



Review

Antecedents and consequences of problematic smartphone use: A systematic literature review of an emerging research area[☆]

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ABSTRACT

This article provides a systematic review of existing research on problematic smartphone use (PSU) to guide other researchers in search of relevant studies, and to propose areas for future research. In total, 293 studies were analyzed leading to the development of an overview model in the field of PSU, presenting findings on demographic factors, explanations for smartphone use and why this use becomes problematic, consequences of PSU, and how such use can be corrected. In addition, we considered in which contexts, with which methods, and with which theoretical lenses this stream of research has been studied to date. Smartphone use is most often explained by the smartphone design, and users' emotional health and their ability to control smartphone use. Our review suggests that people who are young, female, and highly educated are more prone to PSU. Emotional health issues are the most frequently identified consequence of PSU. Strategies for correcting PSU fall into three categories: information-enhancing, capacity-enhancing, and behavior reinforcement strategies. The studies on PSU are most often conducted using quantitative surveys with university and college participants considering their personal smartphone use. Whereas a variety of theoretical frameworks have been adopted to investigate PSU, they are often related to identifying factors explaining use and problematic use, and more seldom to analyze the findings. A future research agenda for PSU is proposed consisting of seven key research questions which can be investigated by researchers going forward.

1. Introduction

Information systems (IS) research is often conducted under the premise that technology use is positive for society – leading to innovation, development, and value creation (Turel, Serenko, & Giles, 2011). However, we continue to see examples of technology use which do not create a better world (Turel et al., 2011; Walsham, 2012). For example, cases abound of where private details about individuals are exposed, fundamentalist groups are enabled to contact and recruit vulnerable people, and people have become overly attached to technologies. These unfortunate use of technology can have long-term and severe impacts on the quality of life for users of technology and their peers. Despite the notable practical and theoretical implications of problematic technology use, research efforts to date have been more focused on studying the positive sides of technology (Chen, Liu, et al., 2017).

The smartphone is one notable type of technology which can have negative use consequences. Smartphone use becomes problematic when

users have difficulties controlling their use and as a result suffers impaired daily functioning (Ezoe et al., 2009; Horwood & Anglim, 2018). These effects were recognized as early as 2006 when Americans popularized the term « CrackBerry » to describe the addictive nature of the BlackBerry smartphone (Turel, Serenko, & Bontis, 2008). Problematic smartphone use (PSU) may lead to various unfortunate consequences such as the lack of sleep (Lapointe, Boudreau-Pinsonneault, & Vaghefi, 2013), family conflicts (Turel et al., 2008), and the experience of imagined phone signals (Tanis, Beukeboom, Hartmann, & Vermeulen, 2015). It could also lead to more serious consequences such as dangerous driving (Soror, Steelman, & Limayem, 2012), depression (Harwood, Dooley, Scott, & Joiner, 2014), and anxiety (Hartanto & Yang, 2016).

PSU, therefore, concerns us not only on the individual level but also more broadly on an organizational and societal level. The smartphone has become one of the most widespread and influential technological innovations that we as a society immerse ourselves in and offers a

[☆] “When the phone was tied with a wire—humans were free”(unknown source).

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computing platform with greater portability than many other devices such as laptops and tablets (Barnes, Pressey, & Scornavacca, 2019; Bernroider, Krumay, & Margiol, 2014). Smartphones are widely used in various contexts such as in personal life, in encounters with private and public organizations, and in work life. As a result, the number of active mobile subscriptions are now estimated to exceed the total world population (Konok, Pogány, & Miklósi, 2017). Because smartphones are easily accessible, and their use socially acceptable, the actual frequency and duration required for smartphone use to become problematic are disputed (Kim & Koh, 2018). Despite an increasing body of research within this area, important questions remain about normative smartphone usage, and antecedents and consequences of PSU.

Given the potential for unfortunate consequences, researchers must create societal awareness about PSU, suggest normative smartphone use, and recommend how unfortunate consequences can be avoided and how problematic usage can be corrected to return to a healthy level (Mahapatra, 2019; Turel et al., 2008).

This article presents a systematic review of studies which have looked at PSU to date, summarizes what we know about the phenomenon, and suggests areas for future research. The literature review is guided by the following research questions:

1.1. RQ1. What factors explain smartphone use?

Technology use has often been explored through various technology acceptance and continuance models mostly underpinned by rational explanations such as perceived usefulness, perceived ease of use, and facilitating conditions. We are interested in knowing why people use smartphones.

1.2. RQ2. What are the antecedents of PSU?

Whereas smartphone use can be highly rational, engaging in problematic use may not. After initial adoption, researchers focus on why people continue to use the smartphone to the extent that the use is embedded or routinized in users' lives (Davazdahemami, Hammer, & Soror, 2016). These repetitive usage behaviors are defined as habit in the IS literature and can have negative consequences on the lives of the users (Davazdahemami et al., 2016; Turel et al., 2011). We are interested in explanations for why smartphone use can become problematic.

1.3. RQ3. Which demographic groups are most prone to PSU?

Over the past four decades, the personal computer has become publicly available for many people worldwide. Over time, other technological artifacts such as the smartphone, have become widespread in use, and for some, are now considered necessary to conduct everyday tasks. Adolescents today have not experienced a society without these artifacts and take them for granted. We are interested in knowledge about how factors such as age, gender, education, and contextual use impact proneness to PSU.

1.4. RQ4. What are the consequences of PSU?

Whereas outcomes of technology use are often considered favorable expecting gains in terms of productivity and quality (Bruzzi & Joia, 2015), studies of PSU have shown that excessive smartphone use can have severe effects on mental health and well-being (e.g., Samaha & Hawi, 2016). We are interested in learning about the various consequences of PSU identified in the literature.

1.5. RQ5. What strategies are used to correct PSU?

Knowing about potential ill consequences of PSU, it is important to create awareness and gain knowledge about unhealthy use for it to be corrected and brought back to normal use levels. We seek to understand

what measures can be taken to help people suffering from PSU.

This review presented in this article has analyzed 293 articles about PSU published between 2008 and 2019. To identify studies, we searched Scopus, Web of Science, and PsycInfo for high-end journals and conference proceedings across multiple disciplinary fields such as psychology, sociology, medicine, and computer science. The remainder of this article is organized in the following manner. First, we describe our understanding of PSU derived from the studies included in our review. Thereafter, we present our methodology for searching, identifying, and analyzing the studies. Then, we lay out the main characteristics of the studies before we answer our research questions. The literature review ends with a discussion of potential areas for future research and a summary of our main findings and discussion points.

2. Problematic smartphone use

PSU, also often referred to as smartphone addiction (e.g., Sun, Liu, & Yu, 2019) or nomophobia (no mobile phone phobia) (e.g., Tams, Legoux, & Léger, 2018), has garnered increased attention from researchers and public health practitioners in recent years. However, given the relatively recent emergence of PSU as an area of research, definitions on the concept are still evolving (Horwood & Anglim, 2018; Nahas, Hlais, Saberian, & Antoun, 2018). PSU is broadly defined as a compulsive pattern of smartphone usage which can result in negative consequences that impair the daily functioning of the user (Ezoe et al., 2009; Horwood & Anglim, 2018; Lepp, Li, & Barkley, 2016; Shin & Dey, 2013). Compulsive use refers to an uncontrollable overuse characterized by maladaptive dependency (Chen, Liu, et al., 2017) and a tendency to use the smartphone without being separated from it (Cho & Lee, 2017). Negative consequences refer to symptoms such as withdrawal, and impeded user productivity, social relationships, physical health, or emotional well-being in daily life (Horwood & Anglim, 2018; Shin & Dey, 2013).

Literature has also discussed PSU in relation to the setting in which the smartphone is used (Lepp et al., 2016; Shin & Dey, 2013; Soror et al., 2012). For instance, PSU in the bedroom during normal hours of sleep has been linked to poor sleep quality and sleep disorders (Bernroider et al., 2014), while PSU in the classroom has been linked to procrastination (Rozgonjuk, Kattago, & Täht, 2018). Furthermore, dangerous smartphone use has been put forward as a specific type of PSU, where usage of the smartphone places the user or other individuals at risk of injury (Soror et al., 2012; Steelman, Soror, Limayem, & Worrell, 2012). Dangerous smartphone use can result in road traffic injuries from smartphone use while driving, as well as pedestrian collisions and falls from smartphone use while walking (Chang et al., 2019; Soror et al., 2012).

A number of scholars have conceptualized PSU as an addiction, one which is non-chemical and behavioral in nature (Billieux, 2012; Contractor, Frankfurt, Weiss, & Elhai, 2017; Enez Darcin et al., 2016; Gökçeşlan, Mumcu, Haşlamam, & Çevik, 2016). Davazdahemami et al. (2016) further differentiate between addiction to a mobile phone and addiction through a mobile phone (i.e., where the user becomes addicted to a mobile phone application). Some researchers have described smartphone addiction as analogous to other forms of addiction such as gambling or internet addiction given that it may similarly lead to an uncontrolled psychological dependency on use, craving, withdrawal symptoms, and anxiety when not available (Bian & Leung, 2015; Jun, 2016; Seo, Kim, & David, 2015).

While the concepts of 'smartphone addiction' and 'PSU' are often used interchangeably (Nahas et al., 2018), some scholars assert that use of the term addiction in the context of PSU is controversial (cf. Seo et al., 2015). It is argued that problematic use should not necessarily be considered an addiction *prima facie* as it may also derive from other sources such as obsessive compulsive checking (Steeleman et al., 2012), loneliness (Kim, 2017, 2018), anxiety (Contractor et al., 2017), or unresolved real-life problems (Wang, Wang, Gaskin, & Wang, 2015). For

instance, [Steelman et al. \(2012\)](#) note that while addiction motivates repeated behaviors in order to achieve pleasure, obsessive compulsive checking in contrast aims to reduce anxiety and distress. [Steelman et al. \(2012\)](#) also point out that research on the influence of addiction on mobile phone use has only been able to explain part of the phenomenon with R2 values ranging from 10 to 27% (cf. [Beranuy, Oberst, Carbonell, & Chamarro, 2009](#); [Leung, 2008](#)). Whereas the term ‘addiction’ should be used with caution, PSU shares characteristics similar to other addictive behaviors, which is why our review on PSU includes literature discussing such behaviors.

In this paper, PSU is defined as the recurrent craving to use a smartphone in a way that is difficult to control and leads to impaired daily functioning (adapted from [Ezoe et al., 2009](#); [Horwood & Anglim, 2018](#)). The remainder of this paper is dedicated to presenting a systematic review of literature on PSU. In particular, the main focus of the literature review is to investigate potential antecedents of the recurrent craving of smartphone use and how user’s daily functioning is impaired as a result. However, it should be noted that our definition of PSU does not consider the inappropriate or illicit usage of smartphones e.g., sending unwarranted nude photos without the recipient’s consent; contacting and recruiting vulnerable people for fundamentalist groups; or disseminating private or falsified details about another individual. While these forms of smartphone use are indeed problematic, our definition aligns with the majority of papers in our sample by solely focusing on instances where smartphone use results in recurrent cravings and impaired daily functioning.

3. Methodology

This study follows the guidelines for systematic literature reviews presented by [Kitchenham \(2004\)](#), and has been conducted in seven steps: (1) development of a review protocol, (2) identification of research, (3) selection of relevant studies, (4) supplementary searches, (5) quality assessment of studies, (6) data extraction, and (7) data synthesis. The first step was to make a plan for executing the review. The protocol was peer reviewed prior to the study and changes were made to the protocol based on the provided feedback. The protocol clarified several aspects of the review: study rationale, search engines, outlets, research questions, search strings and identification of studies, study selection criteria, and data extraction. The protocol functioned as a detailed manual to ensure rigor in the review process. The protocol is provided as supplementary material to this review.

Given the relatively newfound interest in the phenomenon of PSU, we aimed for exhaustiveness in our search. Hence, we included as many articles from journal and conference outlets as possible. In particular, we completed comprehensive searches on Scopus, Web of Science, and PsycInfo databases. To identify literature, we first sought to identify appropriate search words for our review. These were selected based on several initial literature searches where titles, abstract, and definitions were read. The initial investigations showed that research on PSU adopted a variety of terms, and therefore, several search strings were necessary to capture as much of the extant literature as possible. During the initial screening of the articles, additional search terms were identified and used. The terms (a) smartphone, (b) ‘mobile phone’, and (c) ‘cell phone’ were the strings we combined with the terms ‘problematic use’, addiction, dependence, overuse, obsessive, and disorder. In the database, titles, abstracts, and keywords were searched to ensure relevancy. Our argument is that if the selected search strings were not mentioned in these fields, the article was most likely not relevant for our study since our search strings could appear in passing in some articles without constituting the main focus in them. The initial search identified 788 journal and conference articles.

In the third step, non-relevant studies were excluded. Exclusion was based on seven criteria described in more detail in the review protocol (number of excluded articles in parentheses): duplicates (165), accessibility (56), research-in-progress articles (21), recurrence of study (18),

articles written in a non-English language (10), non-research articles (8), and articles with anonymous author (1). After exclusion, we assessed the remaining articles based on three criteria described in more detail in the review protocol (number of articles not matching the inclusion criteria in parentheses): not pertinent to our research questions (115), articles mainly focusing on developing measurement instruments (94), and not focusing on smartphones (7).

We thereafter engaged in backward and forward reference searching as the fourth step. These techniques involve identifying research cited in an already identified article (backward; we build on literature reviews by peers) and research citing an already identified article (forward; we include research by peers who showed interest in the same articles as us). The search for literature ended in identifying a total of 293 articles.

In the fifth step, we conducted a quality assessment of all the articles in our dataset. To guide the assessment, we adapted the validated quality assessment criteria and scoring measures developed by [Beecham et al. \(2008\)](#), detailed in the review protocol. In particular, we adapted the ‘response options for scoring’ slightly by adding a ‘moderate’ response option for the first, third, and sixth assessment criteria. This provided us with a more nuanced scoring system to aid the quality assessment of our extensive literature review. Following [Beecham et al. \(2008\)](#), we used the scoring as a heuristic to assess quality rather than as a basis to reject a study. We first examined a sample of 15 articles and compared results to ensure scoring consistency. We then independently reviewed the remainder of the articles in our set of articles to generate a score for each article. The data was normalized by recording the percentage score. Overall, the majority of articles in the sample were rated as “good” or “very good” by the authors.

In the sixth step, we examined each article independently to identify core characteristics of PSU research and answers to our research questions. A list of the identified articles was made listing their core focus and research questions, theoretical frameworks, methodological approaches, and conclusions. The title, abstract, introduction and conclusion for each article were read. Other parts of an article were read if necessary to extract relevant data. To assure consistency in the data extraction, two reviewers worked through all the coded articles and discussed problematic issues together until discrepancies were resolved. [Appendix A](#) lists all the reviewed articles with their individual core focus, methodology, and sample.

The final step consisted of synthesizing the literature to answer our research questions. The synthesis was based on our data extraction and in-depth reading of the articles if necessary. To understand antecedents of smartphone use (RQ1) and PSU (RQ2), we first derived all factors from the data extraction. Each researcher analyzed the list to (1) remove recurring factors and (2) categorize them. The categorization was demanding since it required researchers to read articles in-depth to identify and/or assess whether the factors explained smartphone use or PSU. The categorization was discussed between the researchers until agreement around the coding process was achieved. To gain high-level insights into the demographic groups which are most prone to PSU (RQ3), we categorized studies based on the demographic factors age, gender, educational level, and occupation. Finally, we investigated the associated consequences of PSU (RQ4) and strategies that can be used to correct PSU (RQ5). This process followed the same procedures as earlier where we (1) removed recurring consequences and strategies, (2) categorized them, and (3) discussed the categorization until agreement was achieved between the researchers.

4. Descriptives

The research interest in PSU is relatively newfound. Our literature search resulted in a list of 293 articles, the earliest article identified being a study from 2008. *Computers in Human Behavior* was the most favored journal and [Oulasvirta, Rattenbury, Ma, and Raita \(2012\)](#) the most cited article (according to Google Scholar). The number of published articles and citations varies by each year. To illustrate the

research interest in PSU, we calculated a research interest factor (RIF) by dividing the number of Google Scholar citations the reviewed articles received each year by the accumulated number of citable articles for each year (i.e., as soon as they became available online). Thus, the RIF shows how many citations each citable article in our review receives each year on average. For example, 218 out of the 293 articles in our review were citable in 2018 receiving 2946 citations resulting in a $RIF = 13.51$. Incorrect and undated citations were removed before calculating the RIF. The procedures to calculate the RIF are described in more detail in the review protocol. Fig. 1 depicts the research interest in PSU in the years 2008–2019.

PSU has received attention from researchers all over the world (46 different countries representing all parts of the world). Researchers from South Korea, the United States, and China are the most active in this stream of research. Their affiliation was used to associate them with a research discipline showing that research within PSU is characterized by multidisciplinary collaborations involving IS, psychology, health, media and communication, management, education, and psychiatry. The research background of the authors influences the context in which the studies are conducted. Whereas other research disciplines have suggested that certain geographical areas are overrepresented such as the US/Anglo-centric perspective in public administration research, our review shows that PSU has been studied in different geographical areas with data from several countries, of which the United States and China were the most frequently studied. Smartphone use may differ based on geographical factors such as the digitalization rate in the country (Barnes et al., 2019), pressures to perform in business (Seo et al., 2015), and the level of parental control (Chang et al., 2019). Thus, the extent to which smartphone use becomes problematic can vary among countries.

A wide variety of theoretical frameworks have been adopted to investigate PSU. Based on our analysis, we found that more than 25 different theoretical lenses were used in the articles. However, the theories are often related to identifying factors explaining use and problematic use, and more seldom to analyze the findings. Also, there was frequently no specific theoretical lens employed. Considering all the lenses, theoretical frames looking at cognitive aspects were most frequent. Of the reviewed articles, the following theories were most frequently used: compensatory internet use theory (e.g., Elhai & Contractor, 2018; Elhai, Levine, Dvorak, & Hall, 2016; Hong et al., 2019; Rozgonjuk, Levine, Hall, & Elhai, 2018; Wang et al., 2015), extended self-theory (e.g., Clayton, Leshner, & Almond, 2015; Hartanto & Yang, 2016), the functionalist perspective (e.g., Chen, Liu, et al., 2017; Zhang, Chen, Zhao, & Lee, 2014a), uses and gratifications theory (e.g., Elhai & Contractor, 2018; Kim, Park, Lee, Ko, & Lee, 2019; Mei, Xu, Gao, Ren, & Li, 2018; Zhitomirsky-Geffet & Blau, 2016), social cognitive theory (e.g., Chen, Liu, et al., 2017; Kim, Park, Lee, et al., 2019), and attachment theory (e.g., Eichenberg, Schott, & Schroiff, 2019; Li & Hao, 2019; Zhang, Tan, & Lei, 2019).

Only a few studies applied (combinations of) qualitative methods

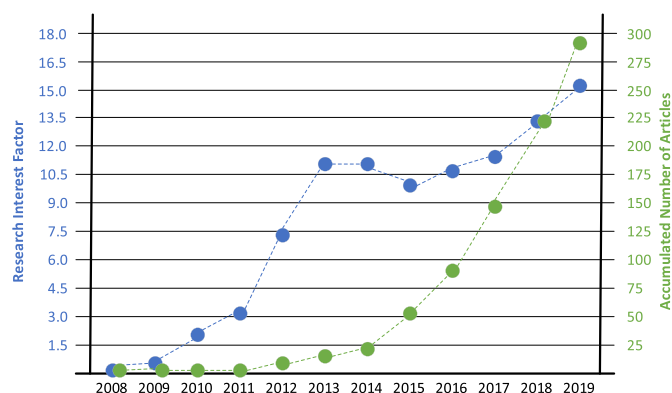


Fig. 1. Research interest in PSU (2008–2019).

using interviews, experiments, focus groups, cluster analysis, and analysis of documents. Six of the studies used mixed methods approaches applying both qualitative and quantitative methods. The rest of the studies applied quantitative research methods. During our review of the studies, we observed that several quantitative studies did not provide readers with the research model and results of the hypotheses. We encourage authors to do so, since a study becomes easier to understand and the main findings are more easily identified. Many of the studies applied well-defined and validated measurement scales. However, we would like to point out the value of including the measurement instruments where items have been developed or adapted for other researchers to reuse them and/or replicate studies. Appendix B lists measurement instruments used to measure PSU in the quantitative studies (for additional instruments, see e.g., Billieux (2012), De-Sola Gutiérrez, Rodríguez de Fonseca, and Rubio (2017), and (Harris, Regan, Schueler, & Fields, 2020). Several of the studies measured other constructs as well, which are not included in Appendix B. Furthermore, reliability is stated in the appendix using values from Cronbach's Alpha tests. However, some of the studies used the newer composite reliability (CR) to claim measurement reliability.

The samples were biased in terms of types of informants where university students comprised the majority of them. It is debatable whether students are representative of the general population (Peterson, 2001) and smartphone users in general. For example, people working and receiving salaries are faced with tougher requirements to perform than students, children do not have the same cognitive capabilities as adults, and elderly people are less used to smartphones because they have not grown up with them. Thus, researchers should exercise caution when attempting to extend findings from using student subjects to non-student populations (Peterson, 2001).

The number of respondents across the quantitative studies ranged from about a hundred to nearly ten thousand. The studies reported a slight majority of female respondents. Some of the studies (e.g., Chotpitayasonondh & Douglas, 2016; Contractor et al., 2017; Elhai et al., 2016; Seo et al., 2015; Steelman et al., 2012; Tanis et al., 2015) recruited their respondents from Amazon's Mechanical Turk (MTurk); a crowdsourcing internet marketplace where work can be posted for pay (Buhrmester, Kwang, & Gosling, 2011). The service was originally intended for internal purposes, but has evolved to be open for both people requesting work to be done and people with various backgrounds completing this work (Landers & Behrend, 2015). Social science researchers have used MTurk since at least 2009 to recruit participants for a variety of topics and research designs (Buhrmester et al., 2011; Landers & Behrend, 2015). The included studies in this literature review used MTurk exclusively for surveys. Sampling based on MTurk is debatable since it could (1) facilitate repeated completions of different forms for different studies, (2) raise concerns over the participants' commitment due to low compensation, (3) create selection bias because participants can choose not to complete the forms, and (4) be non-representative of working populations (Landers & Behrend, 2015).

Whereas these concerns are not without merit, we consider MTurk as a promising option for researchers studying PSU. It could address the problems with severe oversampling of university students and recruit participants from developing countries (e.g., African countries which are underrepresented in the reviewed studies), from different organizational contexts (the reviewed studies mainly considers smartphone use in general, i.e., both work-related and private use), and with different educational backgrounds (e.g., other users than those who are highly educated). Studies in our review reporting monetary compensation paid MTurk respondents modestly (ranging from 20 cents to \$1.5).

The consistency in terms of the applied research methods imply that research on PSU has reached some agreement, and that researchers vary their perspectives based on explanations for PSU, consequences, mediators, and moderators. The various research endeavors within PSU are presented in Fig. 2.

Fig. 2 can also be mapped to the aforementioned research questions

in this paper, which aims to provide a broad overview of PSU studies to date in literature. Firstly, factors explaining smartphone use map to RQ1. Factors explaining PSU map to RQ2, and actors and settings map to RQ3. Consequences relate to RQ4. And lastly, evaluation relates to RQ5. Next, we describe research on PSU based on the perspectives represented in Fig. 2.

5. Research on PSU

In this section, we outline the different strands of research on PSU as depicted in Fig. 2 and represented in our five broad research questions. Based on an analysis of the findings from the systematic literature review, the authors coded factors associated with smartphone use, antecedents of PSU, and consequences of PSU into six overarching categories: emotional health, physical health, control, professional performance, social performance, and technology features. The factors, antecedents, and consequences are henceforth classified as ‘sub-categories’ in the proceeding tables. This classification was useful for making sense of the multitude of factors identified across the research questions and exploring overarching themes.

5.1. What factors explain smartphone use?

The categories of smartphone use investigated across all reviewed studies were largely consistent. Commonly investigated categories of smartphone use included: voice-calls, text, social media, instant messaging, email, information seeking (i.e., news headlines), web surfing, playing games, music/video streaming, taking photos/videos, functional apps (i.e., maps, calendar, clock, memo/note taking), and educational apps (i.e., online learning, school websites). More recently, studies have begun to increasingly study the relationship between specific types of apps available on their smartphone and an individual’s level of usage (Lee, Kim, & Choi, 2017; Prasad et al., 2018; Rozgonjuk, Kattago, et al., 2018); this contrast previous approaches which sought to

study smartphone use as a more holistic phenomenon, irrespective of the app used. However, the growing capabilities of smartphones mean they are no longer used solely for communication, and users can now utilize dedicated apps for other purposes such as gaming, web surfing, gambling etc. Positive associations have been found between smartphone usage and the availability of different features such as voice-calls, text, social media, email, instant messenger, video, gaming, functional apps etc. (Davazdahemami et al., 2016; Lapointe et al., 2013; Van Deursen, Bolle, Hegner, & Kommers, 2015). In particular, Noë et al. (2019) found that the social app Snapchat was associated with the highest levels of smartphone use, an app widely used by teenagers.

