSS-14/Transactional-focused	SAS-C	Correlation, Regression	-Correlation analysis has shown that stress is significantly and positively related to problematic smartphone use in both problematic smartphones use group (R= 0.33, p<0.001) and non-problematic smartphone use group (R=0.30, p<0.001). -Regression analysis has shown that, across various models with different set of predictors, stress is positively and significantly related to problematic smartphone use (β ranges from 0.19 to 0.31, p<0.05).
[18]	Cross-sectional	Convenience sampling	520 high school	Domain specific:	MPAI	Correlation, Regression,	-Correlation analysis has shown that

Table 1. Study characteristics and findings (*Continue*)

Authors	Research design	Sampling method	Sample characteristic	Stress type/measure /perspective	Problematic smartphone use measure	Analysis	Relationship between stress and problematic smartphone use
			students in China	Academic stress/Academic Stress Questionnaire/Transactional-focused		Mediation, Moderated Mediation	academic stress is significantly and positively corelated with problematic smartphone use (R=0.36, p<0.05) -Regression analysis has shown that academic stress is significantly and positively related to problematic smartphone use (β=0.25, p<0.001). -Mediation analysis has shown that psychological distress mediated the relationship between academic stress and problematic smartphone use (β=0.10, 95% CI [0.06:0.15]). -Moderated mediation analysis has shown that indirect effect of academic stress on problematic smartphone use through psychological distress is negatively moderated by academic resilience (indirect effect in low academic resilience group β=0.11, 95% CI [0.06:0.16]; high group β=0.05. CI [0.01:0.09].
[19]	Cross-sectional	Not specified	2263 university students in China	General life stress/Stress subscale of DASS-21/Response-focused	SAS-SV	Correlation, Regression, Mediation, Serial Mediation,	-Correlation analysis has shown that stress is significantly and positively corelated with problematic smartphone use (R=0.49, p<0.001). -Regression analysis has shown that stress is significantly and positively related to problematic smartphone use (β=0.45, p<0.001). -Mediation analysis has shown that fear of missing out (FOMO) mediated the relationship between stress and problematic smartphone use (β=0.04, p<0.05, 95% CI [0.005:0.068]). -Mediation analysis has shown that smartphone use frequency (SUF) does not mediate the relationship between

Table 1. Study characteristics and findings (*Continue*)

Authors	Research design	Sampling method	Sample characteristic	Stress type/measure /perspective	Problematic smartphone use measure	Analysis	Relationship between stress and problematic smartphone use
							stress and problematic smartphone use (β=0.01, p>0.05, 95% CI [-0.008:0.025]). -Serial mediation analysis has shown that fear of missing out (FOMO) and smartphone use frequency (SUF) sequentially mediated the relationship between stress and problematic smartphone use (β=0.007, p<0.05, 95% CI [0.026:0.053]).
[20]	Cross-sectional	Not specified	1718 middle/high school students in China	Domain-specific: Academic stress/Single-item measure/Response-focused	SAS-SV	Correlation, Regression, Mediation, Moderated Mediation	-Correlation analysis has shown that academic stress is significantly and positively correlated with problematic smartphone use (R= 0.117, p<0.01). -Regression analysis has shown that the relationship between academic stress and problematic smartphone use is not significant (β= 0.01, 95% CI [-0.008:0.028]). -Mediation analysis and Moderated Mediation analysis have shown that depression mediated the relationship between academic stress and problematic smartphone use. Indirect effect of academic stress through depression on problematic smartphone use is moderated by usage types (utilitarian, hedonic, social) (indirect effect for utilitarian usage β=0.036, 95% CI [0.021:0.053]; hedonic usage β=0.031, 95% CI [0.021:0.043]; social usage β=0.018, 95% CI [0.005:0.031]).
[21]	Cross-sectional	Not specified	899 high school students in China	General life stress/Stress subscale of DASS-21/Response-focused	MPAI	Correlation, Regression, Mediation, Moderation, Moderated Mediation	-Correlation analysis has shown that stress is significantly and positively corelated with problematic smartphone use

Table 1. Study characteristics and findings (*Continue*)