Many studies included in our review investigate both antecedents of smartphone usage and PSU in tandem, at times using the two terms interchangeably, or focusing on instances of high levels of smartphone usage. However, for the purposes of RQ1, we have focused on the factors explicitly associated with smartphone usage (regardless of the level of usage), rather than factors explicitly associated with PSU. A distinction should also be made between studies which adopted ‘self-reported’ measures of smartphone usage, and studies which adopted ‘actual’ measures of usage. While most studies included in our systematic review asked individuals to self-report their level of smartphone use, more recent studies have adopted objective measures of ‘real use’ using applications that monitor actual time spent on the smartphone; e.g., the duration and frequency of calls made using the smartphone (Noë et al., 2019; Yook, Park, Choi, Kim, & Choi, 2019). These studies suggest a discrepancy between self-reported assessment of mobile phone use and real use activity (Yook et al., 2019). Differentiations have also been made between screen time minutes and phone screen unlocking, suggesting different causal links for each (Rozgonjuk, Kattago, et al., 2018). This has implications for categorizing different levels of smartphone usage (e.g., light vs. heavy usage) across users, and understanding smartphone usage as an antecedent of smartphone addiction (Carbonell et al., 2012; Lee, Ahn, Choi, & Choi, 2014).

Based on our systematic literature review of RQ1, factors related to

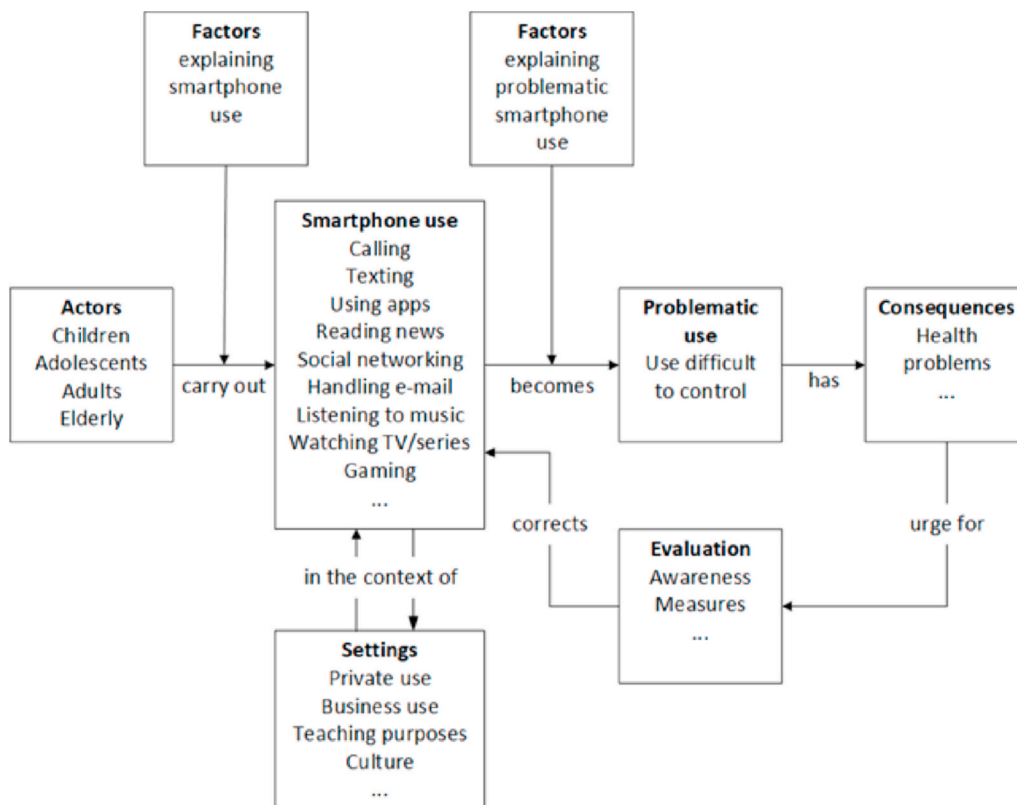


Fig. 2. Research on PSU.

emotional health constituted one of the primary reasons for smartphone use, suggesting that an individual's mental wellbeing may affect the degree to which they engage in smartphone usage. Smartphone use is often motivated by an individual's desire to experience an emotional lift and regulate or alleviate their mood through texting, email, and social media (Kim, Seo, & David, 2015; Shin & Lee, 2015; Zhang, Chen, Zhao, & Lee, 2014b; Zhang, Chen, Zhao, & Lee, 2014a). In particular, users may be more likely to engage in smartphone usage in order to alleviate negative moods such as depression and spend more time on communication activities via the smartphone to distract from their feelings (Elhai et al., 2016; Kim, Seo, et al., 2015). Nevertheless, the results are inconclusive as to whether depression constitutes an antecedent of smartphone usage (Nahas et al., 2018). In addition, individuals experiencing loneliness may be more likely to engage in smartphone usage to contact others in order to alleviate negative feelings and gain assurance from friends, family, or their partner (Bian & Leung, 2015; Kim, 2017; Lapointe et al., 2013). Lonely individuals may also become more reluctant to engage in face-to-face interaction, preferring smartphone-mediated communication instead (Kim, 2017).

Other studies have shown a positive association between an individual's desire to alleviate boredom and smartphone usage (Fullwood, Quinn, Kaye, & Redding, 2017; Lapointe et al., 2013) and an individual's desire for instant gratification and smartphone use (Rozgonjuk, Kattago, et al., 2018; aZhang et al., 2014; 2014b). These factors can in turn impede professional performance both within an academic and work setting, leading to distraction and decreased engagement with the task at hand. Habituation has been found to be a key driver of smartphone usage here, as conditioned patterns of usage tend to be repeated by individuals over time (Fullwood et al., 2017; Oulasvirta et al., 2012; Soror et al., 2012). Deficiencies in self-regulation and control can further contribute to higher levels of mobile phone use (e.g., Lee, Lee, et al., 2014; Soror et al., 2012), in turn affecting an individual's ability to alter their habits of smartphone use.

The main factor explaining smartphone use within the social performance category was the personality characteristics of individuals (Horwood & Anglim, 2018; Lapointe et al., 2013; Panda & Jain, 2018); in particular, studies employing the "big five personality traits" or Five-Factor Model suggest a positive relationship between extraversion and an individual's levels of smartphone usage, as extraverts are more likely to use their smartphone to socialize (Bian & Leung, 2015;

Horwood & Anglim, 2018; Lapointe et al., 2013). Meanwhile, negative relationships have been found between openness to experience and PSU (Kita & Luria, 2018), as well as conscientiousness (Prasad et al., 2018). Results on the impact of personality on smartphone use are not consistent however, with some studies finding no relationship between social extraversion and mobile phone usage behavior (Herrero, Torres, Vivas, & Urueña, 2019; Hong, Chiu, & Huang, 2012).

The most frequently identified moderator of smartphone use was age (Anshari et al., 2016; Elhai & Contractor, 2018; Nahas et al., 2018; Van Deursen et al., 2015). Studies have found that smartphone usage varied depending on which generation (i.e., X, Y, or Z) the participants belonged to. Most studies suggest that younger generations tend to use smartphones more heavily than older generations; nevertheless, Nahas et al. (2018) caution against this generalization by asserting that older adults still engage in considerable levels of smartphone use, which warrants further investigation. Gender was also identified as a moderator of smartphone use in a number of papers (Anshari et al., 2016; Davazdahemami et al., 2016; Elhai & Contractor, 2018; Lee, 2015; Lee, Lee, et al., 2014; Van Deursen et al., 2015; Volkmer & Lerner, 2019). Research on gender differences suggests that males have a more instrumental view of smartphone use, whereas females use the smartphone more to facilitate social interaction (Anshari, Alas, & Sulaiman, 2019; Chotpitayasunondh & Douglas, 2016; Hong et al., 2012; Lee, Lee, et al., 2014; Van Deursen et al., 2015). Women may also have a higher chance of developing habitual smartphone behavior (Van Deursen et al., 2015). Nevertheless, Salehan and Negahban (2013) found that the

moderating influence of gender on smartphone use was inconclusive. In addition, the papers showed that smartphone use can be moderated by context (Fullwood et al., 2017) and time spent on the smartphone (Panda & Jain, 2018).

5.2. What are the antecedents of PSU?

Table 1 presents our literature review results for the antecedents of PSU. The most commonly referenced cut-off point for determining when smartphone use becomes problematic was based on the work of Kwon, Lee, et al. (2013) and their Smartphone Addiction Scale (Chotpitayasunondh & Douglas, 2016; Contractor et al., 2017; Enez; Enez Darcin et al., 2016; Hartanto & Yang, 2016). Kwon, Lee, et al. (2013) suggest a cut-off score of >31 for males and >33 for females, with higher scores predicting a higher risk of PSU. Meanwhile, a cut-off score of 160 has been suggested for the original MPPUS-27 and an extrapolated cut-off score of 59 for MPPUS-10 (Nahas et al., 2018). Rozgonjuk, Kattago, et al. (2018) and Rozgonjuk, Levine, et al. (2018) also found that PSU was positively associated with an individual's average minutes of screen time over a week, which ranged from a minimum of 46.571 min over a week, to a maximum of 608.143 min over a week. In contrast, they found that average phone screen unlocks over a week was not associated with PSU. However, overall, there is a lack of consistency in the cut-off scores for determining when smartphone use becomes PSU, and there is no unanimously agreed cut-off score to determine PSU (F.-C. Chang et al., 2019; Nahas et al., 2018).

In terms of antecedents, control appears to be central to our understanding of how PSU emerges, with a number of studies suggesting that deficiencies in an individual's ability to self-regulate their smartphone use can lead to problematic habitual behaviors over time. Indeed, PSU is commonly defined as a poorly controlled occupation with the smartphone or usage behavior marked by a loss of control (Chang et al., 2019; Jeong, Kim, Yum, & Hwang, 2016; Roberts, Yaya, & Manolis, 2014). Individuals with poor self-control may be more likely to respond to notifications as soon as they appear, potentially creating a habitual dependence on their smartphone (increased use frequency and uncontrolled frequent checking) (Berger, Wyss, & Knoch, 2018). Both social and process related usage of the smartphone may also increase the risk of PSU through the development of habitual behaviors (Van Deursen et al., 2015). These habitual usage patterns can in turn lead to users repeatedly engaging in content consumption through the smartphone, especially when patterns are positively reinforced (Kwon, So, Han, & Oh, 2016; Lee, Lee, et al., 2014). Self-control can also mediate the relationship between stress and PSU, as individuals with poor self-control use their smartphone to deal with stress (Cho, Kim, & Park, 2017; Heo & Lee, 2018; Liu et al., 2018). However, in contrast, Kanhawongs, Jabutay, Upalanala, and Kanhawongs (2016) did not find a significant relationship between a respondent's self-regulation and PSU.

In addition, our systematic review suggests that PSU often arises in tandem with emotional health issues such as depression, anxiety, anger, and stress. Smartphone use can act as an avoidance strategy to distract from negative emotional experiences, potentially leading to the development of problematic usage trends. For instance, individuals experiencing anxiety may become dependent on their smartphone by regularly communicating (calls and messaging) with others, or engage in sensation seeking through entertainment to deal with their negative emotional state (Lopez-Fernandez, Männikkö, Kääriäinen, Griffiths, & Kuss, 2018; Wang et al., 2018). The effect may also be cumulative as Jun (2016) found a consistently increasing severity of PSU and depressive symptoms among respondents over a three-year period, and noted that the relationship between the two was bidirectional.

However, the link between both depression and anxiety sensitivity with PSU may be mediated by an individual's mindfulness i.e., their ability to consciously present and aware of what is being experienced in the moment (Elhai, Levine, et al., 2018; Yang, Zhou, Liu, & Fan, 2019). Meanwhile, positive associations were found between loneliness and

Table 1
Antecedents of PSU.

Category	Subcategory	References
Control	Habit, checking smartphone	Davazdahemami et al. (2016); Lee, U., Lee, J., Ko, M., Lee, C., Kim, Y., Yang, S., et al. (2014); Xie et al. (2018); Jilisha et al. (2019)
	Intolerance for uncertainty, need for compulsive control, dysfunctional impulsivities, propensity to risk Self-control, parental control, self-efficacy in exercising control, regulation, mood regulation, emotional lift, emotional gain, self-expressive benefits, self-directedness	Cho and Lee (2017); Rozgonjuk et al. (2019); Rho et al. (2019); b)Herrero, Torres, et al. (2019) and Herrero, Uruena, et al. (2019) Berger et al. (2018); Chen, Liu, et al. (2017) and Chen, Zhang, et al. (2017); Chotpitayasunondh and Douglas (2016); Davazdahemami et al. (2016); Gökçeşlan et al. (2016); Jeong et al. (2016); Kwon et al. (2016); Lee et al., 2014b; Shin and Lee (2015); Vaghefi et al. (2017); Van Deursen et al. (2015); Zhang et al. (2014b); Zhitomirsky-Geffet and Blau (2016); Lachmann et al. (2019); Kim, Park, Lee, et al. (2019); Rho et al. (2019); Servidio (2019); Lee and Kim (2018); Lee and Ogbolu (2018); Arpacı (2019); Ayar et al. (2017); Tang et al. (2017); Lee, Chang, Lin, and Cheng (2017); Kanthawongs et al. (2016); Roberts et al. (2015); Kim, Kim, Kim, et al. (2015); Chen, Liu, et al. (2017) and Chen, Zhang, et al. (2017); Yang et al. (2016); Kim, Min, Min, Lee, Yoo. (2018); Kim, M., Kim, H., Kim, K., Ju, S., Choi, J., and Yu, M. (2015); Yıldız (2017); Mitchell and Hussain (2018); Pivetta et al. (2019) Marchant and O'Donohoe (2019); Vaghefi et al. (2017)
Emotional health	Threats to smartphone user's sense of agency, obsessed Use frequency (overuse, smartphone usage, time spent on mobile, process and social oriented smartphone usage, daily usage time, average minutes of screen time over a week), forward-looking mindset (Extent of consumption inertia), use states (time availability), duration of ownership	Aljomaa et al. (2016); Elhai, Levine, O'Brien and Armour (2018); Elhai, Vasquez, Lustgarten, Levine, and Hall (2018); Gökçeşlan et al. (2016); Jeong et al. (2016); Khang et al. (2013); Kwon et al. (2016); Lee et al., 2014b; Rozgonjuk, Kattago, et al. (2018) and Rozgonjuk, Levine, et al. (2018); Salehan and Negahban (2013); C. Shin and Dey (2013); Van Deursen et al. (2015); Zhitomirsky-Geffet and Blau (2016); Kim, Park, Lee, et al. (2019); Tunc- Arnavut and Nuri (2018); Aktürk et al. (2018); Arnavut & Nuri, 2018; Lee and Kim (2018); Nayak (2018); Alhazmi et al. (2018); Ibrahim, Baharoon et al. (2018); Lopez- Fernandez et al. (2018); Cha and Seo (2018); Xie et al. (2018) Guazzini et al. (2019); Mahmoodi et al. (2018); Jilisha et al. (2019); Ayar et al. (2017); Bae (2017); Swar and Hameed (2017); Liu et al. (2016); Alosaimi et al. (2016); Ding et al. (2016); Lee, Seo, and Choi (2016); Cho and Lee (2016); Lee, Lee, and Lee (2016); Haug et al. (2015); Choi et al. (2015); Olufadi (2015); Demirci et al. (2015); Karadağ et al. (2015); Tossell et al. (2014); Lee, Arnavut and Nuri (2018); Carbonell et al. (2012); Boumosleh and Jaalouk (2017); Kim et al. (2016); Durak (2018); Chou and Chou (2019); Traş and Öztemel (2019); Sözbilir and Dursun (2018)
	Addiction-proneness, insecure attachment style, reinforcement rewards Anger, hostility, need frustration	Sapacz et al. (2016), Eichenberg et al. (2019) Dey et al. (2019); Firat et al. (2018); Li and Lin (2018); Gugliandolo et al. (2019); Kim, Kim, Kim, et al. (2015); Lee, Sung, et al. (2018); Kim et al., 2015b
Conscientiousness	Anxiety (social anxiety, psychological-social, attachment anxiety), somatization	Aljomaa et al. (2016); Elhai, Levine, et al. (2018) and Elhai, Vasquez, et al. (2018); Elhai, Levine, et al. (2018) and Elhai, Vasquez, et al. (2018); Enez Darcin et al. (2016); Han et al. (2017); Hong et al. (2012); Kim and Koh (2018); Lapointe et al. (2013); Lu et al. (2011); Sapacz et al. (2016); Vaghefi et al. (2017); Van Deursen et al. (2015); Rho et al. (2019); Guazzini et al. (2019); You et al. (2019); Dey et al. (2019); Firat et al. (2018); Lopez-Fernandez et al. (2018); Liu et al. (2019); Yuchang et al. (2017); Aker et al. (2017); De-Sola et al. (2017); Lee (2015); Mok et al. (2014); Boumosleh and Jaalouk (2017); Ayar et al. (2018)
	Depression, less optimistic than others	Lian and You (2017); Lee (2015); Pivetta et al. (2019); Mosalanejad et al. (2019); Lee, J., Chung, Y., Kim, S., Kim, J., Shin, I., Yoon, J., et al. (2019) Chang et al. (2019); Elhai, Levine, et al. (2018) and Elhai, Vasquez, et al. (2018); Elhai, Levine, et al. (2018) and Elhai, Vasquez, et al. (2018); Jun (2016); Kim, Seo, et al. (2015); Lu et al. (2011); Rozgonjuk, Kattago, et al. (2018) and Rozgonjuk, Levine, et al. (2018); Vaghefi et al. (2017); Lu, Xu et al. (2019); Rho et al. (2019); Dey et al. (2019); Lee and Ogbolu (2018); Aker et al. (2017); De-Sola et al. (2017); Kim, Kim, Kim, et al. (2015); Kim et al., 2015b; Boumosleh and Jaalouk (2017); Mitchell and Hussain (2018); Chiang et al. (2019); Kim, J.-H., Seo, M., and David, P. (2015) Lachmann et al. (2018)
Mindfulness	Empathy Escapism motivation, dissociative experiences, alexithymia (lack of emotional awareness)	Wang et al. (2015); De Pasquale et al. (2019); Mei et al. (2018); Gao, Zhang et al. (2018); Hao et al. (2019)
	Intensifying emotional investment in the human-smartphone assemblage (e.g., identity as an 'iPhone user') Impatience Loneliness	Marchant and O'Donohoe (2019) Arefin et al. (2018) Bian and Leung (2015); Enez Darcin et al. (2016); Jeong et al. (2016); Kim (2018); Lapointe et al. (2013); Mahapatra (2019); Durak (2018); Taghizadeh et al. (2019); Mosalanejad et al. (2019)
Mindfulness	Negative parenting style, child neglect, psychological abuse, parental phubbing, mothers' abusive parenting, parental attachment, parent-child communication, parental control	Lian et al. (2016); Sun et al. (2019); Xie et al. (2019); Jahng (2019); Zhang et al. (2019); Emirtekin et al. (2019); Li and Hao (2019); Lee and Kim (2018); Kwak et al. (2018); Gugliandolo et al. (2019); Lee and Lee (2017); Bae (2015); Lee, Sung, et al. (2018); Kim, Jun, et al. (2018) and Kim, Min, et al. (2018)
		Elhai, Levine, et al. (2018) and Elhai, Vasquez, et al. (2018); Volkmer and Lerner (2019)

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Table 1 (continued)

Category	Subcategory	References
	Personality distortion, disturbances, narcissism	Cho and Lee (2017); Xie et al. (2018); Pearson and Hussain (2017)
	Stress, Post-traumatic Stress Disorder (PTSD), psychological distress, distress tolerance	Beranuy et al. (2009); Chiu (2014); Contractor et al. (2017); Elhai, Levine, et al. (2018) and Elhai, Vasquez, et al. (2018); Jeong et al. (2016); Lapointe et al. (2013); Liu et al. (2018); Samaha and Hawi (2016); Volungis et al. (2019); Gökçearsan et al. (2018); Lachmann et al. (2018); Lopez-Fernandez et al. (2018); Cho et al. (2017); Kuang-Tsan and Fu-Yuan (2017); Long et al. (2016); Mosalanejad et al. (2019)
	Well-being, emotional stability, negative emotions, neuroticism, mental state, emotional suppression, withdrawal	Volkmer and Lerner (2019); Kim, Park, Lee, et al. (2019), Rozgonjuk and Elhai (2019); Lachmann et al. (2018); Xie et al. (2018); Gao et al. (2017); Roberts et al. (2015); Lee (2015); Mok et al. (2014); Yildiz (2017); Arefin et al. (2018); Pivetta et al. (2019); Hanafi et al. (2019)
	Physical health	Individual's health status, physical status, drinking, smoking, cannabis use
	Over-exercise, perception og being overweight	
	Physical predisposition	
	Sleep quality	
	Preconditions	Domestic violence, characteristics of the family (e.g., alcoholism) Characteristics of the father (e.g., educational level) and the mother (e.g., income)
	Professional performance	Pastime Academic performance, perceived academic competence
		Attention Deficit Hyperactivity Disorder
		Boredom
		Cyberloafing, trait procrastination
		Workload context, dependence on smartphone for work
		Personality (e.g., social extraversion)/self-traits, personality beliefs
		Conformity, need for approval, social environment pressure to use a smartphone, need to belong
		Daily-life disturbance
		Evolving identities
		FoMO, fear of rejection, abandonment, avoidant attachment, envy
		Isolation, interference with daily life, shame
		Romantic relationships
		Shyness, social liquidity (i.e., the ease with which one can establish interpersonal relationships), introversion, self-esteem, social assurance, social self-efficacy, interpersonal sensitivity, relational maladjustment, adult attachment, attachment to friends
		Social relationships, relationship with teacher, association with classmates, social support, social involvement, phubbing, cyber friendship
		Socialization practices, need for immediate connection
		Victim of bullying (cyber and traditional)
		Preoccupation, cognitive absorption, engagement
		Breakdowns as material and immaterial components failed to interact as expected
		Mobile use motives, user needs, entertainment motivation
		Need for touch
		Ownership of a smartphone, unlimited mobile data
		Personalization of components and capacities, role of smartphone in life
		Satisfaction, perceived enjoyment, mobile flow, sensation seeking
		Self-reported internet safety literacy

(continued on next page)

Table 1 (continued)

Category	Subcategory	References
	Smartphone use classes, type of smartphone use, various mobile apps, social networking sites and instant messaging, gaming, internet addiction/app addiction, task context	Chang et al. (2019); Chotpitayasunondh and Douglas (2016); Davazdahemami et al. (2016); Elhai and Contractor (2018); Jeong et al. (2016); Lee, S.-J., Lee, C., and Lee, C. (2016); Nahas et al. (2018); Zhitomirsky-Geffet and Blau (2016); Kim, Park, Lee, et al. (2019); Mahmoodi et al. (2018)
	Technological dimensions, smartphone characteristics, design (ease of use, speed, useful, efficient, convenient, portable, easily accessible), materialism	Aljomaa et al. (2016); Kwon et al. (2016); Lapointe et al. (2013); Shin and Lee (2015); Vaghefi et al. (2017); Chen, Zhang, Xiang et al. (2019); Chen and Pai (2018); Yoon Y.W. with Lee, Chang, et al. (2014); Long et al. (2019); Lee, Y.-K., Chang, C.-T., Lin, Y., & Cheng, Z.-H. (2014)

PSU, where individuals experiencing loneliness tend to rely more on their smartphone to connect with others, in turn leading to problematic behaviors (Bian & Leung, 2015; Enez; Enez Darcin et al., 2016; Kim, 2018; Lapointe et al., 2013; Mahapatra, 2019). Finally, emotional pain inflicted from parents has also been shown to increase the likelihood of PSU as the smartphone may be used as a means to avoid dealing with past traumas such as child neglect and psychological abuse from parents (Lian, You, Huang, & Yang, 2016; Sun et al., 2019; Xie, Chen, Zhu, & He, 2019).