Authors	Research design	Sampling method	Sample characteristic	Stress type/measure /perspective	Problematic smartphone use measure	Analysis	Relationship between stress and problematic smartphone use
							(R=0.34, p<0.001). -Regression analysis has shown that stress is significantly and positively related to problematic smartphone use (β=0.21, p<0.001). -Moderation analysis has shown that mindfulness negatively moderated the relationship between stress and problematic smartphone use (β= -0.13, p<0.001). -Mediation analysis has shown that self-control mediated the relationship between stress and problematic smartphone use (β=0.12, 95% CI [0.09:0.16]). -Moderated mediation analysis has shown that indirect effect of stress on problematic smartphone use through self-control is negatively moderated by mindfulness (indirect effect in low mindfulness group β=0.11, 95% CI [0.07:0.16]; average group β=0.07, 95% CI [0.04:0.11]; high group β=0.03, 95% CI [0.01:0.16]).
[22]	Cross-sectional	Not specified	549 college students in China	General life stress/PSS-10/Transactional-focused	SAS-C	Correlation	-Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.26, p<0.01).
[23]	Longitudinal	Convenience sampling	124 middle school students in China	Domain specific: Interpersonal relationship, Study pressure, Change for adaptation, and Punishment/ Adolescent Self-Rating Life Events Checklist/Stimulus-focused	MPAI	Correlation, Regression, Mediation	-Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.22, p<0.05). - Regression analysis has shown that the relationship between stress and problematic smartphone use is not significant (β=0.17, p>0.05). -Mediation analysis has shown that depression mediated the relationship between stress and problematic

Table 1. Study characteristics and findings (*Continue*)

Authors	Research design	Sampling method	Sample characteristic	Stress type/measure /perspective	Problematic smartphone use measure	Analysis	Relationship between stress and problematic smartphone use
							smartphone use (β=0.11 p<0.01, 95% CI [0.031: 0.239]).
[24]	Cross-sectional	Not specified	574 university students in Malaysia	General life stress/Stress subscale of DASS-21/Response-focused	SAS-SV	Correlation, Regression	-Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.329, p<0.001) -Regression analysis has shown that stress is significantly and positively related to problematic smartphone use (β=0.132, p<0.001).
[27]	Cross-sectional	Convenience sampling	769 university students in China	General life stress/PSS-14/Transactional-focused	MPAI	Correlation, Regression, Mediation, Moderation, Moderated Mediation	-Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.18, p<0.01) -Regression analysis has shown that stress is significantly and positively related to problematic smartphone use (β=0.18, p<0.01). -Moderation analysis has shown that psychological capital does not moderate the relationship between stress and problematic smartphone use (β= -0.04, p>0.05). -Mediation analysis has shown that negative emotions mediated the relationship between stress and problematic smartphone use (β=0.06, 95% CI [0.10:0.24]). -Moderated mediation analysis has shown that indirect effect of stress on problematic smartphone use through negative emotions is negatively moderated by psychological capital (indirect effect in low psychological capital group β=0.16, 95% CI [0.08:0.27]; high psychological capital group β=0.06, 95% CI [0.02:0.13].
[28]	Cross-sectional	Convenience sampling	628 university students in China	General life stress/Stress subscale of DASS-	SAS-SV	Correlation, Regression, Mediation, Moderation	-Correlation analysis has shown that stress is significantly and positively correlated

Table 1. Study characteristics and findings (*Continue*)

Authors	Research design	Sampling method	Sample characteristic	Stress type/measure /perspective	Problematic smartphone use measure	Analysis	Relationship between stress and problematic smartphone use
				21/Response-focused			with problematic smartphone use (R=0.29, p<0.01). -Regression analysis has shown that the relationship between stress and problematic smartphone use is not significant (β=0.11 p=0.05). -Moderation analysis has shown that self-control does not moderate the relationship between stress and problematic smartphone use (β=0.06 p>0.05). -Mediation analysis has shown that rumination mediated the relationship between stress and problematic smartphone use (β=0.19, 95% CI [0.12:0.28]).
[29]	Longitudinal	Convenience sampling	197 university students in China	Domain specific: Interpersonal relationship, Study pressure, Change for adaptation, and Punishment/ Adolescent Self-Rating Life Events Checklist/Stimulus-focused	MPAI	Correlation, Regression, Mediation	-Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.17, p<0.05). -Regression analysis has shown that the relationship between stress and problematic smartphone use is not significant in three different models (A, B, C) (A: β=0.126, p>0.05; B: β = 0.134, p>0.05; C: β=0.101, p>0.05). -Mediation analysis has shown that depression (β=0.042, 95% CI [0.014:0.098], sleeping quality (β=0.034, 95% CI [0.003:0.086], and suicidal ideation (β=0.067, 95% CI [0.022:0.124] mediated the relationship between stress and problematic smartphone use.
[30]	Cross-sectional	Stratified random sampling	249 university students in Lebanon	General life stress/PSS-10/Transactional-focused	SAS-SV	Correlation	-Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.193, p<0.0005).
[31]	Cross-sectional	Not specified	386 general populations in	Domain-specific: Social	MPPUS	Correlation, Regression	-Correlation analysis has shown that stress is significantly and