Social relationships have been identified as another antecedent of PSU by a number of studies. Individuals with large social networks may rely on smartphones more than others to maintain relationships, making them susceptible to PSU over time. Nevertheless, this link has not been consistently demonstrated and some studies did not find any significant connection between PSU and social connectedness or social relationships (Chen, Liu, et al., 2017; Ihm, 2018; Sapacz, Rockman, & Clark, 2016). Similarly, Li and Lin (2019) found that a dependence on smartphones for communication has no influence on PSU. However, a significant relationship was found between self-esteem and PSU, suggesting that PSU may be affected by an individual's confidence in their own worth or abilities (Hong et al., 2012; Kim & Koh, 2018). Individuals suffering from low self-esteem may experience a strong need for social assurance by contacting friends, partners, and family, using the smartphone as a means of multi-communication (Seo et al., 2015). This in turn can make them more at risk of developing a reliance on their mobile phone, potentially leading to problematic usage. Similarly, shyness may moderate PSU through social anxiety for adolescents with a higher level of relatedness need satisfaction from the smartphone (Hong et al., 2012). Taken together, this suggests that self-esteem, shyness, and social anxiety may be confounding antecedents of PSU (Kim, Cho, et al., 2017). A number of studies have utilized the Five-Factor Model to investigate the impact of personality on PSU as well. In general, they find that individuals with the personality trait of extroversion may be susceptible to PSU given their heightened motivation to engage in frequent communication using the smartphone to form and maintain relationships (Hong et al., 2012; Li & Lin, 2019; Panda & Jain, 2018). Individuals with the trait of neuroticism may also develop an excessive dependence on the smartphone due to social anxiety and their need to constantly seek reassurance from peers through smartphone mediated communication (Horwood & Anglim, 2018; Li & Lin, 2019). The relationship between other personality traits (e.g., agreeableness and conscientiousness) and PSU was generally negative but inconclusive overall (Lee, 2015; Lee, Chung, et al., 2019; Panda & Jain, 2018).

Technology features of smartphones have been identified as a further antecedent of PSU. Features and characteristics related to the smartphone design such as ease of use, speed, portability, and accessibility may contribute to PSU (Aljomaa, Qudah, Albursan, Bakhtiet, & Abduljabbar, 2016; Kwon et al., 2016; Lapointe et al., 2013; Shin & Lee, 2015; Vaghefi, Lapointe, & Boudreau-Pinsonneault, 2017). The availability of applications such as social networking services (SNS) and instant messaging (IM) was also identified as an antecedent of PSU (Chang et al., 2019; Nahas et al., 2018; Zhitomirsky-Geffet & Blau, 2016), as was smartphone/tablet gaming and other forms of entertainment (Chang et al., 2019; Jeong et al., 2016; Nahas et al., 2018; Zhitomirsky-Geffet & Blau, 2016). Some studies suggest that individuals who use their

smartphones as a pastime without any productive interest are more likely susceptible to PSU (Chen, Liu, et al., 2017; aZhang et al., 2014). However, more recent studies have offered contradictory evidence around the impact of mobile gaming on PSU, suggesting that individuals that regularly use mobile gaming are not necessarily at a higher risk of addiction to their smartphone or problematic use (Lopez-Fernandez et al., 2018). Mobile game addiction was also shown to have no significant impact on students' academic performance (Fabito et al., 2018).

Nevertheless, professional performance may itself constitute an antecedent of PSU, and students with below average academic performance were more at risk of PSU (Chang et al., 2019; Samaha & Hawi, 2016). Rozgonjuk, Kattago, et al. (2018) and Rozgonjuk, Levine, et al. (2018), looking at a student cohort, found that the relationship between procrastination and PSU may be mediated by social media use in lectures, diverting attention from the lecturer.

5.3. Which demographic groups are most prone to PSU?

Our review suggests that a number of demographic groups may be prone to PSU. Firstly, age has been identified as a predictor of PSU by previous research (e.g., Billieux, 2012; De-Sola, Talledo, Rubio, & de Fonseca, 2017). Most studies found that younger age predicted higher levels of PSU (Aljomaa et al., 2016; Anshari et al., 2016; Elhai, Levine, et al., 2018; Hong et al., 2019; Lu et al., 2011; Nahas et al., 2018; Rozgonjuk, Kattago, et al., 2018; Rozgonjuk, Kattago, et al., 2018; Tanis et al., 2015; Van Deursen et al., 2015), with smartphone users in the adolescent age group most at risk (e.g., Chang et al., 2019; Kim & Koh, 2018). Yet other studies looked at differences between generations (Ahn & Jung, 2016; Gentina, Tang, & Dancoine, 2018; Zhitomirsky-Geffet & Blau, 2016). Findings suggest that, although usage remains the same, Generation Y (the middle generation) has the highest addictive behavior rate (Kim, 2017; Zhitomirsky-Geffet & Blau, 2016), followed by Generation Z, and Generation X has the lowest addictive behavior level (Zhitomirsky-Geffet & Blau, 2016). However, while older generations may feel comfortable living without their smartphones, younger generations do not, and some of the young generation even agreed that they would rather give up their breakfast than give up their phones (Anshari et al., 2016). Differences may also be explained by digital nativity since the young generation has been exposed to smartphones at a younger age, increasing their reliance on the technology over time (Ahn & Jung, 2016; Anshari et al., 2016; Boumosleh & Jaalouk, 2017; Wang, Sigerson, & Cheng, 2019; Wang, H.-Y., Sigerson, L., and Cheng, C. (2019)). Despite this, digital natives may be better able to understand PSU as actual users of smartphones, compared to non-digital natives who can only recognize it as outside observers (Ahn & Jung, 2016).

However, results are inconclusive as some studies did not find a relationship between age and PSU (Barnes et al., 2019; Clayton et al., 2015; Elhai & Contractor, 2018; Elhai, Levine, et al., 2018; Enez; Enez Darcin et al., 2016; Lapointe et al., 2013; Panda & Jain, 2018; Rozgonjuk, Kattago, et al., 2018; Vaghefi, Lapointe, & Boudreau-Pinsonneault, 2017). Reasons for this may be attributed to the fact that there was not much variety with respect to age in many of the samples since respondents mostly were university students (e.g., Elhai, Levine, et al., 2018; Vaghefi et al., 2017). Additional explanations have also been studied finding different predictors of PSU when other factors

were included in addition to age (Beison & Rademacher, 2016; Elhai, Levine, et al., 2018; Horwood & Anglim, 2018; Randler et al., 2016). These findings suggest that although determining high-risk groups based on age offers an efficient approach, there may exist atypical cases which can be neglected such as high-risk individuals from age groups deemed to be low risk in general (Wang, Sigerson, et al., 2019).

Several of the studies in our review were also interested in gender differences in PSU. Whereas the highest risk group of PSU is yet to be discovered, most extant research seems to suggest that females are more prone to PSU than men (Arpaci, 2019; Beranuy et al., 2009; Billieux, 2012; De-Sola et al., 2017; Elhai, Levine, et al., 2018; Harwood et al., 2014; Hong et al., 2019; Horwood & Anglim, 2018; Jeong et al., 2016; Kruger & Djerf, 2017; Lee, 2015; Lee, Chang, Lin, & Cheng, 2014; Nayak, 2018; Randler et al., 2016; Seo et al., 2015; Wang et al., 2015). Using different typifications of smartphone users, researchers found that females were highly over-represented in the 'addicts' category (Lapointe et al., 2013; Vaghefi et al., 2017), and also among 'fanatics' and highly engaged users (Vaghefi et al., 2017). However, yet other studies found that men were more prone to PSU than women (Aljomaa et al., 2016; Jilisha, Venkatachalam, Menon, & Olickal, 2019; Kwon et al., 2016; Lu et al., 2011).

Gender-specific interventions have consequently been proposed as a means of tackling PSU (Lee, S.-Y., Lee, D., Nam, C. R., Kim, D. Y., Park, S., Kwon, J.-G., et al. (2018); Lee & Kim, 2018; Mahmoodi et al., 2018). For instance, females may be more likely to use their smartphone while driving than males (Anshari et al., 2016), while males may be more likely to experience cyberbullying as a consequence of PSU (Qudah et al., 2019). Nevertheless, results are inconclusive as our review revealed that many studies were not able to identify any correlation between gender and PSU (Barnes et al., 2019; Chang et al., 2019; Clayton et al., 2015; Elhai & Contractor, 2018; Elhai, Levine, et al., 2018; Hadlington, 2015; Kwon et al., 2016; Panda & Jain, 2018; Rozgonjuk, Kattago, et al., 2018; Rozgonjuk, Kattago, et al., 2018; Salehan & Negahban, 2013; Van Deursen et al., 2015; Zhitomirsky-Geffet & Blau, 2016). As a final note on gender differences, researchers have raised concerns about gender's moderating effects since gender differences usually are related to culture (Chen, Liu, et al., 2017).

In terms of occupation, none of the reviewed studies concluded on how different occupations engaged in PSU. Whereas most of the studies used students as respondents, they were not included in the studies due to their occupation, but rather based on their age and out of convenience for the researchers. Some of the studies investigated how different educational levels influenced proneness to PSU. Whereas early research showed that educated people were more likely to become engaged in problematic technology use, additional studies found no specific distinction between different demographic groups. Our review revealed inconsistent findings suggesting that both those with lower formal education (Kwon et al., 2016; Shin & Dey, 2013) and higher formal education (Barnes et al., 2019) tend to exhibit greater control over their smartphone use. A few studies did not identify any relationship between these socio-demographic factors and PSU (Ayar et al., 2017; Enez, Enez Darcin et al., 2016; Vaghefi et al., 2017).

5.4. What are the consequences of PSU?

Table 2 presents an overview of the consequences of PSU derived from our literature review. The overview shows that the researched consequences of PSU vary from those which are less serious such as negative emotions and being less resilient to distractions (Chen et al., 2016; Hadlington, 2015; Vaghefi et al., 2017). Whereas most studies are conducted basing their findings on self-perceptions of PSU, other studies use more objective measures such as an app. The use of self-perceptions is disputed since smartphone users may misjudge their use. While Park (2019) found that smartphone users got angry when they were unable to use their devices but still denied that they were addicted to the smartphone, Dharmadhikari, Harshe, and Bhide (2019) found the high

self-awareness among students of their PSU promising. Whereas the reviewed articles study a variety of consequences, none of them have focused on differences based on the type of smartphone (see Table 3).

PSU is found to affect emotional health more than physical health (e.g., Panda & Jain, 2018). In addition, research on the impact on physical health is more scarce than on emotional health. Studies investigating emotional health problems have looked at a variety of consequences such as loneliness, self-esteem, anger, and anxiety. Studies in this category resemble those of other categories; namely that they are also studied as antecedents and to some extent also as mediators and moderators. The fragmented focus in these studies suggests that the consequences of PSU are not clear.

To illustrate these claims, we will point out some ambiguities in the literature. Anxiety is much researched as a consequence of PSU (e.g., Clayton et al., 2015; Elhai et al., 2016; Hartanto & Yang, 2016; Hawi & Samaha, 2017; Park, 2019; Rozgonjuk, Kattago, et al., 2018; Sapacz et al., 2016). Several studies found that smartphone separation, being in the risk of becoming a problematic smartphone user, and PSU led to increased anxiety (e.g., Clayton et al., 2015; Elhai, Rozgonjuk, Alghraibeh, et al., 2019; Hartanto & Yang, 2016). However, studying smartphone usage and involvement, Harwood et al. (2014) found that neither higher involvement nor usage were associated with higher levels of anxiety. Furthermore, Nayak (2018) found that PSU had hardly any effect on females while males experienced severe problems such as feeling anxious, neglecting work, and losing control of themselves. These ambiguities certainly call for more research, and in particular, to establish the conditions under which PSU leads to increased anxiety levels in smartphone users.

Likewise, studies focusing on depression as a result of PSU come to contradictory conclusions. Whereas some studies conclude that PSU does not lead to depression (e.g., Elhai et al., 2016; Rozgonjuk, Kattago, et al., 2018), other studies come to the opposite conclusion claiming that PSU is associated with higher levels of depression. Furthermore, some studies raise concerns about these findings, stating that "the positive correlation between smartphone addiction and depression is alarming" (Alhassan et al., 2018, p. 7). The ambiguous results indicate that PSU can have several effects on smartphone users based on who they are (e.g., gender, age, personality), their background (e.g., culture), and work situation (e.g., managers, politicians). Furthermore, both mediators and moderators could potentially explain ambiguous findings. Harwood et al. (2014) suggest that it is the nature of attachment a user has with their smartphone (i.e., thinking about the phone and keeping it close for constant checking) that is predictive of depression, rather than the extent of use. Such an angle has merit since high smartphone use does not necessarily lead to negative consequences.

The reviewed studies suggest that PSU can result in various types of physical health problems. In particular, studies seem to agree that impaired sleep quality is a prominent consequence of PSU, which subsequently, can lead to other problems such as hypertension and affect growth and emotional stability (Dharmadhikari et al., 2019; Haripriya, Samuel, & Megha, 2019; Liu et al., 2017; Panda & Jain, 2018). Kim, Kim, and Jee (2015) found that people indicative of PSU behavior were less likely to walk for each day and that their body composition, such as muscle mass and fat mass, was significantly different from those who were not indicative of PSU behavior. However, the relationship between PSU and exercise is less researched suggesting further research efforts.

PSU can lead to a loss of control of important aspects of life. One prominent consequence of PSU is insufficient time management and frequent smartphone use (Hong et al., 2012; Lee, Lee, et al., 2014; Rozgonjuk, Kattago, et al., 2018; Sapacz et al., 2016; Steelman & Soror, 2017; Vaghefi et al., 2017). Findings further suggest that smartphone overuse can lead to monetary overspending and thus financial problems (Chen et al., 2016; Soror et al., 2012). This overuse may be explained by inflated beliefs about the utility of the smartphone with regard to the levels of perceived enjoyment and perceived usefulness (Bernroider et al., 2014) and lower mindfulness scores (Volkmer & Lerner, 2019).

Table 2
Consequences of PSU.

Category	Impact(s)	References	
Control	Constant checking, self-control, relapse	Li and Lin (2019); Rho et al. (2019); Sok et al. (2019), Csibi et al. (2019); Baggio et al. (2018); Nayak (2018); Bhavana and Vijayalakshmi (2019); Yang et al. (2019a, 2019b) Tang et al. (2017)	
	Decision-making ability	Chen et al. (2016); Soror et al. (2012)	
	Impact on financial situation	Bernroider et al. (2014); Park (2019); Volkmer and Lerner (2019); Bragazzi et al. (2019)	
	Impaired judgment, denial	Anshari et al. (2019); Rho et al. (2019); Bragazzi et al. (2019); Grant et al. (2019); Jo et al. (2018); Swar and Hameed (2017); Lee, Seo, et al. (2016)	
	Instant rewards, dysfunctional impulsivities, self-distraction, maladjustment	Kruger and Djerf (2017); Tanis et al. (2015); Li and Lin (2019); Mangot et al. (2018)	
	Phantom experiences	Hong et al. (2012); Lee, Lee, et al. (2014); Rozgonjuk, Kattago, et al. (2018) and Rozgonjuk, Levine, et al. (2018); Sapacz et al. (2016); Steelman and Soror (2017); Vaghefi et al. (2017)	
	Time management		
	Emotional health problems	Anger, dysfunctional attitudes, venting	Park (2019), Serin et al. (2019); Bragazzi et al. (2019); Elhai, Rozgonjuk, Yildirim, Alghraibeh, and Alafnan (2019), Lee, Chang, Cheng, and Lin (2018)
		Anxiety, academic anxiety	Clayton et al. (2015); Elhai et al. (2016); Hartanto and Yang (2016); Harwood et al. (2014); Hawi and Samaha (2017); Park (2019); Rozgonjuk, Kattago, et al. (2018) and Rozgonjuk, Levine, et al. (2018); Sapacz et al. (2016), Anshari et al. (2019); aYang, Asbury, et al. (2019) and Yang, Zhou, et al. (2019), 2019b); Rho et al. (2019); Yang, Asbury, et al. (2019) and Yang, Zhou, et al. (2019); Kim, Park, Lee, et al. (2019); Lee, Chung et al. (2019); Grant et al. (2019); Elhai, Rozgonjuk, Alghraibeh, and Yang (2019); Nayak (2018); Lee, Chang, and Cheng (2018); Selçuk and Ayhan (2019)
		Depression, suicidal ideation, thought problems	Chen et al. (2016); Elhai et al. (2016); Harwood et al. (2014); Lu et al. (2011); Rozgonjuk, Kattago, et al. (2018) and Rozgonjuk, Levine, et al. (2018); Wang, P., Liu, S., Zhao, M., Yang, X., Zhang, G., Chu, X., et al. (2019c); Wang, Liu et al. (2019); Rho et al. (2019); Yang, Asbury, et al. (2019) and Yang, Zhou, et al. (2019); Kim, Park, Lee, et al. (2019); Lee, Chung et al. (2019); Grant et al. (2019); Elhai, Rozgonjuk, Alghraibeh, et al. (2019); Sohn et al. (2018); Alhassan et al. (2018); Lee, Chang, and Cheng (2018); Zou, Wu et al. (2019); Selçuk and Ayhan (2019); Gao et al. (2017)
Discomfort, irritability, withdrawal, tolerance, impatience		Chen et al. (2016); Hadlington (2015); Katz et al. (2018); Panda and Jain (2018); Vaghefi et al. (2017); Volkmer and Lerner (2019); Ruiz-Palmero et al. (2019); Anshari et al. (2019); Li and Lin (2019); Csibi et al. (2019); Baggio et al. (2018); Lee, Y.-K., Chang, C.-T., Cheng, Z.-H., & Lin, Y. (2018); Lee, H., Seo, M. J., and Choi, T. Y. (2016)	
Happiness, psychological quality of life, wellbeing, mental health		Guo et al. (2019); Lu, Xu et al. (2019); a)Herrero, Torres, et al. (2019) and Herrero, Uruena, et al. (2019); Yang, Yin, Huang et al. (2018); Lachmann et al. (2018); Mahmoodi et al. (2018); Horwood and Anglim (2019); Gao et al. (2017); Kuang-Tsan and Fu-Yuan (2017); Dharnayanti et al. (2019)	
Insecure, self-esteem, self-blame, worry		Anshari et al. (2019); Bragazzi et al. (2019); Elhai, Rozgonjuk, Alghraibeh, et al. (2019); Lee, Chung et al. (2019); Wang and Lei (2019); Lee et al., 2018a	
Loneliness		Yayan et al. (2019); Mosalanejad et al. (2019)	
Mindfulness		Seo et al. (2015); Volkmer and Lerner (2019)	
Mood modification		Csibi et al. (2019)	
Religious experience, religious beliefs		Shim (2019a, 2019b)	
Stress, post-traumatic stress disorder, distress	Harwood et al. (2014); Park (2019); Samaha and Hawi (2016); Tams et al. (2018); Vaghefi et al. (2017); Sok et al. (2019); Gligor and Mozoş (2019); Lee, Chung, et al. (2019); Grant et al. (2019); Mangot et al. (2018); Lachmann et al. (2018); Dharmadhikari et al. (2019); Selçuk and Ayhan (2019); Mosalanejad et al. (2019)		
Physical health problems	Discomfort	Clayton et al. (2015); Panda and Jain (2018)	
	Health problems, heart problems, physical activity	Clayton et al. (2015); Guo et al. (2019); Anshari et al. (2019); Xie et al. (2018); Ruan et al. (2016); Kim, Kim, et al. (2015); Kim, S.-E., Kim, J.-W., and Jee, Y.-S. (2015); Ahmed et al. (2019); Haripriya et al. (2019)	
	Hypertension	Zou, Wu, et al. (2019); Zou, Wu, et al. (2019) and Zou, Xia, et al. (2019)	
	Risky sexual practices	Grant et al. (2019)	
	Sleep quality, sleep latency, energy	Liu et al. (2017); Panda and Jain (2018), Hughes and Burke (2018), Chung et al. (2018); Ibrahim, Baharoon et al. (2018); Zou, Wu et al. (2019); Dharmadhikari et al. (2019); a) Yang, Asbury, et al. (2019) and Yang, Zhou, et al. (2019); Chang and Choi (2016); Alosaimi et al. (2016); Ruan et al. (2016); Demirci et al. (2015); Boumosleh and Jaalouk (2017); Wang, Chen, Yang, and Lin (2019); Haripriya et al. (2019); Wang, P.-Y., Chen, K.-L., Yang, S.-Y., and Lin, P.-H. (2019)	
	Wellbeing, physical quality of life, smoking, alcohol use	Hughes and Burke (2018), Horwood and Anglim (2019); Guo et al. (2019) I Lu, Xu et al. (2019); Kim, Park, Lee, et al. (2019); Grant et al. (2019); Yang, Yin, Huang et al. (2018); Chung et al. (2018); Alosaimi et al. (2016)	
	Professional performance	Boredom	Ruiz-Palmero et al. (2019); Elhai, Rozgonjuk, Alghraibeh, et al. (2019)
		Academic performance, intensity of reading academic textbooks, academic procrastination, classroom connectedness, school adjustment	(Ahmed et al., 2019; Alosaimi, Alyahya, Alshahwan, Al; Arefin et al., 2018; Bukhori et al., 2019; Firat et al., 2018; Grant et al., 2019; Heo & Lee, 2018; Hong et al., 2012; Mahapatra, 2019; Nayak, 2018; Samaha & Hawi, 2016; Soomro et al., 2019; Soror et al., 2012; Winskel et al., 2019; Yang et al., 2019a, 2019b)
		Attention Deficit Hyperactivity Disorder	Selçuk and Ayhan (2019)
		Break effectiveness, leisure use	Kang and Kurtzberg (2019); Duke and Montag (2017)
Work performance, neglect of other activities, multi-tasking, behavioral disengagement, cognitive interference; cyberloafing		Bian and Leung (2015); Park (2019); Shin and Lee (2015); Soror et al. (2012); Turel et al. (2008); Vaghefi et al. (2017), Ruiz-Palmero et al. (2019); Anshari et al. (2019); Li and Lin (2019); Bragazzi et al. (2019); Nayak (2018); Duke and Montag (2017); Canale et al. (2019); Yang et al., 2019a, 2019b); Saritepeci (2019); Cho and Lee (2016)	
Social performance	(Anshari et al., 2019; Cerit, Çıtak, Bakır, 2018; Lee et al., 2018b; Cerit, B., ÇA±tak Bilgin, N., & Ak, B. (2018); Konan, Durmuş, Türkoğlu, & Ağiroğlu; Lee, Chang, Cheng, & Lin, 2018; Sarti et al., 2019)		
Dangerous use			

(continued on next page)

Table 2 (continued)

Category	Impact(s)	References
	Cyberbullying, cybervictimization, cyber-verbal violence, cyber-sexual delinquency	Qudah et al. (2019); Gül et al. (2019); Choi et al. (2017)
	Denial of national identity	Alavi et al. (2018)
	Family relationships, harmony, maternal parenting behavior	Hawi and Samaha (2017); Lepp et al. (2016); Mahapatra (2019); Panda and Jain (2018); Turel et al. (2008); Guo et al. (2019); Song et al. (2019); Li and Lin (2019); Firat et al. (2018)
	FoMO	Gezgin et al. (2018)
	Personality	Lee, Chung et al. (2019)
	Phubbing	Karadağ et al. (2015); Krasnova et al. (2016); Chotpitayasunondh & Douglas, 2016; Lu et al., 2011; Vaghefi et al., 2017
	Romantic relationships, marital adjustment	Krasnova et al. (2016); Kumcağiz, Şahin, and Köksal (2017)
	Social connectedness, personal relationships, social quality of life, social support, conflict	Chotpitayasunondh and Douglas (2016); Lu et al. (2011); Panda and Jain (2018); Soror et al. (2012); Vaghefi et al. (2017); Hughes and Burke (2018); Lu, Xu et al. (2019); Yayan et al. (2019); a)Herrero, Torres, et al. (2019) and Herrero, Uruña, et al. (2019); Csibi et al. (2019); Lee, Chang, et al. (2018); ihm (2018); Sarti et al. (2019); Savci and Aysan (2017)
	Inattentional blindness and deafness, situational awareness, preoccupation	Chen and Pai (2018); Baggio et al. (2018)
	Dangerous driving	(Kita & Luria, 2018; Soror et al., 2012; Steelman et al., 2012; Vaghefi, Lapointe, & Boudreau-Pinsonneault, 2017)
	Smartphone harm, risk attitude towards smartphone	b)Herrero, Torres, et al. (2019) and Herrero, Uruña, et al. (2019)

Research clearly indicate that smartphone users at risk of PSU show a stronger denial of overuse than normal users (Cha & Seo, 2018) and seem to deny that they are addicted to the smartphone (Park, 2019). Society must begin to realize the negative consequences of PSU and our findings suggest that there is a strong need to raise awareness of the risk of PSU. Smartphone users further do not seem to account for perceived security when deciding on smartphone usage (Bernroider et al., 2014). Other studies identified that PSU strongly predicted the extent to which users experienced imagined smartphone signals (e.g., Kruger & Djerf, 2017; Li & Lin, 2019; Tanis et al., 2015). Tanis et al. (2015) suggest that these phantom experiences might be explained by misinterpretations of other signals, hallucinations, or the perceived importance of smartphone use.

When smartphone use becomes problematic, it may influence both the professional and social performance of the user. Many of the studies used university students as respondents in surveys of which some investigated academic performance and found it negatively influenced by PSU (e.g., Mahapatra, 2019; Nayak, 2018; Samaha & Hawi, 2016; Soror et al., 2012). Other studies investigating the impact on work performance found that work was neglected and productivity reduced (e.g., Bian & Leung, 2015; Duke & Montag, 2017; Shin & Lee, 2015), that users experienced work problems (e.g., Park, 2019; Soror et al.,

2012; Vaghefi et al., 2017) and a perception of work overload (Turel et al., 2008). Shin and Lee (2015) suggest that differences in neglect of work can be experienced based on the type of smartphone use since a popular app generated high usage frequency among Korean smartphone users whereas high smartphone usage hours were generated both for the Korean and U.S. users. The findings reflect the developments in PSU research where researchers seek explanations in the type of smartphone use rather than as a result of general smartphone use (Davazdahemami et al., 2016).

Studies investigating the influence on family relations found that PSU increased users' technology-family conflict (Mahapatra, 2019; Panda & Jain, 2018; Turel et al., 2008) and impacted personal relationships (Mahapatra, 2019; Panda & Jain, 2018; Soror et al., 2012). Hawi and Samaha (2017) identified anxiety as mediating this relationship. It further impacted adolescent users in terms of reduced trust in their parents and increased parent alienation (Lepp et al., 2016). In addition, male adolescents were negatively impacted related to peer communication and peer trust (Lepp et al., 2016). Yet other studies found that PSU resulted in reduced mindfulness (Chotpitayasunondh & Douglas, 2016; Lu et al., 2011; Vaghefi et al., 2017; Volkmer & Lerner, 2019) and phubbing, where smartphone users pays attention to their phone instead of engaging with the person in front of them. Phubbing

Table 3
Status of PSU research.

Research perspective	Status
Actors	Much research is conducted with adolescents in mind, and to a limited extent, children. Research with adults and elderly are vastly missing. Extant research seems to suggest that users who are young, female, and highly educated are more prone for PSU, but the results are inconclusive.
Use setting	Research is most often conducted without a specific setting in mind, and to some extent, in academic settings. Differences explained by different work settings and culture are vastly missing.
Factors explaining use and PSU	A multitude of factors are investigated to explain both use and PSU. There is considerable uncertainty as to whether a factor is explaining use or PSU. E.g., whereas FoMO may explain use, a lack of self-control may explain why this use becomes problematic.
Smartphone use	Recently, research has focused more on the type of smartphone use rather than considering problematic use as a result of the phone itself. Whereas social media and texting seem to be most problematic for females, gaming seems to be more problematic for males.
PSU	PSU is defined in different ways and needs clarity. There is no general agreement on what normative smartphone use is (e.g., by using cut-off values in measurement instruments), and for which user groups (e.g., it is most likely more acceptable with extensive use for a CEO than a student) and for which type of use (e.g., it is most likely more acceptable with extensive calling than extensive gaming).
PSU consequences	Research suggests that emotional health issues are the most prominent consequence of PSU. However, these issues have also explained use and PSU, and there is a need to define and determine how central factors and concepts are related.
Evaluation of use	Whereas many studies suggest measures to avoid PSU, little research is conducted to test working measures.
Theoretical frameworks	Whereas several theoretical frameworks have been adopted, they are often related to identifying factors explaining use and problematic use and more seldom to analyze findings. Also, there was frequently no specific theoretical lens employed.
Methodological approaches	A vast majority of the studies use a quantitative survey to study PSU. The results of the hypotheses testing are often not easily identifiable, and the research model is not always presented.

also occurred in romantic relationships resulting in jealousy among partners and reduced relational cohesion for couples (Krasnova, Abramova, Notter, & Baumann, 2016). Furthermore, gender was found to moderate the relationship between the extent to which people are phubbed and their perception that phubbing is normative (Chotpitayansunondh & Douglas, 2016). Seo et al. (2015) found that PSU was only one reason for multicommuting during a face-to-face conversation. They also found that certain individuals were more vulnerable to this behavior, especially people with attention deficit hyperactivity disorder (ADHD) symptoms. These studies, albeit few, make interesting conclusions suggesting that PSU can change the way we interact socially and further that we as a society seem to be unaware of these consequences.

A limited number of authors focused on the prominent social problem of dangerous driving as a consequence of PSU. These studies found that the legislation was unsuccessful in terms of reducing dangerous driving and that compulsive checking behaviors could explain some of the dangerous driving (Soror et al., 2012; Steelman et al., 2012; Vaghefi et al., 2017). Obviously, this type of driving behavior is a serious societal problem with potential severe consequences. Even though we applied a broad search strategy, the reason for the limited focus on dangerous driving in the reviewed studies may be because this particular focus is studied among researchers within other disciplines.

5.5. What strategies are used to correct PSU?

The reviewed studies focusing on RQ5 suggested preventive and corrective measures to correct unhealthy smartphone use. The measures fell broadly into three main categories: (1) information-enhancing, (2) capacity-enhancing, and (3) behavior reinforcement strategies.

Several information-enhancing strategies were suggested by the reviewed studies: direct warnings similar to those on cigarette packages (Barnes et al., 2019), documentaries and public campaigns emphasizing the severity and risk of PSU (e.g., Chen, Liu, et al., 2017; Cho & Lee, 2017; Hong et al., 2019; Kwon et al., 2016; Soror et al., 2012), and educational programs and guidelines for young children and adolescents (e.g., Bernroider et al., 2014; Cho & Lee, 2017; Hawi & Samaha, 2017; Jeong et al., 2016; Kwak, Kim, & Yoon, 2018; Lee, Chang, et al., 2014; Liu et al., 2017; Panda & Jain, 2018; Salehan & Negahban, 2013; Volkmer & Lerner, 2019). Information-enhancing policies can be effective for individuals who are willing to change their smartphone use based on new information. However, they will most likely not influence those who already are fully informed about smartphone use risks (Kwon et al., 2016; Mahapatra, 2019). In addition, it is difficult for smartphone users to quit their addictive behavior voluntarily, and therefore, the support from peers and friends might be necessary to overcome PSU (Chen, Zhang, Gong, & Lee, 2019b).

Children and adolescents spend much of their time in school, and therefore, researchers suggest that educational curricula should be planned so that it informs both parents and children about the seriousness of PSU and the importance of the countermeasures (e.g., Cho & Lee, 2017; Lian et al., 2016; Liu et al., 2017; Mahapatra, 2019). While addressing internet overuse, Turel, Mouttapa, and Donato (2015) found that adolescents were more in favor of reducing internet use after watching educational videos. Cho and Lee (2017) point out information about usage by infants under the age of 24 months given their tendencies to engage in PSU. In particular, research has emphasized how parents who have young children should be targeted seeking their active participation in activities such as counselling sessions, professional family education, workshops, and training programs (Cho & Lee, 2017; Mahapatra, 2019).

Capacity-enhancing strategies aim at reinforcing self-disciplinary and rational management abilities for individuals with limited willpower in sustaining self-regulation and who tend to entangle themselves in a lifestyle of immediate gratification (Kwon et al., 2016). They are provided with tools and treatment that can help them regulate smartphone usage (e.g., Aljomaa et al., 2016; Cho & Lee, 2017; Eichenberg

et al., 2019; Kwon et al., 2016; Soror et al., 2012). As of tools, developers may build in features that warn users (e.g., Barnes et al., 2019; Salehan & Negahban, 2013) or parents (e.g., Cho & Lee, 2017; Mahapatra, 2019) about excessive or potential harmful use of a specific application or the smartphone as a whole. A timely detection of potential problematic use is important to avoid PSU (e.g., Shin & Dey, 2013).

In treatment, intervention strategies could focus on helping smartphone users with more physical activities and into real social networks focusing on face-to-face interactions rather than interacting through technology-mediated such as social media apps (Hong et al., 2012; Kim, Seo, et al., 2015). In particular, children from a very young age should be encouraged to take up activities that can help them learn self-regulation such as sports, outdoor activities, painting, music, dance, yoga, and meditation (Mahapatra, 2019).

Smartphone users can go through treatment that help them overcome various negative traits: reducing shyness and loneliness through the improvement of communication skills, cognitive restructuring, social skills training, relaxation therapy, and family counselling (e.g., Bian & Leung, 2015; Chiu, 2014; Han, Geng, Jou, Gao, & Yang, 2017; Hong et al., 2019; Kim, Jun, Shin, Lim, & Seo, 2018), increasing self-regulatory abilities (e.g., Davazdahemami et al., 2016; Han et al., 2017; Jeong et al., 2016; Liu et al., 2018; Soror et al., 2012), and improving mindfulness (Liu et al., 2018). Whereas the mainstream narrative in drug addiction treatment has been to separate the addict from drugs and social environments engaging in drug use and abuse, researchers of PSU warn against this approach. Their arguments are that it will be nearly impossible to do so in a smartphone ubiquity society and that being away from the smartphone may even raise anxiety to a more destructive level (Hartanto & Yang, 2016; Rozgonjuk, Kattago, et al., 2018; Tams et al., 2018). Thus, researchers encourage what they term "realistic" treatments of PSU instead of merely encouraging to refrain from smartphone use.

Several researchers focus specifically on how smartphone use among children and adolescents can be corrected. Childhood maltreatment is found to positively predict PSU, and therefore, researchers have suggested that early intervention for child abuse may prevent adolescents from engaging in unhealthy smartphone use (e.g., Jun, 2016; Sun et al., 2019). Studies suggest that this influence is mediated by emotional intelligence, coping style, and psychological factors (e.g., Kim & Koh, 2018; Sun et al., 2019). Thus, researchers propose to foster emotional intelligence among adolescence, and help them enhance specific coping skills (e.g., Elhai, Levine, et al., 2018; Kim & Koh, 2018; Mahapatra, 2019; Rozgonjuk, Kattago, et al., 2018; Sun et al., 2019). Studies further suggest that family therapy programs should be provided to strengthen families who experience abuse and neglect since the mutual trust between family members can collapse under such circumstances (Kwak et al., 2018). In addition, adolescents may be in need of differentiated programs to overcome different levels of PSU also emphasizing easy access to such programs (e.g., Doh, Rhim, & Lee, 2016; Kwak et al., 2018).

In an academic study context, research suggests that students are introduced to methods that prevent and help them cope with procrastination activities (Anshari et al., 2016). Such methods can involve training of self-regulation skills, making realistic plans for how to prioritize tasks, helping them managing time, and limiting access to distractive smartphone use in lectures (e.g., Anshari et al., 2016; Hong et al., 2012; Rozgonjuk, Kattago, et al., 2018). Chen, Liu, et al. (2017) and Chen, Zhang, et al. (2017) argue that treatments should take gender differences into account. Kwak et al. (2018) argue that a continuous follow-up by teachers and social workers is needed in cases where adolescents have experienced familial neglect.

Studies focusing specifically on dangerous driving suggest alternative interventions and treatments that reduce compulsive checking of the phone, for example by distinguishing between different types of communication (e.g., e-mail, texts, calls), networks (friends, work, family), and levels of importance (urgent, when convenient,

unimportant) (Steelman et al., 2012). Chen, Zhang, Gong, and Lee (2019b) propose that help of friends and clinicians may be necessary in reducing PSU since quitting addictive behavior is difficult for smartphone users.

Behavioral reinforcement strategies constrain the ability smartphone users have to exercise self-control and rationally manage their smartphone usage. One way is through intentional design of usability features that directly constrain users by shutting them completely out of an app or the smartphone after a certain period of time or making smartphone use more difficult (e.g., Cho & Lee, 2017; Kim, Park, Lee, et al., 2019; Kwon et al., 2016; Lee, Ahn, et al., 2014; Rad & Ahmadi, 2018). Findings from the reviewed studies indicate clearly that smartphone use is reduced as a result of apps regulating use. Regulatory policies have also been used as constraining measures. For example, the Korean and Vietnamese governments have introduced digital curfews by forbidding online gaming during night hours. However, these directives are questioned due to the many obvious legal loopholes and evasions.

Recent bans on mobile phone use while driving have also been questioned due to their insufficiency (Steelman et al., 2012). And Chang et al. (2019) noted that although most SNS state a minimum age requirement for creating an account (e.g., 13 years old for Facebook), they found that age restrictions were ignored and children frequently used SNS. In sum, regulatory policies have achieved only temporary and limited success in curbing PSU (Kwon et al., 2016; Steelman et al., 2012).

Yet other researchers suggest guidelines for appropriate use of smartphones during school hours. These guidelines include turning network access off and forbidding use for a definite time period in school (Chen et al., 2019b; Mahapatra, 2019). However, policy makers should be careful with a blanket restriction on smartphones in school since smartphone separation may trigger higher anxiety levels which in turn may lead to poorer cognitive regulation and ultimately lower the quality of classroom learning (Hartanto & Yang, 2016). At home, it has been suggested to require parents' approval before children and adolescents can download certain applications (Cho & Lee, 2017).

Only two studies investigated whether intervention actually works. Hughes and Burke (2018) conducted an experiment of 95 participants divided into two groups. The sample included both genders (most females) and represented several age groups (most participants were between 23 and 41 years old). The participants abstained from smartphone use in the bedroom for one week. They found that there was an increase in subjective happiness and quality of life for the experimental group from the beginning to the end of the week whereas no changes were observed for the control group. Furthermore, the level of PSU decreased for the experimental group during the intervention whereas the control group did not experience a change. When open-endedly asked about what changes (if any) they observed in themselves as a result of the intervention, four changes emerged: improved sleeping experiences, reduced anxiety and improved wellbeing, improved personal relationships, and less time-wasting. More than 90% of the experimental group participants said they "might" or "would" consider self-imposing intervention conditions in the future. An assessment of such intervention programs suggests that the levels of PSU are reduced in the intervention groups (e.g., Khoshgoftar, Amidi Mazaheri, & Tarrahi, 2019). However, Katz, Earnest, and Lewis (2018) investigated how college students reacted to policies where smartphone use was (1) prohibited or (2) permitted for academic purposes and found that both groups experienced a more negative mood and increased craving, and they were not able to identify any differences between the two groups as initially hypothesized.

Whereas several studies acknowledge the need for corrective measures and suggest strategies, only a few of these studies have provided evaluations of specific strategies. Thus, the time is now ripe to not only suggest various corrective strategies but also try out these strategies and recommend the most successful. This work should include an assessment of which strategies that are most successful for various groups of

smartphone users such as adolescents and people suffering from loneliness.

6. Future research suggestions

Table 3 summarizes the status of PSU research. Based on our review, we suggest questions to be investigated which are either unclear or missing perspectives in extant research.

6.1. How do different demographics (others than adolescents) experience PSU?

Results are inconclusive about the relationship between PSU and sociodemographic factors such as age and gender. For instance, while many studies suggest a strong relationship with PSU and age, others fail to find a connection. Most of the extant research has studied PSU in teenagers and university students however, research has cautioned against inducing generalizations from university students as subjects (Peterson, 2001). In particular, these groups have grown up with mobile phones as a regular part of their lives, and therefore, may rely more on smartphones and take their use for granted. Other groups such as the elderly are not familiar with having mobile phones as part of their upbringing, and may therefore form another relationship with them. Thus, we recommend researchers to conduct empirical studies with samples consisting of demographic groups other than adolescents to gain a broader understanding of PSU in children and the elderly. Nevertheless, we recognize that the age effect may fall away as digital nativity becomes more prevalent across future generations. In addition, future research could examine whether females, more than males, are more prone to PSU.

While results are again inconclusive, a number of studies found a significant relationship between gender and PSU, suggesting the need for gender-specific interventions to combat PSU.

6.2. What purposes are smartphones used for?

We have observed a change of focus in the most recent studies: instead of focusing on the smartphone as a whole, researchers now focus on PSU through different applications. We believe more research is warranted as the smartphone is a multi-functional tool that means different things for different types of smartphone users. One way forward may be to develop a taxonomy of different types of use instead of focusing merely on different types of applications, e.g., instant messaging, messaging, cyberloafing, competing with others, etc. This question should also provide answers on how the context influences smartphone use. Extant research mostly does not specify the context of smartphone use involved such as private use, use for work-related purposes, and use in the classroom for educational purposes.

6.3. What is normative smartphone use?

Some of the existing measurement instruments include cut-off values that indicate PSU (e.g., MPPUS-27). However, recent studies suggest that high levels of smartphone use would not necessarily mean that the user will experience problematic consequences (Liu et al., 2018). Quantifying normative use as time spent on a smartphone is therefore likely to be inherently flawed as it varies depending on functions, and motivations for usage, of smartphones across ages, genders, cultures etc. We suggest that this issue needs to be looked at in more detail and encourage researchers to investigate the 'how' and 'why' of usage (e.g. normative smartphone use across different usage contexts), rather than 'how much' (e.g., at what levels smartphone use is normal and at what levels the use becomes problematic (Kim & Koh, 2018)). This is of particular interest since smartphone use is now so socially acceptable.

6.4. Which factors explain smartphone use and which factors explain problematic use?

Our review revealed that a multitude of factors are used to explain smartphone use and PSU. Some of these factors explain both uses. Thus, there is a need to further investigate why people are motivated to use the smartphone, and separately, investigate why this use, at some point, becomes problematic. E.g., whereas we are not surprised that FoMO correlates with PSU, the question is whether there may be other explanations to why this phenomenon goes from being considered normal smartphone use and problematic use. Whereas smartphone usage may be described as a rational, attitude-based decision process (Turel et al., 2011), engaging in PSU is not. Therefore, we encourage researchers to identify non-rational explanations for PSU.

6.5. Which came first: the chicken or the egg?

We observed that the same construct (e.g., depression and academic performance) may appear as an antecedent in one study and as a consequence in another study. The literature is unclear whether certain constructs may explain both smartphone use, PSU as well as being a consequence of PSU. We therefore suggest that researchers continue to explore the relationships between these constructs.

6.6. How can PSU be brought back to healthy levels?

In several studies, researchers believed that their findings urged for measures to both avoid and correct PSU back to healthy levels. Given the seriousness of the consequences that smartphone users potentially may face as a result of PSU, this urge is warranted. In particular, this issue is prominent when the users are children and adolescents. Even though many measures are suggested, we strongly encourage researchers to investigate the measures which are most successful. Moreover, policy makers should be provided with recommendations on how to handle smartphone use, e.g., in school. A third potential avenue for future research is to find out how users who are at risk of becoming engaged in PSU can be identified and warned (Beranuy et al., 2009).

6.7. Which research methods can be applied in research on PSU?

Every study must be carefully planned to address the specific research problem in focus. Much of the research on PSU have applied surveys to explore antecedents and consequences of PSU as well as mediating and moderating effects. We expect and encourage researchers to continue exploring these relationships. However, some of our suggestions for future research may warrant other approaches e.g., a Delphi study or qualitative research methods to better understand why smartphone use becomes problematic and if there are any particular characteristics of PSU in other demographic groups than adolescents. We also encourage more use of experiments, e.g., to understand the measures that are most likely to assist in bringing PSU back to healthy levels. In determining the most suitable research method, researchers should avoid methods that make smartphone users report smartphone use more positively than it in reality is, since PSU can be associated with shame and embarrassment. Evidence suggests that self-reported measures of PSU do not reliably correlate with real-time patterns of use (e.g., Wilcockson, Ellis, & Shaw, 2018). Therefore, to address the

methodological shortcomings of subjectively reported smartphone use, more objective measures have been proposed e.g., smartphone applications to monitor daily minutes of smartphone use over the course of one week (Elhai, Tiamiyu, et al., 2018). Indeed, Wilcockson et al. (2018) assert that checking behavior (smartphone uses lasting <15 s) is a more consistent and efficient measure for problematic smartphone use, and can be reliably inferred within two days of data collection.

7. Conclusions and limitations

In this article, we presented a systematic review of studies on PSU. To the best of our knowledge, this represents the first systematic literature review on this topic to date. We therefore take important first steps towards consolidating the diverse and vibrant body of literature on PSU. In particular, we provide a review of literature on the factors explaining smartphone use, antecedents of PSU, demographics most prone to PSU, consequences of PSU, and strategies for correcting PSU. Our work makes a number of major contributions. Firstly, we provide comprehensive insights into our five research questions, and offer a unique categorization to help scholars understand the different types of factors which shape smartphone use, and antecedents and consequences of PSU (e.g., emotional health, physical health, control, professional performance, social performance, and technology features). Secondly, we contribute by providing a novel conceptual model summarizing the various research endeavors on PSU to date, and illustrate how the 'research interest' in PSU has evolved over the last decade, between 2008 and 2019. Thirdly, we provide a future research agenda for PSU which researchers should pursue through further empirical studies and theoretical development. This will be important for building on the significant research efforts conducted to date, and increasing the rigor of future studies going forward.

Our systematic review of PSU literature included a total of 293 studies identified from dedicated search criteria in selected repositories, and backward and forward reference searching. However, given the growing volume of publications in this area, we cannot guarantee that all studies in this area have been covered in our review. Our literature search was finalized in January 2020 therefore, studies published after the period that our literature search was conducted (January 1, 2008 to December 31, 2019), are excluded. Lastly, in answering the identified research questions, we grouped studies from different countries together in order to provide a thematic analysis of literature. Differences between the antecedents and consequences of PSU across countries is therefore not discussed in our results; nevertheless, our systematic literature review still offers clear and comprehensive insights on the topic which will be of value to researchers going forward.

Declaration of competing interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and publication of this article.

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Appendix A

Article	Core focus	Methodology, sample, area	Age	Gender
Ahmed, Pokhrel, Roy, and Samuel (2019)	The impact of nomophobia on the academic performance among students pursuing physiotherapy course.	Quantitative survey of 157 students from India	AVG = 22.2 (SD = ± 3.2)	57.1% female
Ahn and Jung (2016)	How digital natives (DNs) understand the excessive use of smartphones differently from digital immigrants (DIs).	Interviews with 85 participants (47 DNs and 38 DIs)	AVG DNs = 25 AVG DIs = 44	N/A
Aker, Sahin, Sezgin, and Oguz (2017)	Psychosocial factors affecting smartphone addiction in university students.	Quantitative survey of 494 university students in Turkey	AVG = 20.22 (SD = 0.05)	75.9% female
Aktürk, Budak, Gültekin, and Özdemir (2018)	Comparison of the relationship between smartphone addiction and loneliness in high school and university students.	Quantitative survey of 1156 high school and university students	N/A	50.6% female
Alavi et al. (2018)	Comparison of personal and national identity and their subscales between cell phone addicts and non-addicts.	Quantitative survey of 500 student cell phone users from various universities in Tehran	AVG = 27.9 (SD = 6.9)	76.8% female
Albursan et al. (2019)	Comparison of smartphone addiction among students in four Middle Eastern countries: Sudan, Jordan, Saudi Arabia, and Yemen.	Quantitative survey of 2008 university students: 438 in Jordan, 642 in Sudan, 370 in Yemen, and 558 in Saudi Arabia	AVG = 22.1 (SD = 4.6)	Jordan: 49.8% female Sudan: 46.9% female Yemen: 58.4% female Saudi Arabia: 64.5% female
Alhassan et al. (2018)	The prevalence and factors associated with smartphone addiction and depression among a Middle Eastern population.	Quantitative survey of 935 participants from Saudi Arabia	AVG = 31.7 (SD = ± 11)	66.2% female
Alhazmi, Alzahrani, Baig, and Salawati (2018)	Smartphone addiction among medical students and factors associated with smartphone addiction among sixth-year medical students.	Quantitative survey of 203 sixth-year medical students in Saudi Arabia	AVG = 24	51.9% female
Aljomaa et al. (2016)	Frequency and indicators of PSU; differences in PSU attributed to gender, social status, educational level, monthly income, and daily use.	Quantitative survey of 416 university students in Saudi Arabia	N/A	49.4% female
Alosaimi, Alyahya, Alshahwan, Al Mahiyjari, and Shaik (2016)	The prevalence and correlates of smartphone addiction among university students in Saudi Arabia.	Quantitative survey of 2367 university students in Saudi Arabia	50% of the respondents were in the age group of 20–24 years	56.4% female
Anshari et al. (2016)	Usage patterns of smartphone users across different demographics.	Quantitative survey of 589 participants countrywide from all the districts in Brunei Darussalam	20 years or younger: 42%; From 21 to 30 years: 31%; From 31 to 40 years: 14%; From 41 to 55 years: 10%; Above 55 years 3%	54.0% female
Anshari et al. (2019)	Nomophobia among youth and how to overcome nomophobia.	Quantitative survey of 230 youth of the first year university students	N/A	N/A
Aranda and Baig (2018)	The continuum between excessive smartphone use and healthy disconnection.	Quantitative survey of 19 participants in Switzerland and the United States	N/A	57.9% female
Arefin, Islam, Mustafi, Afrin, and Islam (2018)	The factors that affect the level of smartphone addiction to the students and its impact on their overall academic performance.	Quantitative survey of 247 undergraduate students studying first year to fourth year participated in the study.	Age range = 18-27	45.8% were female
Arnavut & Nuri, 2018	The relationship between technology usage and smartphone addiction according to certain variables.	Quantitative survey of 714 preservice teachers who studied in Turkey	N/A	42.3% female
Arpaci (2019)	The relationships between early maladaptive schemas (EMSs) and smartphone addiction, the moderating role of mindfulness in the relationship between EMSs and smartphone addiction.	Quantitative survey of 660 mobile users in Turkey	AVG = 22.88 (SD = 4.57, range = 17–32)	72.9% female
Arpaci, Baloğlu, Kozan, and Kesici (2017)	The mediating effect of mindfulness on the relationship between attachment and nomophobia, gender differences in attachment, mindfulness, and nomophobia.	Quantitative survey of 450 students	AVG = 21.94 (SD = 3.61)	70.9% female
Ayar et al. (2017)	The effect of adolescents' Internet addiction levels on smartphone addiction.	Quantitative survey of 609 students from three high schools that are located in western Turkey.	AVG = 12.3 years. Of them, and 42.8% were 10th graders	47.7% female