Table 1. Study characteristics and findings (*Continue*)

Authors	Research design	Sampling method	Sample characteristic	Stress type/measure /perspective	Problematic smartphone use measure	Analysis	Relationship between stress and problematic smartphone use
			Netherlands	stress/Brief fear of negative evaluation scale/Response-focused			positively correlated with problematic smartphone use (R=0.33, p<0.05) -Regression analysis has shown that stress is significantly and positively related to problematic smartphone use (β=0.13,p<0.01).
[32]	Cross-sectional	Not specified	273 adults (Generation X and Y) from 14 countries (country not specified)	General life stress/Stress subscale of DASS-42/Response-focused	PMPUQ	Regression	-Regression analysis has shown that stress is significantly and positively related to problematic smartphone use (β=0.329, p<0.01).
[33]	Cross-sectional	Convenience sampling	195 college students in India	General life stress/PSS-10/Transactional-focused	SAS-SV	Correlation, Regression	-Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.40, p<0.001). -Regression analysis has shown that stress is significantly and positively related to problematic smartphone use (β=0.18, p<0.01).
[34]	Cross-sectional	Not specified	253 university students in Canada	General life stress/PSS-10/Transactional-focused	TMD	Correlation	-Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.397, p<0.001).
[35]	Cross-sectional	Convenience sampling	1004 college students in China	General life stress/Stress subscale of (DASS-21)/Response-focused	MPAI	Correlation, Regression	- Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.44, p<0.001) - Regression analysis has shown that stress is significantly and positively related to problematic smartphone use (β=0.35, p<0.001).
[36]	Cross-sectional	Convenience sampling	668 college students in China	General life stress/PSS-14/Transactional-focused	SAS-C	Correlation, Regression, Moderation	- Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.169, p<0.001) - Regression analysis has shown that stress

Table 1. Study characteristics and findings (*Continue*)

Authors	Research design	Sampling method	Sample characteristic	Stress type/measure /perspective	Problematic smartphone use measure	Analysis	Relationship between stress and problematic smartphone use
							is significantly and positively related to problematic smartphone use (β=0.182, p<0.01). -Moderation analysis has shown that psychological resilience negatively moderated the relationship between stress and problematic smartphone use (β= -0.242, p<0.05).
[37]	Cross-sectional	Convenience sampling	410 general adults (country not specified)	General life stress/PSS-4/ Transactional-focused	SABAS	Correlation, Regression	- Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.31, p<0.001) -Regression analysis has shown that stress is significantly and positively related to problematic smartphone use (β=0.264, p<0.001).
[38]	Cross-sectional	Not specified	885 university students in Turkey	General life stress/ PSS-10/Transactional-focused	SAS	Regression	- Regression analysis has shown that stress is significantly and positively related to problematic smartphone use (β =0.27, p<0.001).
[39]	Cross-sectional	Convenience sampling	235 university students in Turkey	General life stress/Stress subscale of DASS-21/Response-focused	Mobile Phone Problem Use Scale (MMPUS-10)	Correlation	-Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.45, p<0.001).
[40]	Cross-sectional	Convenience sampling	404 university students in Oman	General life stress/Stress subscale of DASS-42/Response-focused	SAS	Correlation	Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R= 0.508, p<0.05).
[41]	Longitudinal	Stratified random sampling	766 university students in China	General life stress/Stress subscale of DASS-21/Response-focused	SAS-SV	Correlation, Mediation	-Correlation analysis has shown that stress is significantly and positively correlated with problematic smartphone use (R=0.294, p<0.001) -Mediation analysis has shown that academic burnout mediated the relationship between stress and problematic smartphone use (β=0.074, p<0.001, 95% CI [0.046:0.117]).
[42]	Cross-	Not	608 college	General life	SAPS	Regression	-Regression analysis