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Article	Core focus	Methodology, sample, area	Age	Gender
Ayar, Gerçeker, Özdemir, and Bektas (2018)	The effect of problematic Internet use, social appearance anxiety, and social media use on nursing students' nomophobia levels.	Quantitative survey of 755 undergraduate nursing students. 59.7% (n = 450) had adequate incomes	AVG = 21.4 (SD = ± 1.3)	82.5% female
Bae (2015)	How perceived parenting style, friendship satisfaction, and academic motivation influence the addictive use of smartphones longitudinally.	Quantitative survey of 2376 individuals in the first year, 2264 individuals in the second year, and 2218 individuals in the third year in Korea	N/A	First year (47.8% girls), second year (47.9% girls), and third year (47.4% girls)
Bae (2017)	Verification of the relationship between type of smartphone use and smartphone dependence.	Quantitative survey of 2212 youths. There were 772 middle school students (32.6%) and 1490 high school students (67.4%)	Age range = 13-18	48.6% female
Baggio et al. (2018)	Whether problematic technology-mediated behaviors could be conceptualized as a spectrum of related, yet distinct disorders (spectrum hypothesis), using the network approach, which considers disorders as networks of symptoms.	Quantitative survey of 3404 young Swiss men (representative sample)	AVG = 25.4 (SD = ± 1.2)	100% male
Balta et al. (2019)	The direct and indirect associations of dark personality traits with PSU via fearful and dismissing attachment.	Quantitative survey of 546 participants in a learning center in Turkey	N/A	54.0% female
Barnes et al. (2019)	Differences between PSU and social network services addiction, users' involvement and engagement with the smartphone, differences in PSU, social network services addiction, and users' involvement attributed to demographic factors.	Quantitative survey of 140 university students in the US	75% were 34 years old or under	68.6% female
Beison and Rademacher (2016)	The factors related to problematic smartphone use.	Quantitative survey of 100 undergraduates	AVG = 20	75.0% female
Beranuy et al. (2009)	The degree to which maladaptive use of the smartphone is related to self-perception of symptoms that appear in different mental disorders; differences in PSU attributed to gender and major studies enrolled.	Quantitative survey of 365 university students in Spain	AVG = 21.37 (SD = 5.46)	75.1% female
Berger et al. (2018)	Differences in PSU attributed to self-control capacity.	Quantitative survey of 108 university students in Switzerland	19 years old and younger: 1.58%, 20–24 years: 75%, 25 and 30 years old: 20.37%, 30–34 age group: 2.78%	52.8% female
Bernroider et al. (2014)	Potential negative effects of PSU on beliefs and implications for technology use.	Quantitative survey of 293 university students in Austria	AVG = 25	56.8% female
Bhavana and Vijayalakshmi (2019)	Identification of various determinants of the smartphone.	Quantitative survey of 108 participants	AVG = 2.45 (SD = 0.50)	25.0% female
Bian and Leung (2015)	The roles of psychological attributes (such as shyness and loneliness) and smartphone usage patterns for the prediction of social capital and PSU symptoms.	Quantitative survey of 414 university students in China	Aged under 18: Nearly 2%, aged from 19 to 22:35.5%, aged from 23 to 26: 60.1%, and aged from 27 to 30: 2.4%.	61.6% female
Boumosleh and Jaalouk (2017)	The prevalence of smartphone addiction symptoms, and to ascertain whether depression or anxiety, independently, contributes to smartphone addiction level among a sample of Lebanese university students, while adjusting simultaneously for important sociodemographic, academic, lifestyle, personality traits, and smartphone-related variables.	Quantitative survey of 688 undergraduate students in Lebanon.	AVG = 20.64 (SD = ± 1.88)	47.0% female
Bragazzi, Re, and Zerbetto (2019)	Coping styles implemented in subjects with nomophobia.	Quantitative survey of 403 subjects from Italy	AVG = 27.91 (SD 8.63)	60.3% female
Bruzzi and Joia (2015)	Smartphone use related to the perception of presence and intensity level of inherent contradictions in smartphones caused by novel possibilities of smartphone use and features.	Quantitative survey of 245 professionals in Brazil	N/A	34.7% female

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Article	Core focus	Methodology, sample, area	Age	Gender
Bukhori, Said, Wijaya, and Nor (2019)	The effect of smartphone addiction, achievement motivation, and textbook reading intensity on academic achievement.	Quantitative survey of 720 students from two public universities	N/A	N/A
Canale et al. (2019)	Whether individual differences in emotion-related impulsivity traits (positive urgency and negative urgency) moderate the effect of smartphone availability on cognitive performance.	Quantitative survey of 132 college students (age 18–25 years) in Italy	AVG = 22.73 (SD = 1.67)	65.0% female
Carbonell et al. (2012)	The problematic uses of Internet and cell phones in Spanish teenagers and young students analyzing the predictive capacity of these problematic uses to explain scores on measurement instruments.	Quantitative survey of 1879 students from Catalanian educational institutions	AVG = 15.5 (SD = 2.43)	54.5% female
Cerit, Çitak Bilgin, and Ak (2018)	The effect of nursing students' smartphone addiction on their communication skills	Quantitative survey of 214 students studying in the nursing department in Turkey	AVG = 20.39 (SD = 1.45)	80.4% female
Cha and Seo (2018)	Smartphone use patterns, smartphone addiction characteristics, and the predictive factors of the smartphone addiction in middle school students in South Korea.	Quantitative survey of 1824 middle school students who used a smartphone in Korea	AVG = 15.6, SD = 0.78)	49.0% female
Chang and Choi (2016)	Factors influencing gender differences in sleep quality between men and women.	Quantitative survey of 300 young adults from three Korean universities	Participants were 20–40 years of age. Most of the women were in their 20 s (66%)	80.0% female
Chang et al. (2019)	The prevalence of PSU among children and risk factors for such use.	Quantitative survey of 2621 fifth-grade students and 2468 parents from 30 primary schools in Taipei, Taiwan	Children: N/A Parents: AVG = 43	Children: 47.8% girls Parents: 68.6% mothers
Cho and Lee (2017) and Chen, Zhang, et al. (2017)	The prevalence of smartphone addiction and the associated factors in male and female undergraduates.	Quantitative survey of 1441 medical undergraduate students in China	AVG = 19.72 (SD = ± 1.43)	51.7% female
Chen, Zhang, Gong, and Lee (2019a)	The interaction between reinforcement reward and automatic habit, as well as role of smartphone features in activating different formation mechanisms.	Quantitative survey of 379 participants in China	91.29 percent of the respondents were aged 18–30	45.1% female
Cho and Lee (2017) and Chen, Zhang, et al. (2017)	Determinants of PSU; the role of individual characteristics in the formation of PSU.	Quantitative survey of 384 university students in China	Most respondents (91.1%) were 18–30 years of age. The minimum age group was <18 years old (N = 7, 1.8%), the maximum age group was >40 years old (N = 6, 1.6%).	45.6% female
Chen et al. (2019b)	Explanations for why smartphone game addicts cannot decrease their addictive behaviors.	Quantitative survey of 381 Chinese smartphone game players	Below 18: 0.8%; 18–24: 13.7%; 25–30: 44.6%; 31–40: 34.6%; Above 40: 6.3%	54.1% female
Chen et al. (2016)	The mediating role of interpersonal problems in the link between PSU levels and negative emotions among smartphone addicts and potential smartphone addicts respectively.	Quantitative survey of 1087 university students in China	AVG = 20.12 (SD = 1.29)	56.1% female
Chen and Pai (2018)	The influence of various smartphone tasks (calling, music listening, texting, playing games, and web surfing) on the smartphone overuse and inattention blindness of pedestrians in Taipei, Taiwan.	Quantitative survey of 2556 pedestrians in Taiwan	AVG = 25.1 (SD: 7.7)	50.1% female
Chiang, Chang, Lee, and Hsu (2019)	The incidence of transitions in smartphone addiction proneness among children examining the effects of gender, use patterns (social networking sites use and smartphone gaming) and depression on smartphone addiction transitions.	Quantitative survey of 2155 children from Taipei	N/A	47.8% girls
Chiu (2014)	The mediating effect of learning self-efficacy and social self-efficacy on the relationship	Quantitative survey of 387 Taiwanese university students	N/A	33.3% female

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Article	Core focus	Methodology, sample, area	Age	Gender
	between perceived life stress and PSU.			
Cho et al. (2017)	The influence of stress on smartphone addiction as well as the mediating effects of self-control, neuroticism, and extraversion.	Quantitative survey of 400 men and women in their 20s–40s in Korea	28.5% were in their 20s, 33.3% in their 30s, and 38.5% in their 40s	48.5% female
Cho and Lee (2017)	The effects of PSU proneness of young children (ages one to six) on problematic behaviors and emotional intelligence; parental self-assessment of smartphone usage related to children’s PSU.	Quantitative survey of 303 parents of young children in South Korea	Children younger than one: 5.9%; two-year-old children: 11.9%; three-year-old children: 19.5%; four-year-old children: 21.5%, five-year-old children: 21.5%, six-year-old children: 19.8%.	49.2% female
Cho and Lee (2016)	Nursing students’ smartphone use as a source of distraction in clinical practice identifying their opinions about policies restricting smartphone use during patient care.	Quantitative survey of 312 third-year nursing students from two nursing schools located in a metropolis and small city in South Korea	AVG age = 21.7 (SD = ±2.59)	89.1% female
Choi, Choi, and Kim (2017)	The relationship between smartphone addiction and cybersexual delinquency, risk factors for smartphone addiction.	Quantitative survey of 1020 high school students in grades 10 to 12. The proportion of grade levels were as follows: 34.5% were 10th graders; 32.2% were 11th graders; and 33.3% were 12th graders	34.5% were 10th graders; 32.2% were 11th graders; and 33.3% were 12th graders	48.4% female
Choi et al. (2015)	The risk and protective factors associated with smartphone addiction in college students comparing these factors to those linked to Internet addiction.	Quantitative survey of 448 college students from Daejeon (n = 155; 33.5%), Sungnam (n = 154; 33.3%), Seoul (n = 78; 16.9%), and Nonsan (n = 76; 16.4%).	AVG = 20.89 (SD = 3.09)	60.3% female
Chotpitayusunondh and Douglas (2016)	Psychological antecedents and consequences of “phubbing” behavior (i.e., the act of snubbing someone in a social setting by concentrating on one’s smartphone instead of talking to the person directly).	Quantitative survey of 251 students and volunteers in the UK recruited through Amazon’s Mechanical Turk labor market.	AVG = 27.70 (SD = 9.59)	62.9% female
Chou and Chou (2019)	Individual and parental factors related to teenagers’ (mainly aged 13 to 18) smartphone addiction tendency with a representative sample of parent-child dyads around Taiwan	Quantitative survey of 713 valid paired parent-child participants collected from 54 junior high schools in Taiwan.	Seventh graders comprised 29.87% (N = 213), eighth graders comprised 34.92% (N = 249), and ninth graders comprised 32.54% (N = 232)	55.5% female
Chun (2018)	Conceptualization of effective interventions for smartphone addiction among female adolescents in South Korea using a mixed method concept-mapping approach.	36 Korean female adolescents	50% were tenth graders, 30.6% were seventh graders and the rest included eighth, ninth and eleventh graders	100% female
Chung et al. (2018)	Daytime sleepiness in association with smartphone addiction risk in Korean adolescents.	Quantitative survey of 1796 adolescents in Korea using smartphones	AVG = 14.9 (SD = ± 1.8)	54.3% girls
Clayton et al. (2015)	The effects on self, cognition, anxiety, and physiology when smartphone users are unable to answer their smartphone while performing cognitive tasks.	Experiment with 40 iPhone users and a quantitative survey of 117 university students in the US (including the 40 iPhone users).	AVG = 21.21 (SD = 3.78)	72.6% female
Coban and Gundogmus (2019)	Smartphone usage profiles and their intended use and the extent to which their intended use affects smartphone addiction in a group selected from university student populations.	Quantitative survey of 1465 university students in Turkey	AVG = 21.10	58.8% female
Cocoradă, Maican, Cazan, and Maican (2018)	The relationships between smartphone addiction, personality traits, smartphone usage and attitudes towards the smartphone.	Quantitative survey of 717 participants, high school (40%) and university students from different programs of study, in science (50.6%) and humanities in Romania.	AVG = 19.8	65% girls
Contractor et al. (2017)	Relations between PTSD symptom clusters and PSU.	Quantitative survey of 347 participants recruited through Amazon’s Mechanical Turk labor market.	AVG = 33.60 (SD = 9.52) AVG = 6.01 (SD = 1.4)	57.7% female N/A

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Article	Core focus	Methodology, sample, area	Age	Gender
Csibi, Griffiths, Demetrovics, and Szabo (2019)	Patterns of problematic symptoms (salience, mood modification, tolerance, withdrawal symptoms, conflict, and relapse) among age groups and developmental stages	Quantitative survey of 1603 individuals representing various age groups in the UK and Hungary		
Davazdahemami et al. (2016)	PSU in terms of attachment to the smartphone itself and through its applications.	Quantitative survey of 333 university students in the US.	AVG = 19.95 (SD = 2.55)	54.1% female
Davie and Hilber (2017)	Whether nomophobia is a problem at the institution and to what extent.	Quantitative survey of 104 undergraduate students of business and engineering programs	The majority of the participants were in the age range 20–25 years	49.0% female
De Pasquale, Sciacca, Conti, Dinario, and Di Nuovo (2019)	The relationship between PSU dissociative experiences and some characteristics of personality.	Quantitative survey of 400 Italian college students	AVG = 21.59, (SD = 1.43)	61.0% female
Demirci, Akgönlü, and Akpınar (2015)	The relationship between smartphone use severity and sleep quality, depression, and anxiety in university students.	Quantitative survey of 319 students in Turkey	AVG = 20.5 (SD = ± 2.45)	63.6% female
De-Sola et al. (2017)	The existing relationships among the factors of state anxiety, depression, impulsivity, and alcohol consumption regarding problematic mobile phone use.	Quantitative survey of 1126 respondents, both men and women, with an age range of 16–65 years.	AVG = 32.8 years, (SD = 11.67)	53.3% female
Dey et al. (2019)	Associations between risk factors, demographic and substance use variables, and PSU.	Quantitative survey of 5096 Swiss men	AVG = 25.5 years, (SD = 1.26)	100% male
Dhamayanti, Dwiwina, and Adawiyah (2019)	Correlation between smartphone addiction and mental-emotional disorders in early adolescents aged 11–12 years old.	Quantitative survey of 178 primary school students in Bandung City and Sumedang District.	Age 11 = 45 (50.6) Age 12 = 44 (49.4)	53.9% female
Dharmadhikari et al. (2019)	Assessing the rate of smartphone addiction in a sample of medical students, with a focus on its correlation with sleep quality and stress levels.	Quantitative survey of 195 medical students in India	AVG = 20.23 (SD = ±1.63)	50.8% female
Ding, Xu, Chen, and Xu (2016)	App addiction.	26 out of 32 participants completed 4 weeks of study during the spring semester of 2015 and were compensated with a \$20 gift card.	AVG = 21.9 (SD = 2.4)	30.8% female
Direktör and Nuri (2019)	The relation between smartphone addiction and personality beliefs of university students.	Quantitative survey of 1007 students in Cyprus	N/A	63.3% female
Doh et al. (2016)	Framework of preventive intervention programs to promote adolescents' healthy smartphone use.	Phase 1: Focus Group Interviews (FGIs) were conducted on twenty young adults; Phase 2: In the first FGI (n = 21; parents: 21), we explored experiences of parents regarding their children's media usage. In the second FGI (n = 24; parent: 13, child: 11), digital media usage rules applied at home were examined from both adolescents' and parents' perspectives; Phase 3: 18 parent-child dyads (n = 37; parent: 18, child: 19)	AVG = 28.4 (SD = 2)	Phase 1: 35.0% female
Duke and Montag (2017)	The link between smartphone overuse and loss of productivity.	Quantitative survey of 262 participants in Germany	AVG = 29.64 (SD = 12.99)	59.0% female
Durak (2018)	Adolescents' smartphone usage and levels of nomophobia examining variables related to nomophobia.	Quantitative survey of 786 students studying in the 7th and 8th grades of a middle school in the fall semester of 2016	AVG = 12.79	48.0% female
Eichenberg et al. (2019)	Attachment-specific differences between students with and without PSU.	Quantitative survey of 1836 students in Austria	AVG = 19.38 (SD = 16.50)	75.8% female
Elhai and Contractor (2018)	Frequency of the use of various smartphone features and PSU; psychopathology constructs (ruminative thinking and emotion regulation deficits) and demographics (age and gender) as	Quantitative survey of 293 university students in the US	AVG = 19.44 (SD = 2.16)	76.7% female

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Article	Core focus	Methodology, sample, area	Age	Gender
Elhai et al. (2016)	potential covariates of smartphone use patterns. PSU, frequency of smartphone use, depression and anxiety, and mechanisms that maintain PSU behavior.	Quantitative survey of 308 participants recruited through Amazon's Mechanical Turk labor market	AVG = 33.15 (SD = 10.21)	46.4% female
Elhai, Levine, et al. (2018) and Elhai, Vasquez, et al. (2018)	Psychopathology-related variables mediating relations between depression/anxiety and PSU.	Quantitative survey of 261 college students.	AVG = 19.73 (SD = 3.52)	N/A
Elhai, Rozgonjuk, Alghraibeh, et al. (2019)	Several mental health constructs in relation to disruptions in various daily activities resulting from smartphone interruptive notifications.	Quantitative survey of 316 undergraduate students in US	AVG = 19.21 (SD = 1.74)	66.8% female
Elhai, Rozgonjuk, Alghraibeh, et al. (2019)	Worry and anger in relation to PSU.	Quantitative survey of 300 American college students	AVG = 19.87 (SD = 3.79)	75.7% female
Elhai, Levine, et al. (2018) and Elhai, Vasquez, et al. (2018)	Proneness to boredom as predictor of PSU and mediator between both depression and anxiety symptom severity with PSU.	Quantitative survey of 298 college students in the US.	AVG = 19.45 (SD = 2.17)	76.8% female
Emirtekin et al. (2019)	The direct and indirect relationships of emotional abuse and neglect with PSU via specific mediational pathways including body image dissatisfaction, social anxiety, and depression.	Quantitative survey of 443 adolescents in Turkey	AVG = 15.95 (SD = 1.07)	60% female
Enez Darcin et al. (2016)	The relationship between PSU, and social phobia and loneliness.	Quantitative survey of 367 university students in Turkey	AVG = 19.5 (SD = 1.15)	61.6% female
Ergun and Guzel (2019)	The relationship of exercise dependence to smartphone addiction and the emotional intelligence levels of gym-goers.	Quantitative survey of 822 individuals who exercised regularly (at least three times a week) in fitness centers located in the province of Burdur, Turkey.	AVG = 25.6 (SD = ± 9.19)	46.9% female
Fabito et al. (2018)	The possible correlation between mobile game addiction and cyberbullying with student academic performance.	Quantitative survey of 85 respondents from the Philippines	Age range = 18 year: 10, 19 years: 27, 20 years: 22, 21 years: 16, 22 years: 7, 23 years: 3	40% female
Fan, Liu, Wang, and Wang (2017)	Formation and process of technology interaction, users' attitude and behavior toward technology, and technology dependence behavior.	Quantitative survey of 255 smartphone users in Korea, mainly students and academics	Age range = 6 aged in '10s' bracket (2.4%); 143 aged in '20s' bracket (56.1%); 73 aged in '30s' bracket (28.6%); 28 aged in '40s' bracket (11.0%); 5 aged in '50s' bracket (2.0%)	46.7% female
Firat et al. (2018)	The prevalence of PSU among adolescents who were referred to clinics, its relationship to sociodemographic characteristics, psychiatric symptoms and emotion regulation problems	Quantitative survey of 150 adolescents in Turkey aged 12–18 years who own smartphones	AVG = 15.28 (SD = ± 1.65)	58.7% girls
Foulonneau, Calvary, and Villain (2016)	Help to fight procrastination and decrease phone usage through a persuasive application.	Six-week trial with 28 participants	N/A	71.4% female
Fullwood et al. (2017)	Types of experiences, attitudes, and feelings characterizing users' relationships with their smartphones; specific smartphone features users value highly.	Qualitative study with three focus groups totaling 18 university students in the UK	AVG = 25.9	77.8% female
Gao et al. (2018)	The role of depression, anxiety, and stress in the relationship between college students' alexithymia and mobile phone addiction.	Quantitative survey of 1105 college students in China	AVG = 20.00 (SD = ± 1.20)	52.2% female
Gao, Xiang, Zhang, Zhang, and Mei (2017)	The mediating effect of smartphone addiction and depression on neuroticism and quality of life.	Quantitative survey of 722 Chinese university students	AVG = 20.50 (SD = 1.42)	71.1% female
Gentina et al. (2018)	The ability of emotional intelligence to curb nomophobia and thereby mitigate academic iCheating.	Quantitative survey of 72 teenagers in three middle schools (grades 10–12) of an urban region in northern France	AVG = 16.21	58.3% girls
	The effect of FoMo on nomophobia.		AVG = 23.40.	67.7% female

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Article	Core focus	Methodology, sample, area	Age	Gender
Gezgin, Hamutoglu, Sezen-Gultekin, and Gemikonakli (2018)		Quantitative survey of 538 university students at Trakya University		
Gligor and Mozoš (2019)	The prevalence of a predisposition to smartphone use disorder in university students and the associations between the intensity of mobile phone use and several variables.	Quantitative survey of 150 students, from two universities from Timisoara	West University: AVG = 20 (SD = ± 1.33) University of Medicine and Pharmacy: AVG = 34 (SD = ± 8.96)	West University: 40% female University of Medicine and Pharmacy: 71% female
Gökçearslan, Uluyol, and Şahin (2018)	The relationships between smartphone addiction, cyberloafing, stress, and social support.	Quantitative survey of 885 undergraduate students studying at a public university in Turkey	N/A	59% female
Gökçearslan et al. (2016)	The roles of smartphone usage, self-regulation, general self-efficacy, and cyberloafing in PSU.	Quantitative survey of 598 university students in Turkey	Age range = 54% of the participants were in the 19–20 age group	70.7% female
Grant, Lust, and Chamberlain (2019)	The occurrence of the problematic use of smartphones in a university sample and associated physical and mental health correlates, including potential relationships with risky sexual practices.	Quantitative survey of 3659 university students at a large, non-denominational, and coeducational Midwestern university in the US	N/A	55.2% female
Guazzini, Duradoni, Capelli, and Meringolo (2019)	A multidimensional model for phubbing considering psychological dimensions and ICT-related habits.	Quantitative survey of 394 individuals	AVG = 24,16 (SD: 8,14)	84.8% female
Gugliandolo, Costa, Kuss, Cuzzocrea, and Verrastro (2019)	The integrated role of parental psychological control and parental autonomy with need satisfaction and need frustration in the understanding of technological addictions in adolescents.	Quantitative survey of 482 adolescents in Italy	Age range between 14 and 17	58.5% female
Gül et al. (2019)	The prevalence of cyberbullying and cyber victimization, examine relationships between PSU, psychiatric symptoms, and emotion regulation difficulties in a clinical adolescent sample. The prediction of risk factors of being an e-victim and e-bully.	Quantitative survey of 150 adolescents in Turkey	AVG = 15.4 (SD = 1.4)	58.7% girls
Guo et al. (2019)	Association of PSU as a predictor with family well-being and the potential mediating role of family communication.	Quantitative survey of 5063 randomly selected adults in Hong Kong	AVG = 48.1 (SD = 18.2)	55.0% female
Hadlington (2015)	The link between internet addiction, PSU, and the occurrence of cognitive failures in daily life.	Quantitative survey of 210 participants	AVG = 23.19 (SD = 7.47)	49.0% female
Han et al. (2017)	The association between shyness and PSU, its underlying mechanisms, and the mediating effects of self-control and attachment anxiety of PSU.	Quantitative survey of 543 college students in China	AVG = 19.85 (SD = 1.00)	59.1% female
Hanafi, Siste, Wiguna, Kusumadewi, and Nasrun (2019)	The temperament profile and its association with vulnerability to smartphone addiction of medical students in Jakarta, Indonesia	Quantitative survey of 185 medical students	AVG = 20.39 (SD = 1.14)	66.5% female
Hao et al. (2019)	The relationship between alexithymia and mobile phone addiction.	Quantitative survey of 847 Chinese undergraduate students (aged from 18 to 24)	AVG = 20.13 (SD = ±1.22)	48.8% female
HariPriya et al. (2019)	The relationship between smartphone addiction, sleep quality and physical activity among young adults.	Quantitative survey of 113 students recruited from a health science college in Mangaluru	AVG = 22.15 (SD = 1.69)	44.2% female
Hartanto and Yang (2016)	Whether separation from a smartphone influences state anxiety and impairs higher-order cognitive processes, such as executive functions.	Two experiments of (1) 87 and (2) 66 university students in Singapore	(1) AVG = 21.60 (SD = 2.11) (2) AVG = 21.40 (SD = 1.87)	(1) N/A (2) 57.6% female
Harwood et al. (2014)	The association between smartphone use, smartphone involvement and mental health.	Quantitative survey of 274 students (67.9%), employees in professional (20.4%) and managerial (8.0%) positions, and others (3.7%) in the UK.	AVG = 27.24 (SD = 12.09)	74.8% female
Haug et al. (2015)			AVG = 18.2 (SD = 3.6)	51.8% female

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Article	Core focus	Methodology, sample, area	Age	Gender
Hawi and Samaha (2017)	Indicators of smartphone use, smartphone addiction, and their associations with demographic and health behavior-related variables in young people. The relationships among PSU, anxiety, and family relations.	Quantitative survey of 1519 students from 127 Swiss vocational school classes. The majority (82.2%) having a secondary school degree. Quantitative survey of 381 university students at a private university in Lebanon that adopts the American system of education	AVG = 20.84 (SD = 1.92)	40.9% female
Hawi and Samaha (2016)	Whether achieving a distinctive academic performance is unlikely for students at high risk of smartphone addiction as well as gender differences.	Quantitative survey of 249 students	AVG = 20.96 (SD = 1.93)	45.8% female
Heo and Lee (2018)	The association between smartphone addiction and school adjustment and the mediating effect of self-control in this association.	Quantitative survey of 790 students from five high schools in Daegu City, South Korea	N/A	76.6% female
Herrero, Torres, et al. (2019) and Herrero, Uruña, et al. (2019)	The influence of the social context—through the perceived social disorder in the neighborhood—on the extensive use and addiction to the smartphone.	Quantitative survey of 3619 Spanish users	AVG = 3.23 (SD = 1.36)	50.1% female
Herrero, Uruña, Torres, and Hidalgo (2019a, 2019b)	Smartphone extensive use and addiction as well as its relationship to smartphone harm.	Quantitative survey of 526 smartphone users in Spain	AVG = 3.27 (SD = 1.07)	47.8% female
Herrero et al. (2019a, 2019b)	The relationship between the excessive use of the smartphone, a social technology that allows social connectivity in real time, and the potential negative implications it has on the social world of the user.	Quantitative survey of 416 smartphone users from Spain	AVG = 3.08, (SD = 0.96)	44.7% female
Hong et al. (2012)	The relationship between psychological characteristics, PSU, and smartphone use.	Quantitative survey of 269 Taiwanese female university students	N/A	100.0% female
Hong et al. (2019)	The association between shyness and PSU, the mediating role of social anxiety, and the moderating role of relatedness need satisfaction perceived on the smartphone.	Quantitative survey of 1050 adolescents recruited from middle schools in China	AVG = 13.77 (SD = 1.62)	55.2% female
Horwood and Anglim (2019)	Comprehensive assessment of the relationship between general usage and PSU, and subjective wellbeing and psychological wellbeing.	Quantitative survey of 539 Australian adults	AVG = 25.1 (SD = 7.8)	79% female
Horwood and Anglim (2018)	PSU prediction based on the HEXACO and Big Five models of personality.	Quantitative survey of 393 university students in Australia	AVG = 24.4 (SD = 7.1)	78.9% female
Hughes and Burke (2018)	The impact of bedroom smartphone use on happiness and wellbeing.	Experiments with 95 participants, divided randomly into the experimental (n = 49) and control (n = 46) groups. The majority was based in the UK (n = 88, 92.6%)	N/A	67.4% female
Hussain, Griffiths, and Sheffield (2017)	The psychological aspects of smartphone use particularly in relation to problematic use, narcissism, anxiety, and personality factors.	Quantitative survey of 640 participants (73.5%). Six people did not provide information about gender. Participants were mostly students (68.6%), employed (23.6%), self-employed (3.0%), unemployed (4.3%), or retired (0.5%). The marital status of participants was single (52.5%)	AVG = 24.89 (SD = 8.54)	65.6% female
Hwang and Jeong (2015)	The predictors of parental mediation regarding children's smartphone addiction.	Quantitative survey of 460 respondents recruited from a panel maintained by Macromill Embrain	AVG = 41.12 (SD = 3.61)	50.2% female
Ibrahim et al. (2018)	The pattern of mobile phone usage, and its relation to sleep		AVG = 21.60 (SD = ± 2)	48.5% female

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Article	Core focus	Methodology, sample, area	Age	Gender
Ihm (2018)	quality and academic performance between medical students. Smartphone addiction as a social problem stemming from a lack of offline social networks resulting in a decline of social engagement.	Quantitative survey of 610 medical students in Saudi Arabia Quantitative survey of 2000 children in Korea	AVG = 12	50.5% female
Jahng (2019)	Mothers' abusive parenting and young adolescents' PSU.	Quantitative survey of 506 middle school students aged between 13 and 15 years in South Korea	AVG = 14.01, SD = 0.20)	47.0% female
Jeong et al. (2016)	User characteristics and media content types that can lead to PSU.	Quantitative survey of 944 6th graders recruited from 20 elementary schools in South Korea	N/A	49.0% girls
Jiang, Li, and Shypenka (2018)	The levels of loneliness of international students in China.	Quantitative survey of 438 international students voluntarily participated in the survey. The participants were from 67 countries and have been studying in China for months	AVG = 24.85, SD = 4.45	43.4% female
Jilisha et al. (2019)	The prevalence and factors associated with nomophobia and the perception of young adults about excessive smartphone usage.	Quantitative survey of 774 college students in India	Age 18:368 respondents Age 19: 278 respondents Age 20: 106 respondents Age >20: 22 respondents	58.8% female
Jo, Na, and Kim (2018)	The prevalence of smartphone addiction predisposition (SAP) in adolescents and adults investigating associations between impulsivity and SAP.	Quantitative survey of 7003 participants in Korea	AVG for male = 24.89 (SD = ±7.27) and for female = 23.52 (SD = ±6.13)	55.5% female
Jun (2016)	The stability of changes in PSU and depressive symptoms across time including the direction of these reciprocal longitudinal relationships.	Longitudinal (T1-3), quantitative surveys of 1877 adolescents in South Korea	T1 AVG = 13.89 (SD = 0.34)T3 AVG = 15.89 (SD = 0.34)	50.2% girls
Kang and Kurtzberg (2019)	The use of cell phones and its relationship with cognitive tasks.	Quantitative survey of 414 undergraduate students	AVG = 22	44% female
Kanthawongs et al. (2016)	The impact of self-regulation and compulsivity towards smartphone addiction of university students in two private universities in Thailand.	Quantitative survey of 157 students at two private universities in Thailand	Age of 19- years- old (31.2%)	42.7% female
Karadağ et al. (2015)	Determinants of phubbing behavior, the effects of gender, smartphone ownership, and social media membership as moderators.	Quantitative survey of 401 randomly selected university students.	AVG = 21.9	71.6% female
Katz et al. (2018)	The impact of a classroom policy prohibiting smartphone use on negative mood and craving.	Experiment with 98 college students in courses in which smartphone use was (1) prohibited or (2) permitted for academic purposes	AVG = 20.7 (SD = 1.7)	71.4% female
Khang, Kim, and Kim (2013)	The influence of self-esteem, self-efficacy, self-control, and dispositional media use motives on media users' experiences of flow and levels of PSU.	Quantitative survey of 290 university students in the US	AVG = 21 (SD = 3.72)	63.8% female
Khoshgoftar et al. (2019)	The effect of educational intervention to decrease and prevent mobile phone addiction among female high school students.	Quantitative survey of 112 female high school students in Iran	AVG for intervention group = 14.62 (SD = ± 0.52) AVG for control group = 14.66 (SD = ± 0.83)	100% female
Kim and Koh (2018)	The structural relationship between avoidant attachment, self-esteem, anxiety, and PSU in college students.	Quantitative survey of 313 college students in South Korea	AVG = 22 (SD = 3.4)	58.1% female
Kim and Jahng (2019)	The moderating effect of weekend family rituals on the relationship between children's low self-esteem and their PSU.	Quantitative survey of 274 fifth and sixth graders in five elementary schools located in Seoul and Incheon, South Korea	N/A	53.3% female
Kim, Cho, et al. (2017) and Kim, Min, et al. (2017)	Mediating effects of loneliness and depression on the relationship between adult	Quantitative survey of 200 university students	AVG = 21.6 (SD = 2.0)	63.0% female

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Article	Core focus	Methodology, sample, area	Age	Gender
Kim, Cho, et al. (2017) and Kim, Min, et al. (2017)	attachment and smartphone addiction in university students. Associations between psychological and subjective health conditions and smartphone overuse.	Quantitative survey of 608 college students in Korea	AVG = 15.00 (SD = 1.75)	49.2% girls
Kim, Jun, et al. (2018) and Kim, Min, et al. (2018)	The association of adolescents' smartphone addiction with family environment (specifically, domestic violence and parental addiction), whether self-control and friendship quality, as predictors of smartphone addiction, may reduce the observed risk.	Quantitative survey of 3380 adolescents	Age range = 5–54 years old	48.7% female
Kim, Park, Lee, et al. (2019)	The effect of increasing the interaction cost of accessing an app for the discouragement of app use.	Targeted intervention with 40 participants	AVG = 23 (SD = 3.09)	45% female
Kim (2017)	Alleviation of loneliness through escape motivation and smartphone-mediated communication vs. relationship motivation and face-to-face interaction.	Quantitative survey of 930 participants in the US recruited through a professional survey company	AVG = 25.56 (SD = 8.20)	48.7% female
Kim (2018)	The covert mechanism connecting psychological issues (loneliness and ADHD) and PSU.	Quantitative survey of 615 adults in the US recruited nationally	AVG = 30.39 (SD = 5.62)	48.7% female
Kim, Seo, et al. (2015) and Kim et al., 2015a	Depression as a key antecedent to PSU and the mediating role of motivations and the amount of time spent on communication activities available via smartphones.	Quantitative survey of 395 adults in the US recruited through Amazon's Mechanical Turk labor market	AVG = 31.64 (SD = 9.69)	47.1% female
Kim, Kim, Kim, et al. (2015)	The relationship among smartphone addiction tendency, depression, aggression and impulsions in college students.	Quantitative survey of 353 university middle school students located in Cheonan. 144 first year students (40.8%); 88 s year students (33.2%), 218 third year students (36.9%), and 61 fourth year students (17.3%)	AVG = 20.27 (SD = 3.94)	69.1% female
Kim, Kim, et al. (2015) and Kim et al., 2015c	The relationship and the impact of excessive smartphone use on physical activity.	Quantitative survey of 110 Chinese international students in Korea	AVG = 21.03 (SD = ±1.61)	39.1% females
Kim et al., 2019a	The prevalence of smartphone addiction and its association with depression, anxiety, and attention deficit hyperactivity disorder (ADHD)symptoms in a large sample of Korean adolescents.	Quantitative survey of 4512 middle- and high-school students in South Korea	AVG = 15.15 (SD = 1.62)	54.9% females
Kim, Jun, et al. (2018) and Kim, Min, et al. (2018)	The preliminary effects of the Peer Relationship Enhancement Program in adolescents deemed to be in an at-risk group for Internet and smartphone addiction.	Quantitative survey of 33middle school students taking part in the adolescent Internet and smartphone usage status survey and preventative training in a small-to-medium sized city in the Chungcheongbuk-do	N/A	27.3% female
Kim et al. (2016)	Personality factor-associated predictors of smartphone addiction predisposition.	Quantitative survey of 4854 participants with smartphones	AVG for male = 34.12 (SD = 7.39) and for female = 32.73 (SD = 7.59)	47.0% female
Kita and Luria (2018)	Relationship between personality traits and the use of smartphones.	Quantitative survey of 221 young drivers aged 17–22 years in Israel	AVG = 19.3 (SD = 1.71)	35.3% female
Konan, Durmuş, Türkoğlu, and Ağroğlu Bakır (2018)	The relationship between prospective teachers' smartphone addiction and interaction anxiety.	Quantitative survey of 330 prospective teachers in Turkey	Age range = 20–24 years old	63.6% female
Konok et al. (2017)	The existence of PSU.	Experiments with 93 university students in Hungary	MED = 21 (range: 18–26 years)	54.8% female
Krasnova et al. (2016)	The role of jealousy as a mediating mechanism in the relationships between partner's smartphone use and corresponding relational outcomes.	Quantitative survey of 286 online respondents from a large German university	Age range = 79.7% belong to the 26–30 age cohort, nearly 17.5% are 31–35 years old and 2.8% are at the age of 36–40.	64.0% female

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Article	Core focus	Methodology, sample, area	Age	Gender
Kruger and Djerf (2017)	How age, gender, personality factors, and symptoms of PSU relate to the frequency of imagined phone experiences.	Quantitative survey of 766 university students recruited from the Psychology Subject Pool of a large public university in the US.	AVG = 19 (SD = 1)	50.1% female
Kuang-Tsan and Fu-Yuan (2017)	The relationships among the types of life stress, smart mobile phone addiction, and life satisfaction of university students in Taiwan.	Quantitative survey of 332 participants	Age range = 18–22 years old	35.2% female
Kumcağiz, Şahin, and Köksal (2017)	The role of smartphone dependency in communication conflicts between partners during marital adjustment.	Quantitative survey of 428 married family physicians and health care workers working at Samsun Public Health Directorate	N/A	63.5% female
Kumcagiz (2019)	Quality of life as a predictor of smartphone addiction risk among Turkish adolescents.	Quantitative survey of 352 high school students in Turkey	AVG = 16.26 (SD = 2.00)	56.5% female
Kwon et al. (2016)	Digital vulnerabilities driven by dependence on mobile social apps (e.g., social network sites and social games).	13-month, individual-level panel data on the weekly app usage of thousands of smartphone users	N/A	N/A
Kwak et al. (2018)	The relationships with parents, peers, and teachers as a cause of adolescents' smartphone addiction, and to examine the effect of parental neglect on smartphone addiction and the mediating effect of relational maladjustment in school, especially focusing on the relational maladjustment with peers and teachers.	Quantitative survey of 1170 middle-school students in South Korea	Age range = 80% of the participants are enrolled in the 2nd grade of middle school	58.4% female
Lachmann, Duke, Sariyska, and Montag (2019)	Whether the same personality traits can be linked to overuse of both problematic internet use and PSU.	Quantitative survey of 612 participants, whereof 572 (160 males and 412 females) owned a smartphone (all participants are part of the Ulm Gene Brain Behavior Project)	AVG = 23.55 (SD5.92)	71.1% female
Lachmann et al. (2018)	The relationship between empathy, life satisfaction, and the related phenomenon of smartphone use disorder.	Quantitative survey of participants from China (N = 612) and Germany (N = 304)	AVG = 24.05 (SD = 8.85)	China: 26.5% female Germany: 68.1% female
Lapointe et al. (2013)	Smartphone usage through four smartphone user profiles, of which users are exhibiting addictive behaviors in two of these profiles.	Quantitative survey of 182 respondents	Age range = 17 and 29 years old	55.0% female
Lee and Lee (2017)	The influences of demographic, contextual, and motivational factors on adolescent smartphone addiction proneness.	Quantitative survey of 3000 adolescents. About half of the students (47.5%) had a medium level of academic performance	N/A	47.3% female
Lee (2015)	Predictors of smartphone addiction among African American college students, predictors of Facebook addiction among African American college students, the effect of multitasking on smartphones on academic performance of African American college students.	Quantitative survey of 304 African American college students at one of the largest Historically Black College and Universities (HBCUs) in Texas participated in the survey in the spring semester of 2014	AVG = 22.45 (SD = 6.1)	56% female
Lee and Kim (2018)	Gender differences in smartphone addiction behaviors associated with parent-child bonding, parent-child communication, and parental mediation.	Quantitative survey of 224 smartphone users in a Korean elementary school students, aged 11–13 years	Age range = 11–13 years old	50% girls
Lee and Ogbolu (2018)	The relationship between personal characteristics (age, gender), psychological factors (depression), and physical factors (sleep time) on smartphone addiction in children, whether parental control is associated with a lower incidence of smartphone addiction.	Quantitative survey of 208 children	AVG = 11.1 (SD = 0.81)	52.4% female
Lee et al., 2014a			MED = 28.98 (SD = 9.34)	55.7% female

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Article	Core focus	Methodology, sample, area	Age	Gender
Lee, Ahn, et al. (2014)	The link between psychological traits and compulsive behaviors of smartphone users as well as stress caused by compulsive behaviors. Development of SAMS (Smartphone Addiction Management System); a comprehensive ICT system for objective assessment-based diagnosis and intervention for smartphone addiction.	Quantitative survey of 325 citizens in Kaohsiung, Taiwan The SAMS client application was uploaded to the SAMS server and SMS messages to request install SAMS app were sent to about 120 anonymous users that were from 4 persons (lab members, including the SAMS developers) phone number list	AVG = 26.57 (SD = 8.25)	50% female
Lee, Chang, et al. (2017) and Lee, Kim, et al. (2017)	Risk factors for smartphone addiction.	Quantitative survey of 370 students	AVG = 13.15	50.8% female
Lee, Seo, et al. (2016)	Therapeutic effectiveness of a home-based daily journal of smartphone use (HDJ-J) in Korean adolescents.	Quantitative survey of 335 students of a junior high school located in Daegu Metropolitan City	AVG = 13.13	53.7% female
Li and Lin (2019) and Lee et al., 2019	The relationships of victimization of traditional and cyber homophobic bullying during childhood and adolescence with problematic internet and smartphone use and activities during early adulthood among sexual minority men in Taiwan.	Quantitative survey of 500 homosexual or bisexual men in Taiwan	AVG = 22.9 years (SD = 1.6, range: 20–25 years)	100% men
Lee, Sung, et al. (2018)	The prevalence of young adolescents at risk of smartphone addiction and the psychological factors associated with smartphone addiction.	Quantitative survey of 490 students from an all-boys middle school in South Korea	AVG = 14 (SD = ± 0.89)	100% boys
Lee et al., 2019b	Smartphone use in young patients with schizophrenia, factors that may affect the severity of PSU.	Quantitative survey of 148 schizophrenia patients in Korea	AVG = 27.5 (SD = ± 4.5)	48.0% female
Lee et al., 2016b	Adolescent application usage related to smartphone addiction, mediation strategies used to prevent addiction.	Quantitative survey of 3000 adolescents. They included 484 students in grade 7, 494 students in grade 8, 519 students in grade 9, 503 students in grade 10, 503 students in grade 11, and 494 students in grade 12	Age range = adolescents in grades 7 to 12 (age range = 13–18 years)	47.3% female
Lee, Chang, et al. (2018)	The dynamics of mechanisms that might potentially cause smartphone addiction.	Quantitative survey of 450 in the United States and 400 in China	AVG = 30.95 (SD = 11.72)	57.5% female
Li and Lin (2018)	Whether smartphone-related problems differ from those of computer use according to gender.	Quantitative survey of 555 Korean middle-school students	N/A	46.8% female
Lee et al., 2018b	Smartphone addiction subscales and social support related to interpersonal competence of nursing students.	Quantitative survey of 324 college students were recruited at Catholic University in Seoul, Korea	N/A	N/A
Lee, Lee, et al. (2014)	Differences in usage patterns of two groups by comparing various usage features.	Quantitative survey of 95 college undergraduate students at a large university in Korea. Used a mixed methods approach: surveys, logged data, and interviews.	AVG = 20.6 (SD 1.7)	29.5% female
Lee, Chang, et al. (2017) and Lee, Kim, et al. (2017)	Development of a model to explain smartphone addiction.	Quantitative survey of 1300 respondents in China, South Korea, and Japan	Taiwan: AVG = 30.40 (SD = 9.62); China: AVG = 21.27 (SD = 3.24); South Korea: AVG = 22.10 (SD = 4.72); Japan: AVG = 23.31 (SD = 6.29)	Taiwan: 57.5% female, China: 58.6% female, South Korea: 56.3% female, Japan: 18.8% female
Lepp et al. (2016)	The impact of various smartphone use behaviors on social relations.	Quantitative survey of 493 college students in the US	Age range = 18–29 years old	79.9% female
Li and Lin (2019)	The symptoms of smartphone addiction among working adults in China and the psychological factors that affect such addiction	Interviews with 32 Chinese workers	AVG = 28.09 (SD = 2.79)	46.9% female
Li and Lin (2018)	How dependence on smartphones for various goals at work, such as understanding, orientation, and communication, relates to employees' job performance,	Quantitative survey of 527 workers in urban China	(AVG = 27.01, SD = 3.41)	54.5% female

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Article	Core focus	Methodology, sample, area	Age	Gender
Li and Hao (2019)	workplace social capital, and smartphone addiction The association between parental attachment and mobile phone dependence as well as its influence mechanism.	Quantitative survey of 693 middle schools in rural areas of Jiangxi and Hubei Province	AVG = 14.88 (SD = 1.77)	46.5% female
Lian et al. (2016)	The mediation of virtues (i.e., relationship, vitality, and conscientiousness) on the association between parenting style and PSU.	Quantitative survey of 742 college students in China	AVG = 19.14 (SD = 1.21)	44.2% female
Lian and You (2017)	The relationship between three key virtues (i.e., relationship, vitality, and conscientiousness) and smartphone addiction as well as evaluated the specific contributions of these virtues as applied to smartphone use among Chinese university students.	Quantitative survey of 682 undergraduates (aged 18–24 years) from three universities	AVG = 19.34 (SD = 1.26)	41.6% female
Lin et al. (2015)	A proposed diagnostic criteria and the designing of a mobile application to identify smartphone addiction.	79 young adults (students) were recruited from the Department of Electrical Engineering and Department of Computer and Communication Engineering of two universities in Northern Taiwan	AVG = of 22.4 (SD = ±2.3)	27.8% female
Liu, Lin, Pan, and Lin (2016)	The risk factors of smartphone addiction in high school students.	Quantitative survey of 880 high school students	AVG = 18.2 (SD = ± 3.6)	6.7% female
Liu et al. (2017)	The mediating role of rumination and moderating role of mindfulness in the association between PSU and sleep quality.	Quantitative survey of 1196 adolescents in China	AVG = 16.75 (SD = 0.94)	47.0% female
Liu et al. (2018)	The mediating role of self-control and moderating role of mindfulness in the link between perceived stress and PSU.	Quantitative survey of 899 high school students in China	AVG = 16.75 (SD = 0.92)	54.0% female
Liu, Yang, Zhu, and Zhang (2019)	The mediating role of loneliness and the moderating role of rumination in the link between attachment anxiety and mobile phone dependence.	Quantitative survey of 908 Chinese university students	AVG = 21.04 (SD = 1.84)	52.2% female
Long et al. (2016)	The prevalence of PSU and to screen suitable predictors for PSU among Chinese undergraduates in the framework of the stress-coping theory.	Quantitative survey of 1062 participants	AVG = 20.65 (SD = ±1.54)	53.9% female
Long, Wang, Liu, and Lei (2019)	Whether FoMO would mediate the relationship between materialism and adolescent PSU; the moderating role of narcissism in this mediating process.	Quantitative survey of 677 middle school students in China	AVG = 16.79 (SD = 0.72)	
Lopez-Fernandez et al. (2018)	The relationship between gaming on smartphones and self-perceived problematic smartphone use via an online survey to ascertain potential predictors.	Quantitative survey of 899 participants across Belgium and Finland	Age range = 18–67 years old	70% female
Lu et al. (2011)	Prevalence of problematic uses of internet and text messaging and the association between depression and anxiety and internet and text-messaging dependency.	Quantitative survey of 146 office employees	AVG = 42.4 (SD = 10.4)	37.0% female
Lu et al. (2019)	Compared mobile phone addiction patterns between Tibetan and Han adolescents in China	Quantitative survey of 755 Tibetan and 606 Han students	AVG = 15.1 (SD = 1.9)	46.1% female
Mahapatra (2019)	Antecedents of PSU and resultant negative consequences.	Quantitative survey of 330 adolescents in India	Age range = 15–20 years old	42.1% female
Mahmoodi et al. (2018)	The association between mobile phone overuse and mental health, in the presence of other determinant factors, among high school students in Iran.	Quantitative survey of 1034 high school students in Saqqez County, Iran	Male: AVG = 6.22 (SD = 1.25), female: AVG = 16.15 (SD = 1.17)	50.2% female
			N/A	63% female