Table 1. Study characteristics and findings (*Continue*)

Authors	Research design	Sampling method	Sample characteristic	Stress type/measure /perspective	Problematic smartphone use measure	Analysis	Relationship between stress and problematic smartphone use
	sectional	specified	students in Korea	stress/Single-item measure/Response-focused			has shown that stress is significantly and positively related to four subdimensions of problematic smartphone use: disturbance of adaptive functions (β=0.91, p<0.05), virtual life orientation (β=0.57, p<0.05), withdrawal (β=0.82, p<0.05), tolerance (β=0.74, p<0.05).
[43]	Cross-sectional	Not specified	148 patients with schizophrenia in Korea	General life stress/PSS-10/Transactional-focused	SAS	Correlation	-Correlation analysis has shown that stress is positively and significantly correlated with problematic smartphone use (R=0.340, p<0.001).
[44]	Cross-sectional	Cluster sampling	600 international students (Bachelor, Master, Doctoral) in China	General life stress/ PSS-14/Transactional-focused	(MPAI)	Correlation, Regression	-Correlation analysis has shown that stress is positively and significantly correlated with problematic smartphone use (R=0.113, p<0.05) -Regression analysis has shown that stress is positively and significantly related to problematic smartphone use (β=0.001, p<0.05).
[45]	Cross-sectional	Multi-stage cluster sampling	5109 students from middle school, high school, colleges in China	Domain specific: Academic stress/Single-item measure/Response-focused	MPAI	Correlation	-Correlation analysis has shown that academic stress is positively and significantly correlated with problematic smartphone use (R=0.164, p<0.01).
[46]	Cross-sectional	Not specified	339 university students in Korea	General life stress/PSS-14/Transactional-focused	SAPS	Correlation, Regression	-Correlation analysis has shown that stress is positively and significantly correlated with problematic smartphone use (R=0.366, p<0.001). -Regression analysis has shown that stress is positively and significantly related to problematic smartphone use (β=0.284, p<0.001).
[47]	Cross-sectional	Convenience sampling	1123 college students in China	General life stress/PSS-14/Transactional-focused	MPAI	Correlation, Regression, Mediation, Moderation	-Correlation analysis has shown that stress is positively and significantly correlated with problematic smartphone use (R=0.231, p<0.001). -Regression analysis

Table 1. Study characteristics and findings (*Continue*)

Authors	Research design	Sampling method	Sample characteristic	Stress type/measure /perspective	Problematic smartphone use measure	Analysis	Relationship between stress and problematic smartphone use
							has shown that stress is positively and significantly related to problematic smartphone use (β=0.211, p<0.001). -Mediation analysis has shown that online social support mediated the relationship between stress and problematic smartphone use (β=0.014, p<0.05, 95% CI [0.002:0.03]). -Moderation analysis has shown that perceived social support does not moderate the relationship between stress and problematic smartphone use (β=0.012, p>0.05, 95% CI [-0.069:0.078]).
[48]	Cross-sectional	Convenience sampling	100 college students in India	General life stress/Stress subscale of DASS-21/Response-focused	SAS-SV	Correlation	-Correlation analysis has shown that stress is positively and significantly correlated with problematic smartphone use (R=0.458, p<0.001).
[49]	Longitudinal	Not specified	96 general adults in Brazil	General life stress/Stress subscale of DASS-21/Response-focused	SAS-SV	Correlation	-Correlation analysis has shown that stress is positively and significantly correlated with problematic smartphone use (R=0.490, p<0.001).
[50]	Cross-sectional	Not specified	274 general adults recruited online (country not specified)	General life stress/Stress subscale of DASS-21/Response-focused	MPIQ	Correlation	-Correlation analysis has shown that stress is positively and significantly correlated with problematic smartphone use (R=0.27, p<0.05).