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Article	Core focus	Methodology, sample, area	Age	Gender
Mangot, Murthy, Kshirsagar, Deshmukh, and Tembe (2018)	The prevalence of such sensations among medical interns and their association with perceived stress levels and smartphone usage pattern.	Quantitative survey of 93 medical students in India		
Marchant and O'Donohoe (2019)	The blurring of human/technology boundaries between emerging adults and their smartphones.	Qualitative, interpretive study using smartphone diaries and friendship pair/small group discussions with 27 British merging adults	Age range = 16–19 years old	51.2% female
Mei et al. (2018)	The relationship between college students' alexithymia and mobile phone addiction as well as the mediating effects of mental health and the moderating role of being a single child or not.	Quantitative survey of 1034 college students from Changchun	AVG = 19.97 (SD = 1.22)	52.7% female 52.7%
Mitchell and Hussain (2018)	The Integrative Pathways Model and the effect of age, gender, impulsiveness, excessive reassurance seeking, extraversion, and depression on problematic smartphone use.	Quantitative survey of 147 smartphone users in the UK	AVG = 30.96 (SD = 12.97)	69.4% female
Mok et al. (2014)	Classification of distinct subgroups of people who use both smartphone and the internet based on addiction severity levels, how the classified groups differed in terms of sex and psychosocial traits.	Quantitative survey of 463 Korean college students from Seoul (n = 78, 16.9%), Sungnam (n = 154, 33.3%), Nonsan (n = 76, 16.4%), and Daejeon (n = 155, 33.5%) participated in the study	Male, AVG = 21.80 (SD = 3.39); female, AVG = 20.38 (SD = 2.45)	60.3% female
Montag et al. (2015)	Smartphone ownership and use of zeitgebers among participants.	Quantitative survey of 3084 exhibition visitors from all over Germany/Austria participated.	AVG = 29.77 (SD = 17.19)	48.5% female
Mosalanejad, Nikbakht, Abdollahifrad, and Kalani (2019)	The prevalence of smartphone addiction and its relationship with personality traits, loneliness, and daily stress of students.	Quantitative survey of 233 students of Jahrom University of Medical Sciences.	Age range = 19 years–35 years old	82.1% female
Nahas et al. (2018)	The extent of PSU among adults aged 18 to 65.	Quantitative survey of 207 Lebanese adults.	Age range = 111 aged 18–34 (53.6%), 63 aged 35–49 (30.4%), 33 aged 50–64 (16%)	51.2% female
Nayak (2018)	Smartphone addiction on students' academic performance; the effect of gender and relationship status on smartphone usage and addiction.	Quantitative survey of 429 higher education students in India	AVG = 19.5	64.8% female
Noë et al. (2019)	Predictors of Snapchat usage based on a range of data collected through surveys and from interaction with the handset	Quantitative survey of 64 participants from Cardiff University, UK	AVG = 25.44 (SD = 5.87)	46.9% female
Olivencia-Carrión, Ferri-García, del Mar Rueda, Jiménez-Torres, and López-Torrecillas (2018)	The relationship between temperament and personality and the development of nomophobia	Quantitative survey of 968 participants selected from the Andalusian population	AVG = 23.19 (SD 7.23)	81.1% female
Olufadi (2015)	Mobile phone use behaviors.	Quantitative survey of 286 students in the two universities.	AVG = 21 (SD = 1.96)	52.1% female
Oulasvirta et al. (2012)	The habit-forming nature of smartphones with a specific view to what habits are and what their role is in human–computer interaction.	Study 1: 136 participants, of which 20 were selected for semi-structured, ethnographic interviews Study 2: field experiment involving three user groups Study 3: self-reports on the use of smartphone12 university students	Age range = Study 1: 35% were between the ages of 18 and 25, 50% were between the ages of 26 and 39, and 14% were between the ages of 40 and 54 Study 2: N/A Study 3: N/A	Study 1: 56.7% female Study 2: N/A Study 3: N/A
Panda and Jain (2018)	How personality characteristics are related to PSU and if PSU impacts users' ill being.	Quantitative survey of 276 young smartphones users in India.	Age range = <25 years: 175 (63.41%); 25–35 years: 98 (35.51%); >35 years: 3 (1.09%)	38.8% female
Park (2019)	Smartphone users' perception and evaluation of their dependent behavior during the 2014 communication blackout in South Korea that lasted 6 h.	Qualitative interviews with 70 smartphone users	AVG = 33.8, age range 18–57 years old	48.6% female
Pearson and Hussain (2017)	The relationship between smartphone use, narcissistic	Quantitative survey of 256 participants recruited via	AVG = 29.2 (SD = 9.4)	71% female

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Article	Core focus	Methodology, sample, area	Age	Gender
	tendencies and personality as predictors of smartphone addiction. The distinction between addiction specificity and co-occurrence in smartphone addiction. Reasons for why people continue to use smartphones in banned areas.	opportunity sampling from a UK University and the internet via social networking sites and smartphone forums		
Pivetta, Harkin, Billieux, Kanjo, and Kuss (2019)	An empirically validated model testing the contribution of specific factors leading to PSU.	Online survey was administered to a convenience sample (N = 511) of smartphone users	AVG = 25.5 (SD = 9.9)	78.3% female
Prasad et al. (2018)	The psychological correlates of excessive smartphone use.	Quantitative survey of 140 consenting undergraduate and postgraduate students using an Android smartphone at a tertiary care teaching hospital in India.	AVG = 22.89 (SD = ±2.79)	50% female
Qudah et al. (2019)	Smartphone addiction and cyberbullying among a group of university students.	Quantitative survey of 449 male and female university students whose ages ranged from 17 to 24 years.	AVG = 20.93 (SD = 2.96)	49.4% female
Rad and Ahmadi (2018)	The design of an Android mobile application to measure and decrease the social networking addiction level.	Experiment with 100 students randomly as an intervention group and was sent to 100 students randomly as a control group	Intervention: age min 19, max 26 Control: age min 18, max 28	65% female (intervention group), 62% female (control group)
Randler et al. (2016)	Morning- and evening-oriented students related to PSU and addiction proneness.	Study 1 was conducted with 342 younger adolescents. Study 2 was conducted with 208 older adolescents	N/A	48.4% girls (Study 1), 70.2% girls (Study 2)
Rho et al. (2019)	Types of PSU based on psychiatric symptoms, using the decision tree method.	Quantitative survey of 5372 smartphone users in Korea	AVG = 26.43 (SD = 5.95)	54.5% female
Roberts, Pullig, and Manolis (2015)	The relationship between a full range of personality traits and cell phone addiction.	Quantitative survey of 346 respondents. Members of a student subject pool and were contacted by e-mail which included a secure link to the survey questionnaire	AVG = 21	51% female
Roberts et al. (2014)	Cell-phone activities associated with cell-phone addiction.	Quantitative survey of 164 college students from a major university in Texas. 6% of the sample was sophomores, 71% juniors, and 23% seniors.	AVG = 21	49% female
Rozgonjuk and Elhai (2019)	The association between expressive emotional suppression with PSU.	Quantitative survey of 300 American college students	AVG = 19.45 (SD = 2.17)	79% female
Rozgonjuk et al. (2019)	Relations between PSU severity and intolerance of uncertainty.	Quantitative survey of 261 college students in the US	AVG = 19.73 (SD = 3.52)	76.9% female
Rozgonjuk, Kattago, et al. (2018) and Rozgonjuk, Levine, et al. (2018)	The relationships between PSU, procrastination, and social media use in lectures.	Quantitative survey of 366 university students in Estonia	AVG = 25.75 (SD = 7.70)	78.7% female
Rozgonjuk, Kattago, et al. (2018) and Rozgonjuk, Levine, et al. (2018)	How self-reported levels of PSU, depression, anxiety, and daily depressive mood relate to objectively measured smartphone use over one week.	Quantitative survey of 101 students in the US	AVG = 19.53 (SD = 4.31)	76.2% female
Ruan, Sheng, Yao, Tran, and Yang (2016)	The potential of exploiting sensors embedded in smartphones to detect and prevent such unhealthy habit by measuring the ambient light intensity and detecting the smartphone motion.	N/A	N/A	N/A
Ruiz-Palmero, Sánchez-Rivas, Gómez-García, and Sánchez Vega (2019)	How devices are being used and whether students are at risk of addiction.	Quantitative survey of 453 students between the ages of 18 and 47 was analyzed from two Spanish Universities	AVG = 20.67 (SD = 4.89)	76.8% female
Salehan and Negahban (2013)	The relationship between smartphone use for social networking and PSU.	Quantitative survey of 209 university students in the US	90% of the respondents were aged 18-30	39.2% female
Samaha and Hawi (2016)	The relationship between PSU risk and satisfaction with life mediated by stress and academic performance.	Quantitative survey of 249 university students	AVG = 20.96 (SD = 1.93)	45.8% female
Sapacz et al. (2016)				77.0% female

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Article	Core focus	Methodology, sample, area	Age	Gender
	The prevalence of characteristics of PSU along with possible predictors of high frequency smartphone use.	Quantitative survey of 152 university students in Canada	Age range = 85% of participants (n = 130) were between the ages 18 and 24.	
Saritepeci (2019)	Cyberloafing behaviors of high school students in terms of several variables, including gender, ICT usage, unauthorized access to school network, metacognitive awareness and smartphone addiction.	269 9th grade students in Turkey	N/A	54.3% female
Sarti et al. (2019)	Socio-emotional functioning and its relation to wellbeing, school engagement, and PSU.	38 adults in Italy (19 adolescents with a diagnosis of SLD and 19 control adolescents were assessed through a narrative test)	AVG = 15.16 (SD = 0.36)	73.7% female
Savci and Aysan (2017)	The predictor effects of four technological addictions, including Internet addiction, social media addiction, digital game addiction, and smartphone addiction on social connectedness.	Quantitative survey of 201 adolescents who have been using Internet, playing digital games, and using social media for at least one year, and have at least one social media account and a smartphone	Age range = 14–18 years old.	50.2% girls
Selçuk and Ayhan (2019)	The relationship between smartphone addiction risk and sleep duration and psychosocial comorbidities in health professional candidates.	Quantitative survey of 408 students in Turkey	AVG = 20.13 (SD = ± 2.43)	81.1% female
Seo et al. (2015)	PSU and multicomputing explained by symptoms of adult ADHD and a strong need of social assurance or need to belong as well as gender differences.	Quantitative survey of 432 adults in the US recruited through Amazon Mechanical Turk	AVG = 32.01 (SD = 10.10)	48.9% female
Serin, Durmaz, and Polat (2019)	The correlation between smartphone addiction and dysfunctional attitudes.	Quantitative survey of 748 students	Age range = 63.4% of the respondents were aged 17 to 20.	85.7% female
Servidio (2019)	The mediating role of FoMO and of smartphone use patterns on self-control and PSU among Italian university students.	Quantitative survey of 405 students in Italy	AVG = 22.11, SD = 3.80	71.11% female
Shim (2019a, 2019b)	Aspects of Christian spirituality among three groups: the high-risk, potential-risk and normal control groups for smartphone addiction.	Experiment - 11 adolescents in the high-risk group for smartphone addiction; 20 adolescents who were potentially at risk of smartphone addiction, and 254 adolescents who were in the normal control group from Korea	Age range = 12–19 years old.	51.6% female
Shim (2019a, 2019b)	The relationship of smartphone addiction with external shame and internal shame in a sample of Christian adolescents in Korea.	Quantitative survey of 220 adolescents answered a survey in Korea	Ages ranged = middle school grade 1 to high school grade 3 (middle school grade 1: N = 12; grade 2: N = 17; grade 3: N = 34; and high school grade 1: N = 55; grade 2: N = 58; grade 3: N = 44).	54.1% female
Shin and Dey (2013)	Correlation of smartphone context and usage features with PSU, detection model to identify users exhibiting PSU.	Quantitative survey of 48 participants from a local university community (25) and from an Android marketplace (23). Qualitative interviews with 25 respondents.	AVG = 26.7	29.2% female
Shin and Lee (2015)	Smartphone usage patterns associated with its PSU drivers and results.	Quantitative survey of 543 college students in the US and in South Korea	AVG = 24	63.0% female
Sohn, Oh, Lee, and Potenza (2018)	The association among suicidal ideation, cyber addiction, and school bullying of Korean high school students	Quantitative survey of 400 students in Korea	AVG = 17.9 (SD = + 0.8)	44.5% girls
Sok, Seong, and Ryu (2019)	The differences of self-control, daily life stress, and communication skills between smartphone addiction risk group and general group in nursing students, South Korea.	Quantitative survey of 139 nursing students (addictive risk: n = 40, general: n = 99) in South Korea	Age range = ≤22 82 (59.0) ≥23 57 (41.0)	84.2 female
Song, Park, Kim, Kim, and Park (2019)	The relationship between maternal life satisfaction,		Age range = 8 mothers (2.4%) were under 30 years old, 59 (18.0%) were	N/A

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Article	Core focus	Methodology, sample, area	Age	Gender
	smartphone addiction, and parenting behavior.	Quantitative survey of 328 Korean mothers with children aged 3–5 years	from 30 to 34 years old, 175 (53.4%) were aged 35 to 39, 70 (21.3%) were 40–44 years old, and 12 (3.7%) were above 45	
Soomro, Zai, and Hina (2019)	Examination of university students' addiction levels; the impact of PSU on their satisfaction with classroom connectedness.	Quantitative survey of 438 students at two Pakistan universities. The participants came from both genders and included both undergraduate and graduate students	AVG = 15.6 (SD = 0.78)	39.5% female
Soror et al. (2012)	The role of deficient self-regulation in PSU.	Quantitative survey of 266 smartphone owners	AVG = 30 (SD = 8.57)	48.9% female
Steelman and Soror (2017)	Mechanisms driving the continued use decisions of smartphones.	Quantitative survey of 436 recruited through Amazon's Mechanical Turk	AVG = 31.69	48.6% female
Steelman et al. (2012)	Dangerous smartphone use and PSU through the lens of obsessive compulsive checkers.	Quantitative survey of 432 participants recruited through Amazon's Mechanical Turk	AVG = 28.26 (SD = 8.28)	38.0% female
Sun et al. (2019)	The mediation effects of emotional intelligence and coping style between child neglect and psychological abuse and PSU.	Quantitative survey of 1041 adolescents in China	AVG = 12.41 (SD = 0.65)	44.5% female
Swar and Hameed (2017)	The moderating role of mobile applications (or self-help interventions) on inter-relationships between social media engagement, smartphone addiction, and smartphone distractions.	Quantitative survey of 284 college students	Age range = <17 = 0 (0%) 18–22 = 205 (72.18%) 23–27 = 72 (25.35%) 28–32 = 5 (1.76%) >33 = 2 (0.70%)	54.2% female
Sözbilir and Dursun (2018)	The interactions among the factors of time spent on social media, gender, and smartphone ownership with social media usage; the links between social media usage and smartphone addiction.	Quantitative survey of 1147 children aged 9–12 studying in the public schools in Turkey	Age range = 34.4% of the participants are 11 years old and 10.3% are 9 years old	51.1% female
Taghizadeh et al. (2019)	The relationship between smartphone addiction and loneliness, the motivation to progress and other relevant variables among high school students.	Quantitative survey of 348 high school girls and boys (first year of high school) in Iran	N/A	52.2% female
Tams et al. (2018)	Fear of not being able to use one's smartphone.	Quantitative survey of 270 smartphone users recruited via a university research panel and, subsequently, divided into four groups by random allocation	N/A	N/A
Tang, Zhang, Yan, and Qu (2017)	Decision control of smartphone high users.	Quantitative survey of 125 students from South China Normal University was recruited to participate in this study	AVG = 19.92, (SD = 1.20)	58.4% female
Tanis et al. (2015)	Imagined cell phone signals.	Quantitative survey of 403 respondents recruited through Amazon's Mechanical Turk	AVG = 34.18 (SD = 12.14)	52.6% female
Tossell, Kortum, Shepard, Rahmati, and Zhong (2015)	Smartphone user behaviors and their relation to self-reported smartphone addiction.	A total of 34 students participated in the research. These students had diverse academic majors, socioeconomic levels, and ethnicities	N/A	44.2% female
(Traş; Öztemel, 2019)	The relationship between Facebook intensity and both the FoMO and smartphone addiction.	Quantitative survey of 608 participating university students in Turkey	AVG = 21.34 (SD = 2.00)	71.9% female
Tunc-Aksan and Akbay (2019)	The smartphone addiction, FoMO, and perceived social and academic competence that predict social media addiction on high school students.	Quantitative survey of 296 high school students studying in Anatolian High Schools and Vocational High School in Mersin	N/A	45.9% female
Turel et al. (2008)	Negative outcomes of excessive use of pervasive technologies such as the smartphone.	Quantitative survey of 241 mobile email users	AVG = 38 (SD = 13)	39.8% female
Vaghefi et al. (2017)	User liability to PSU, variations in PSU liability among users, the	Interviews of 15 heavy smartphone users being	Age range = 17–29 years old	54.9% female (three unspecified)

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Article	Core focus	Methodology, sample, area	Age	Gender
	nature of the antecedents, behaviors and consequences associated with each type of PSU liability.	university faculty members and students and quantitative survey of 182 respondents from a North American university		
Van Deursen et al. (2015)	The role of process and social oriented smartphone usage, emotional intelligence, social stress, self-regulation, gender, and age in relation to habitual and addictive smartphone behavior.	Quantitative survey of 386 respondents in the Netherlands	AVG = 35.2 (SD = 14.7)	67.9% female
Volkmer and Lerner (2019)	The relationship between smartphone use and different concepts of positive psychology: life satisfaction, well-being, and mindfulness.	Quantitative survey of 461 German speaking participants	AVG = 30.00 (SD = 11.97)	71.4% female
Volungis, Kalpidou, Popores, and Joyce (2019)	Relationships among smartphone addiction, social-emotional distress (e.g., anxiety, depression, sleep quality, and loneliness), and personality traits	150 undergraduate college students in the US	AVG = 19.28	83.2% female
Wang et al. (2019a)	Associations between digital nativity and four common types of PSU (i.e., internet addiction, internet gaming disorder, smartphone addiction, and Facebook addiction).	Quantitative survey of 1001 US residents recruited through Amazon's MTurk	AVG = 35.0 (SD = 10.6)	56.2% female
Wang, Wang, Yang, Asbury, and Griffiths (2019a, 2019b) and Wang et al. (2019b)	The predictive role of sensation seeking on adolescent smartphone addiction and investigated whether FoMO and procrastination sequentially mediated the relation between sensation seeking and adolescent smartphone addiction.	Quantitative survey of 794 high school students	AVG age = 16.80 (SD = 0.73)	55% female
Wang et al. (2015)	The moderating role of perceived stress on the relationship between entertainment or escapism motivation and PSU.	Quantitative survey of 549 college students in China	AVG = 18.39 (SD = 1.92)	65.2% female
Wang and Lei (2019)	The mediating effect of procrastination in the association between PSU and adolescent self-esteem; the moderating effect of upward social comparison in the relationships between PSU and adolescent self-esteem.	Quantitative survey of 762 Chinese adolescents	AVG = 16.79 (SD = .91)	56% female
Wang et al. (2018)	The relation between sensation seeking and adolescent smartphone addiction testing the moderating roles of perceived social support and depression.	Quantitative survey of 655 adolescents in China	AVG = 16.80 (SD = 0.74)	45% female
Wang and Lei (2019)	The mediating role of procrastination in the association between PSU and adolescent depression; the moderating role of perceived social support in the relationships between PSU and adolescent depression.	Quantitative survey of 772 Chinese adolescents	AVG = 16.81 years (SD = 0.73)	56.0% female
Wang et al., 2019d	Whether envy would be positively related to adolescent PSU, whether FoMO would mediate the relationship between envy and PSU, and whether student-student relationship would moderate the pathways between envy and PSU.	Quantitative survey of 724 Chinese adolescents	AVG = 16.79 (SD = 0.91)	56.9% girls
Wang et al. (2017)	The mediating role of self-esteem in the association between student-student relationship and smartphone addiction; , the moderating role of the need to belong in the indirect relationship between student-student relationship and adolescent smartphone addiction.	Quantitative survey of 768 adolescents recruited from two middle schools of Hebei Province, China	AVG = 16.81 (SD = 0.73)	56% female
	The relationship between female college students' sleep quality,		AVG = 17.35, (SD = 1.39)	100% female

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Article	Core focus	Methodology, sample, area	Age	Gender
Wang, Chen, Yang et al. (2019a, 2019b) and Wang et al. (2019e)	smartphone dependence, and health-related behaviors; identification of predictors of sleep quality.	Quantitative survey of 409 subjects at a junior college in southern Taiwan.		
Winkel, Kim, Kardash, and Belic (2019)	The relationship between smartphone use during study, PSU, and academic performance in Korean and Australian university students.	Quantitative survey of 119 Korean and 270 Australian students aged between 18 and 26 years.	Korea: AVG = 20.64 (SD = 1.71) Australia: AVG = 21.26 (SD = 2.55)	Korea: 50.4% female Australia: 77.8% female
Xie et al. (2019)	Whether adolescents' mobile phone addiction increase after being phubbed by parents; effects of the mediating roles of parent-child attachment, deviant peer affiliation, and moderating role of gender.	Quantitative survey of 1007 adolescents from three middle schools and one high school in a large city in Central China	AVG = 13.85 (SD = 1.53)	51.4% girls
Xie, Dong, and Wang (2018)	The relationship between PSU and clinical health symptoms (e.g., body dysfunction) and the mediating effects of sleep quality on this relationship in adolescents.	Quantitative survey of 686 middle- and high-school students in China	AVG = 12.98 (±1.38)	55.7% girls
Yang, Lin, Huang, and Chang (2018)	Variations in the degree of smartphone use behavior among male and female adolescents as well as the association between various degrees of smartphone use behavior and the vitality and mental health of each gender.	Quantitative survey of adolescents recruited from a junior college in September 2014	AVG = 18.23 (SD = ±0.91)	42% female
Yang, Wang, and Lu (2016)	The dual effects of enjoyment on mobile social networking service (Mobile SNS) usage behaviors by focusing on not only its positive outcomes but also its potential adverse consequences; the impacts of social self-efficacy and habit on these dual causal processes.	Quantitative survey of 398 participants.	A majority of respondents (52%) were in their 20s and 30s	53.3% female
Yang, Asbury, et al. (2019) and Yang, Zhou, et al. (2019)	Whether mindfulness moderated the relations between mobile phone addiction and both anxiety and depression in adolescents.	Quantitative survey of 1258 high school students in China	AVG = 16.76 (SD = .94)	46.6% female
a)Yang, Asbury, et al. (2019) and Yang, Zhou, et al. (2019)	Attitudes towards—and self-reported impacts of—smartphone use among British young adult students, as well as perceived causes of PSU.	Quantitative survey of 265 British undergraduates at an English university	AVG = 20.26 (SD = 3.40)	82.6% females
b)Yang, Asbury, et al. (2019) and Yang, Zhou, et al. (2019)	The prevalence and correlates of PSU among Chinese university students.	Quantitative survey of 475 Chinese university students	AVG = 19.77 (SD = 1.11)	44% female
Yayan, Suna Dağ, and Düken (2019)	The effects of technology use on working young loneliness and social relationships.	Quantitative survey of 1312 young in Turkey	AVG = 13.81 (SD = ±2.22)	26.4% female
Yildiz (2017)	Strategies of adolescents' emotion regulation to predict the Internet addiction and the smartphone addiction.	Quantitative survey of 262 high school students with, attending three high schools in the city of Adöyaman	AVG = 16.57 (SD = 1.13)	50.4% female
Yook et al. (2019)	Demographic and social factors that affect smartphone usage self-report levels.	Quantitative survey of 382 participants who lived in a metropolitan area of Korea	Age 20's = 111 Age 30's = 135 Age 40's = 136	44.5% female
You, Zhang, Zhang, Xu, and Chen (2019)	Hypothesized that social anxiety and interpersonal sensitivity may mediate the relationship between self-esteem and PSU.	Quantitative survey of 653 college students in China	AVG = 19.94 (SD = 1.34)	54.1% girls
Yuchang, Cuicui, Junxiu, and Junyi (2017)	The relationships between attachment styles and smartphone addiction, and then investigated the mediating roles of dysfunctional attitudes and self-esteem.	Quantitative survey of 297 college student sample in China	AVG = 20.24 (SD = 1.08)	45.5% female
Zhang et al. (2014b)	Significant determinants of PSU.	Quantitative survey of 384 smartphone users at two universities in China	Age range = 1.8% < 18 years of age (n = 7); 62.9% 18–24 years of age (n = 248); 28.4% 25–30 years of age (n = 112); 5.4% 31–40years of age (n = 21); 1.5% above 40 (n = 6)	45.9% female
a)Zhang et al. (2014)	Key determinants of PSU.			45.6% female

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Article	Core focus	Methodology, sample, area	Age	Gender
Zhang et al. (2019)	The mediating role of interpersonal adaptation and moderating role of self-control in the association between parental attachment and problematic smartphone use.	Quantitative survey of 394 university students in China	Age range = 1.8% < 18 years of age (n = 7); 63.5% 8–24 years of age (n = 244); 27.6% 25–30 years of age (n = 106); 7.1% > 30 years of age (n = 27)	59% female
Zhitomirsky-Geffet and Blau (2016)	The relation between various mobile apps and users' needs, and PSU.	Quantitative survey of 216 respondents in Israel	34% ages 13–19 (n = 71); 43% ages 20–35 (n = 90); 23% ages 36–68 (n = 48)	59.3% female
Zou, Wu, et al. (2019)	The association between PMPU and symptoms of depression, as well as the mediating role of sleep quality.	Quantitative survey of 4624 college students in China	AVG = 19.91 (SD = ± 1.27)	55.5% female
Zou, Wu, et al. (2019) and Zou, Xia, et al. (2019)	The prevalence of hypertension and its association with smartphone addiction among junior school students in China.	Quantitative survey of 2639 junior school students enrolled in the study by random cluster sampling	AVG = 13.18 (SD = ± 0.93)	53.8% girls

Appendix B

Instrument	Origin	Description	Items	Scores indicating PSU	Cronbach's Alpha (CA), used in studies
Addiction to device	Charlton (2002), Charlton and Danforth (2007)	Addiction to device is an adapted instrument containing descriptions and symptoms of problematic smartphone use.	7- item Likert scale (7-points), with the anchors being –strongly disagree and –strongly agree		.835 (Barnes et al., 2019); .888 (Chen, Liu, et al., 2017); .870 (Davazdahemami et al., 2016); CA N/A, uses CR (Steelman & Soror, 2017); CA N/A (Bernroider et al., 2014); CA N/A, uses CR (aChen et al., 2019)
Addiction to social networking apps	Charlton and Danforth (2007)	Addiction to social networking apps is an adapted instrument containing descriptions and symptoms of problematic smartphone use.	7- item Likert scale (7-points), with the anchors being –strongly disagree and –strongly agree		.890 (Barnes et al., 2019); .930 (Davazdahemami et al., 2016)
APS-A	Shin, Kim, and Jung (2011)	The Smartphone Addiction Proneness Scale for Adult (APS-A) is an instrument developed by the Korean National Information Society Agency (NIA) measuring disturbance of adaptive function, withdrawal, tolerance, and virtual life orientation.	15-item Likert scale (4- points), with the anchors being –not at all and –highly agree	Total scores range from 15 to 60 points. High-risk group: > 45. Potential risk group: 42–44.	.830 adapted scales (Kim & Koh, 2018)
CERM	Gracia Blanco, Vigo Anglada, Fernández Pérez, and Marcó Arnavut and Nuri (2018)	Cuestionario de Experiencias Relacionadas con el Móvil (CERM) is an adapted Spanish questionnaire measuring mobile phone abuse in terms of increment of tolerance, negative effects on behavior, deterioration of family and social relationships, reduction of other activities, loss of control, tendency to evade problems, and craving.	20-item Likert scale (4-points). Anchors not specified.		.859 (Beranuy et al., 2009); .805 (Carbonell et al., 2012)
CPAS	Roberts et al. (2014)	The Cell-Phone Addiction Scale (CPAS) is an instrument focusing on cell-phone availability and time spent on the cell-phone.	4-item Likert scale (5-points). Anchors not specified.		.870 (Mahapatra, 2019); .848 German translation (Krasnova et al., 2016); CA N/A (Roberts et al., 2015); .87 (Roberts et al., 2014)
E-SAPS18	Kwon, Lee, et al. (2013), Rozgonjuk, Rosenvald, Janno, and Täht (2016)	The Estonian Smartphone Addiction Proneness Scale (E-SAPS) is a questionnaire measuring the severity of PSU-related symptoms. It consists of five factors (tolerance, positive anticipation, cyberspace-oriented relationships,	18-item Likert scale (6-points), with the anchors being –strongly disagree and –strongly agree		.910 (Rozgonjuk, Kattago, et al., 2018; Rozgonjuk, Kattago, et al., 2018)

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Instrument	Origin	Description	Items	Scores indicating PSU	Cronbach's Alpha (CA), used in studies
Mobile addiction scale	Han and Hur (2004)	withdrawal, and physical symptoms). The mobile addiction scale measures dependency on the cell phone. Mobile phone addiction was operationalized as the sum of all dimensions (measured by the items).	9 items, 7-point scale. Anchors not specified.		CA N/A (Khang et al., 2013)
Mobile phone addiction	Lee et al. (2002)	The mobile phone addiction instrument is intended for younger participants, and is based on the Korea Children and Youth Planet Survey (KCYPs).	7-item Likert scale, with the anchors being –never true and –always true		.896 at T1, .895 at T2, and .885 at T3. (Jun, 2016)
MPAI	Leung (2008)	The Mobile Phone Addiction Index (MPAI) questionnaire assesses four aspects of mobile phone addiction: (1) control craving, (2) anxiety and feeling lost, (3) withdrawal and escape, and (4) productivity loss.	17-item Likert scale (5-points), with the anchors being –completely disagree and –completely agree (variances in wording)	The summed up responses across all items constitute a MPAI score (ranging from 17 to 85). Score >50 is considered an addiction.	.864 (Han et al., 2017); .890 (Lian et al., 2016); .880 (Liu et al., 2017; 2018); .88 (Yang et al., 2019a, 2019b); .87 (Zhang et al., 2019); .91 (Li & Hao, 2019); .87 Chinese translation (Mei et al., 2018); .87 (Gao et al., 2018); .87 (Mahmoodi et al., 2018); .89 (Lian & You, 2017); CA N/A Persian translation (Khoshgoffar et al., 2019); .88 Chinese translation (Hao et al., 2019); .94 Chinese translation (Liu et al., 2019); .93 (Gugliandolo et al., 2019)
MPAS	Young (1998)	The Mobile Phone Addiction Scale (MPAS) is a questionnaire assessing four factors of mobile phone addiction: (1) withdrawal symptoms (six items); (2) salience (four items); (3) social comfort (three items); (4) mood changes (three items).	16-item Likert scale (5-points), with the anchors being –not at all and –extremely	Scores range from 16 to 80. Scores of 16–31 indicate “no addiction”, scores of 32–56 represent “possible addiction”, and scores above 57 are classified as “addiction”	.830 (Chen et al., 2016); .940 (Chiu, 2014); .865 adapted scales (Hong et al., 2012); CA N/A (Lu et al., 2019); .8645 (Gao et al., 2017); .90 (Kuang-Tsan & Fu-Yuan, 2017)
MPDQ	Toda, Monden, Kubo, and Morimoto (2006)	The Mobile Phone Dependence Questionnaire (MPDQ) evaluates smartphone addiction proneness from responses given to 20 items related to mobile phone use.	20-item Likert scale (4-points), with the anchors being –rarely –always	The total score ranges from 0 to 60. Subjects exceeding the AVG + 1 SD are considered high-dependence.	CA N/A (Gligor & Mozoş, 2019)
MPIQ	Walsh, White, and Young (2010)	The Mobile Phone Involvement Questionnaire (MPIQ) is a questionnaire relating to cognitive and behavioral associations to mobile phones. The instrument measures withdrawal, cognitive and behavior salience, euphoria, loss of control, relapse and reinstatement, conflict with other activities, and interpersonal conflict.	8-item Likert scale (7-points), with the anchors being –strongly disagree and –strongly agree	A mobile phone involvement score is calculated by averaging participants' responses to the eight items.	.830 (Harwood et al., 2014)
MPPUS-27	Bianchi and Phillips (2005)	The Mobile Phone Problematic Use Scale (MPPUS) evaluates symptoms such as withdrawal symptoms, smartphone craving, and negative effects on health in adult populations.	27-item Likert scale (10-points), with the anchors being –not at all true and –extremely true (variances in wording)	Scores range from 27 to 270. PSU is recognized for scores above 160.	CA N/A (Hadlington, 2015); .910 adapted scales (Horwood & Anglim, 2018); .950 adapted scales (Kim, 2017, 2018); .909 (Sapacz et al., 2016); .930 (Van Deursen et al., 2015); CA N/A adapted scales (C. Shin & Dey, 2013); .91 (Alavi et al., 2018); .939 Spanish translation (De-Sola et al., 2017); .92 (Beison & Rademacher, 2016)
MPPUS-10	Foerster, Roser, Schoeni, and Rössli (2015)	MPPUS-10 is the short version of MPPUS-27. It consists of items highly reflecting the original MPPUS.	10-item Likert scale (10- points), with the anchors being –not true at all and –extremely true (variances in wording)	Scores range from 10 to 100. PSU is recognized for scores above 59.	.850 (Nahas et al., 2018); .816 Kruger and Djerf (2017); .822 (Hong et al., 2019)
NMP-Q	Yildirim and Correia (2015)	The Nomophobia Questionnaire (NMP-Q) is an instrument assessing giving up convenience, losing connectedness, not being able to	20-item Likert scale (7-points), with the anchors being –strongly disagree and –strongly agree	Scores below 20 are considered as the absence of nomophobia, 21 to 60 as mild, 61 to 100 as moderate, and 101 to 140 as severe nomophobia.	.95 Italian translation (Bragazzi et al., 2019); .91 Turkish translation (Gezgin et al., 2018); CA N/A Turkish translation (Arpaci et al., 2017); .92 Turkish translation (Ayar, Gerçekler, Özdemir, & Bektas, 2018);

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Instrument	Origin	Description	Items	Scores indicating PSU	Cronbach's Alpha (CA), used in studies
		access information, and not being able to communicate.			CA N/A (Ahmed et al., 2019); .97 (Durak, 2018); CA N/A adapted (Gentina et al., 2018); .87 Tamil translation (Jilisha et al., 2019)
PCPUQ	Yen et al. (2009)	The Problematic Cellular Phone Use Questionnaire (PCPUQ) assesses PSU through symptoms in the preceding year and participants' subjective functional impairment caused by excessive mobile phone use.	12-item Likert scale. Anchors not specified.	Participants who have positive responses to four or more of the first seven questions and any of the last five questions are classified as having PSU.	.72 Chinese translation (Long et al., 2016)
PMPUQ-SV	Lopez-Fernandez (2017)	The short version of the Problematic Mobile Phone Use Questionnaire (PMPUQ-SV) assesses forbidden, dangerous, and self-perceived smartphone dependence.	15-item Likert scale (4-points), with the anchors being –strongly disagree and –strongly agree	Total scores range from 15 to 60, with higher scores representing increased presence of PSU	CA N/A (Lopez-Fernandez et al., 2018)
PMPUS	Arnavut and Nuri (2018)	The Problematic Mobile Phone Usage Scale (PMPUS) consists of three parts measuring the excessive use of mobile phones, relationship between mobile phone use and some mental health variables, and the negative effects that may arise from the long-term use of mobile phones.	5-item Likert scale (5-points), with the anchors being –no and –very frequent and –strongly disagree and –strongly agree	The total score for the entire scale ranges from 0 to 104 (points above 30 are regarded as PSU)	.94 Turkish translation (Firat et al., 2018); CA N/A Turkish translation (Gül et al., 2019)
Problematic cell phone use (onset of sleep)	Thomé, Härenstam, and Hagberg (2011)	This scale assesses how often cell phone use interfered with the onset of sleep during the past month.	8-item Likert scale (5-points), with the anchors being –never and –almost every day		.810 adapted scales (Lepp et al., 2016)
Problematic cell phone use (after onset of sleep)	Thomé et al. (2011)	This scale assesses cell phone use after the initial onset of nightly sleep through four items.	4-item Likert scale (5-points), with the anchors being –strongly disagree and –strongly agree		.820 adapted scales (Lepp et al., 2016)
PUMP	Kim and Haridakis (2009)	The Problematic Mobile Phone Use (PUMP) scale assesses how often participants engaged in 16 behaviors indicative of PSU.	16-item Likert scale (5-points), with the anchors being –never and –always		CA N/A (Kim, Seo, et al., 2015); .930 (Seo et al., 2015)
QANIP	Olivencia-Carrión, Ferri-García, Rueda, et al. (2018)	The Questionnaire to Assess Nomophobia (QANIP) assesses text message abuse, high frequency of use, spending more than 4 h per day using the mobile phone (using the mobile phone all of the time) to cope with negative emotions or problems, to feel better, showing extreme nervousness and aggressive behavior when deprived or unable to use the mobile phone, progressive deterioration in school/work and social and family functioning, and impairments in self and social perception.	11-item Likert scale (5-points). Anchors not specified.		.80 (Olivencia-Carrión et al., 2018)
SAI	Kang and Park (2012)	The smartphone addiction inventory (SAI) was developed for Korean university students. The subscales consider preoccupation, daily-life disturbance, withdrawal, overuse, and cyber-oriented relationships.	23-item Likert scale (5-points), with the anchors being –totally disagree and –totally agree	Total scores range from 23 to 115, with higher scores indicating a higher level of smartphone addiction.	.87 (Lee, Sung, et al., 2018)
SAS	Kwon, Lee, et al. (2013)	The Smartphone Addiction Scale (SAS) is an instrument with six subscales measuring daily life disturbance, positive anticipation, withdrawal, cyberspace oriented relationships, overuse, and tolerance.	33-item Likert scale (6-points), with the anchors being –strongly disagree and –strongly agree (variances in wording)	Scores range from 33 to 198, with higher scores predicting a risk of PSU. No cut-off scores were indicated in the original scale.	.930 (Elhai & Contractor, 2018); .950 (Elhai et al., 2016); .960 (Enez Darcin et al., 2016); .950 adapted scales (Kim, 2017, p. 2018); .930 adapted scales (Rozgonjuk, Kattago, et al., 2018); .900 adapted scales (Zhitomirsky-Geffet & Blau, 2016); .930 (Elhai, Levine, et al., 2018); CA N/A (Noë et al., 2019); .942

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Instrument	Origin	Description	Items	Scores indicating PSU	Cronbach's Alpha (CA), used in studies
SAS-SV	Kwon, Kim, Cho, and Yang (2013)	The short version of the SAS lets participants rate their agreement with items assessing PSU. It has been validated with both adult and adolescent samples.	10-item Likert scale (6-points), with the anchors being –strongly disagree and –strongly agree (<i>variances in wording</i>)	Scores range from 10 to 60. The recommended cut-off score is 31 for males, and 33 for females to identify PSU.	(Ruiz-Palmero et al., 2019); .98 German translation (Lachmann et al., 2019); CA N/A (Yayan et al., 2019); .93 adapted scales (Rozgonjuk & Elhai, 2019); CA N/A (Lee, Chung, et al., 2019); .89 (Volungis et al., 2019); .92 Turkish translation (Tunc-Aksan & Akbay, 2019); .86 Turkish translation (Emirtekin et al., 2019); Lee et al., 2018c; CA N/A (Lee, Lee et al., 2018); CA N/A (Choi et al., 2015); .947 Turkish translation (Demirci et al., 2015); .967 (Mok et al., 2014); CA N/A (Noë et al., 2019); .890 Indonesian translation (Hanafi et al., 2019) 0.91 (Chotpitayasonondh & Douglas, 2016); .910 (Contractor et al., 2017); .91 reworded (Elhai, Levine, et al., 2018); .88 (Elhai, Tiamiyu et al., 2018); .870 Turkish translation (Gökçearslan et al., 2016); CA N/A, uses CR (Balta et al., 2019); .840 (Hawi & Samaha, 2017); .910 (Samaha & Hawi, 2016); .83 (Wang, Sigerson, et al., 2019); .910 (Rozgonjuk et al., 2019); CA N/A (Serin et al., 2019); .844 Chinese translation (Zou, Wu, et al., 2019; Zou, Wu, et al., 2019); .86 (Wang, Liu et al., 2019); .842 Chinese translation (Guo et al., 2019); .85 (Wang, Sigerson, et al., 2019); CA N/A Turkish translation (Ergun & Guzel, 2019); .86 (Wang, Sigerson, et al., 2019); .86 (Winskel et al., 2019); .80 Chinese and .82 British translations (Yang et al., 2018); .97 Turkish translation (Direktör & Nuri, 2019); .88 adapted scales (Elhai, Rozgonjuk, Alghraibeh, et al., 2019); .86 (Wang & Lei, 2019); .85 (De Pasquale et al., 2019); .88 French translation (Dey et al., 2019); .80 Italian translation (Servidio, 2019); .82 (Soomro et al., 2019); CA N/A (Grant et al., 2019); .867 Turkish translation (Konan et al., 2018); .86 (Jiang et al., 2018); .79 adapted scales (Kita & Luria, 2018); .86 (Cocoradäet al., 2018); .91 Turkish translation (Aktürk et al., 2018); CA N/A (Arnavut & Nuri, 2018); CA N/A (Mangot et al., 2018); CA N/A (Prasad et al., 2018); .85 (Wang et al., 2018); .87 Turkish translation (Gökçearslan, Uluyol, & Şahin, 2018); .91 German and .97 English translation (Baggio et al., 2018); .967 (Alhazmi et al., 2018); .91 (Alhassan et al., 2018); .79 German and .87 Chinese translation (Lachmann et al., 2018); .89 (s1) and .91 (s2) (Lee, Sung, et al., 2018); CA N/A (Cho & Lee, 2017); .81 (Yuchang et al., 2017); .87 (Duke & Montag, 2017); .87 Turkish translation (Savci & Aysan, 2017); CA N/A adapted scales (Lee, Kim, et al., 2017); .83 German translation (Randler et al., 2016); .849 (Hawi & Samaha, 2016); .85 German translation (Haug et al., 2015); .83 (Lee, 2015); .86 (Wang et al., 2017);

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Instrument	Origin	Description	Items	Scores indicating PSU	Cronbach's Alpha (CA), used in studies
SAS-C	Su et al. (2014)	The Smartphone Addiction Scale for College Students (SAS-C) measures adolescent smartphone addiction through six factors relating to PSU, including withdrawal behavior, salience behavior, social comfort, negative effects, use of applications, and application renewal.	22-item Likert scale (5-points), with the anchors being –not at all true and –always true <i>(variances in wording)</i>	The scores across the items can be averaged and higher scores indicate a higher level of PSU.	CA N/A (Lee, Sung et al., 2018); .87 Turkish translation (Yildiz, 2017); .85 Turkish translation (Kumcagiz, 2019); CA N/A (Grant et al., 2019); CA N/A Turkish translation (Coban & Gundogmus, 2019); .87 (Tras & Öztemel, 2019); CA N/A Indonesian translation (Dhamayanti et al., 2019); CA N/A (Sarti et al., 2019); CA N/A Indian translation (Dharmadhikari et al., 2019); CA N/A (Yang et al., 2019a, 2019b); .86 Chinese translation (Long et al., 2019); .87 Turkish translation (Selçuk & Ayhan, 2019); .867 Turkish translation, adapted scales (Saritepeci, 2019) .930 (Sun et al., 2019); .910 (Wang et al., 2015); .95 (Xie et al., 2019)
SAQ	Aljomaa et al. (2016)	The smartphone addiction questionnaire (SAQ) consists of 80 items under five dimensions which are overuse of smartphone, the technological dimension, the psychological-social dimension, preoccupation with smartphones, the health dimension.	Likert scale, with the anchors being –always or almost always true of me and –never or almost never true of me <i>(variances in wording)</i>		.97 (Aljomaa et al., 2016); .961 (Albursan et al., 2019); 961 (Qudah et al., 2019)
SAPS	Shin et al. (2011)	The smartphone addiction proneness scale (SAPS) measures addiction tendency of young people. These tendencies are comprised of traits of life disorders, virtual-world orientation, withdrawal symptoms, and tolerance building.	15-item Likert scale (4-points), with the anchors being –strongly disagree –strongly agree <i>(variances in wording)</i>	The total score ranges from 15 to 60. Considered at risk for scores above 42. <i>(variances in scoring)</i>	.904 in daily life disorder variables, .610 in the phenomenon of being left out variables, .767 in the necessity for compulsory control variables, and .661 in the personality distortion variables (Cho & Lee, 2017); CA N/A (Rho et al., 2019); .66 (Lee & Kim, 2018); CA N/A (Sohn et al., 2018); .85 (Lee & Ogbolu, 2018); CA N/A (Lee, Kim, et al., 2017); .92 adapted scales (Kim, Cho, et al., 2017); .91 (Lee & Lee, 2017); .87 German translation (Randler et al., 2016); CA N/A adapted (Ding et al., 2016); .88 (Lee, Seo, et al., 2016); .85 Chinese translation (Kim, Kim, & Jee, 2015); .85 (Kim, Seo, et al., 2015); .865 (Kim et al., 2016); .88 (Kim, Min, et al., 2018); .89 (Heo & Lee, 2018); CA N/A (Kim, Jun et al., 2018); CA N/A (Haripriya et al., 2019); .89 (Shim, 2019a, 2019b); .78 Turkish translation (Sözbilir & Dursun, 2018); .88 (Shim, 2019a, 2019b; 2019b); CA N/A (Lee, Lee et al., 2014); .88 (Jahng, 2019); .91 (Kim & Jahng, 2019); CA N/A (Cha & Seo, 2018); .88 (Kim, Cho, et al., 2017) CA N/A (Song et al., 2019)
Smartphone addiction tendency	Lee, Lim, Son, Kwak, and Chang (2016)	The scale was developed based on the six elements: salience, mood modification, tolerance, withdrawal, conflict, and relapse. Each element has four items.	24-item Likert scale (5-points), with the anchors being –strongly disagree and –strongly agree		CA N/A (Song et al., 2019)
SPAI	Bian and Leung (2015)	The Smartphone Addiction Index (SPAI) is an instrument with adapted scales from three	19-item Likert scale (5-points), with the anchors being		.920 (Bian & Leung, 2015); .70 (Eichenberg et al., 2019); CA N/A adapted scales (Herrero et al.,

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Instrument	Origin	Description	Items	Scores indicating PSU	Cronbach's Alpha (CA), used in studies
		measurement instruments: MPPUS, the Internet Addiction Test, and the Television Addiction Scale.	–not true at all and –extremely true (variances in wording)		2019a, 2019b); .95 adapted scales (Herrero et al., 2019a,2019b); .89 (Herrero, Torres, et al., 2019)
SPAI	Lin et al. (2014)	The Smartphone Addiction Inventory (SPAI) assesses symptoms of PSU in four subscales: compulsive behavior, withdrawal, tolerance, and functional impairment.	26-item Likert scale (4-points), with the anchors being –strongly disagree and –strongly agree		.90 (Tang et al., 2017); .94 (Boumosleh & Jaalouk, 2017); .090 Italian translation (Canale et al., 2019); .93 (Li & Lin, 2019); CA N/A Turkish translation (Arpaci, 2019)
SPAI-SF	Lin, Pan, Lin, and Chen (2017)	The short version of the Smartphone Addiction Inventory (SPAI-SF) assesses symptoms of PSU.	10-item Likert scale (4-points), with the anchors being –strongly disagree and –strongly agree	Scores range from 10 to 40. A cut-off point of 24/25 is suggested with respect to smartphone addiction.	.880 (Chang et al., 2019); .94 (Liu et al., 2016); CA N/A (Chiang et al., 2019)
SQAPMPU	Tao, Fu, Wang, Hao, and Tao (2013)	Self-rating Questionnaire for Adolescent Problematic Mobile Phone Use (SQAPMPU) is used to assess PSU among college students. This questionnaire assessed three dimensions including withdrawal symptoms, craving, and physical and mental health statuses.	13-item Likert scale (5-points), with the anchors being –not true at all and –extremely true		.93 (Zou, Wu, et al., 2019)
STDS	Igarashi, Motoyoshi, Takai, and Yoshida (2005)	The Self-perception of Text-message Dependency Scale (STDS) measures the way in which people perceive their usage of text messages along with their attitudes towards compulsive text-messaging in the context of interpersonal relationships. This scale consists of three subscales measuring sensitive responses to text messages, self-perception about compulsive usage of text messages, and fear of disruption of relationships in the absence of text messages.	15-item Likert scale (5-points), with the anchors being –strongly disagree and –strongly agree	Scores range from 15 to 75. Scores of 15–45 indicate no text-message addiction; 46–60 light to moderate text-message addiction; and 61 or higher denotes severe text-message addiction.	.90 (relationship maintenance), .90 (excessive use), and .91 (emotional reaction) (Lu et al., 2011)
Technology dependence	Wu, Wang, and Tsai (2010)	The instrument is a modified version of an instrument testing proactive stickiness, which indicates an individual's willingness to spend a larger proportion of time to use technology.	4-item Likert scale, (7-points) with the anchors being –strongly disagree and –strongly agree		CA N/A, uses CR (Fan et al., 2017)
TMDbrief	Chóliz et al. (2016)	This scale is a brief version of the Test of Mobile Phone Dependence (TMD). It assesses four main features of mobile phone dependence: abstinence syndrome, lack of control, tolerance development, and interference with other activities.	12-item Likert scale (5-points), with the anchors being –completely disagree and –completely agree		.87 German translation (Volkmer & Lerner, 2019)

Appendix C. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.chb.2020.106414>.

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