

The Relationship between Stress and Smartphone Addiction among Adolescents: The Mediating Effect of Grit

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Original Article

Keywords: grit, stress, smartphone addiction, adolescence, mediating effect

Posted Date: January 29th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-159399/v1>

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Abstract

The purpose of this study was to investigate the mediating effect of grit on the relationship between stress and smartphone addiction among adolescents. Participants were 605 Korean students from age 12 to 16 (mean age = 13.97 years). Stress was assessed using the Daily Hassles Scales for Children in Korea developed by Han and Yoo (1995). Grit was measured by the Korean translated version of the Original Grit Scale (Duckworth et al., 2007; Park et al., 2020), and smartphone addiction was measured by using the Smartphone Addiction Proneness Scale for Youth developed by the National Information Society Agency (2011). The mediating effect was analyzed by using PROCESS macro version 3.5, and bootstrapping was conducted to test the significance of the mediating effect. The results showed that adolescent's stress and grit significantly influenced smartphone addiction. Also, grit partially mediated the relationship between stress and smartphone addiction. This means that high levels of stress reduced grit, which in turn increased smartphone addiction proneness among adolescents. In addition, two factors of grit (consistency of interest and perseverance of effort) both mediated the association between stress and smartphone addiction. The current study is meaningful in that it is the first study to empirically investigate adolescent's grit in relation to stress and smartphone addiction. Moreover, this study can provide useful information about prevention and intervention strategies for smartphone addiction.

Introduction

Since the appearance of the smartphone, the number of people using smartphones is increasing and, smartphones have become an essential part of our lives. According to data from Korea Communications Commission (2020), 91% of Koreans were reported to own a smartphone. Through various applications on smartphones, people can listen to music, play games, watch videos, use social network services, shop, and even learn. Although smartphones provide convenience to everyday life, excessive use and over-dependence on them can lead to problematic smartphone use or smartphone addiction.

Smartphone addiction is characterized by repetitive failure to resist the impulse to use the smartphone, withdrawal, excessive time spent on smartphone usage, and recurrent physical or psychological problem, negative consequences on daily life caused by excessive smartphone use (Lin et al., 2016). Recently, smartphone addiction has notably increased. In fact, according to a recent systematic review about the prevalence of smartphone addiction (Sohn et al., 2019), approximately one in every four children and young people had smartphone addictions. Especially, the prevalence of smartphone addiction was higher in children and adolescents compared with adults (De-Sola et al., 2017; Haug et al., 2015).

Adolescents can easily be addicted to smartphones than adults for following reasons. First, adolescents can be more vulnerable to addiction due to their high impulsivity and novelty-seeking tendencies (Chambers et al., 2003). In fact, a recent study identified that high levels of impulsivity contributed to smartphone addiction in adolescents (Jo et al., 2018). Also, Kim et al. (2012) found that adolescents tended to use smartphones for entertainment purposes (i.e. listening to music, gaming) than adults. When people use smartphones for hedonic purposes (to gain pleasure), they obtain direct gratifications

from the media and are more likely to indulge in the virtual world of smartphones, increasing the danger of addiction (Meng et al., 2020). These findings imply that it is important to examine smartphone addiction focusing on adolescents. Furthermore, according to Cha and Seo (2018), the prevalence of smartphone addiction in Korean adolescents was 30.9%, which is higher than other countries, compared to “10% in England, 21% in the Philippines, and 18% in Hong Kong (Lopez-Fernandez et al., 2014; Mak et al., 2014)” (as cited in Cha & Seo, 2018, p.10). Therefore, Korean adolescents would be an appropriate target when investigating smartphone addiction.

Numerous studies have explored the negative consequences of smartphone addiction. For instance, according to Hawi and Samaha (2016), university students with high risk of smartphone addiction were less likely to have distinctive GPAs. Possible explanation is that smartphone multitasking while studying can impede the cognitive processes required for learning, which in turn can decrease academic achievement (Hawi & Samaha, 2016). Also, studies revealed that smartphone addiction is associated with negative physical health (Kim et al., 2015), lower productivity (Duke & Montag, 2017), and poor mental health (depression, anxiety, suicidal ideation) (Thomé, 2018). Although many studies emphasized the danger of smartphone addiction by stressing the negative consequences, relatively few studies investigated how adolescents become addicted to smartphones. Thus, further work is needed to examine the predictive factors and mechanism of how smartphone addiction is developed in adolescents.

Among various factors that predict smartphone addiction, stress is one of the major factors that is related to problematic smartphone usage and smartphone addiction (Liu et al., 2018; Wang et al., 2015). Individuals with high levels of stress tended to excessively use smartphones to escape from life problems and alleviate stress (Wang et al., 2015). Panova and Lleras (2016) discovered a “security blanket effect” of smartphones among university students. The participants who had access to their mobile phones were more likely to show increased resilience in a stressful situation. Researchers related this effect to the security blanket effect in that it is similar to how children hold on to blankets or other objects to obtain a sense of comfort and safety in a threatening environment. However, the results showed that depending on mobile phones is detrimental to long-term psychological health and thus it may be a maladaptive coping mechanism (Panova & Lleras, 2016). Especially, adolescents in Korea grow in a competitive society, where the academic performance of children is highly valued. Thus, Korean adolescents are more likely to experience greater academic stress than adolescents from other countries, which might have contributed to the high prevalence of smartphone addiction among adolescents in Korea (Cha & Seo, 2018). However, relatively limited studies explored the psychological mechanism of the relationship between stress and smartphone addiction. Thus, the current study focused on how stress influences smartphone addiction among adolescents.

Stress can lead to smartphone addiction through various pathways. For example, according to previous studies, factors such as resilience (Park & Kwon, 2019), self-control (Liu et al., 2018), and grit (Yoo & Choi, 2019) had significant mediating effects on stress and smartphone addiction. Among the various factors that influenced smartphone addiction, this study will be focusing on grit which is a relatively new

psychological concept defined as “perseverance and passion for long-term goals” (Duckworth et al., 2007, p.1087). Grit was first introduced as a non-cognitive skill that leads to success (Duckworth et al., 2007). Grit is characterized by the combination of consistency of interest and perseverance of effort. First, consistency of interest refers to the ability to continuously pursue focused interest over a long period of time without frequently changing goals. Second, perseverance of effort refers to the tendency to sustain effort in accomplishing long-term goals even in the face of adversity and challenges (Duckworth et al., 2007). Gritty people sustain effort and pursue consistent interest to accomplish long-term goals even in the face of failure and adversity. Grit has many significant implications, especially for adolescents. Studies have demonstrated that gritty students engaged in deliberate practice than less gritty students and achieved better performance (Duckworth et al., 2011; Lee & Sohn, 2013). In addition to its relevance with academic performance, grit is also related to graduation (Eskreis-Winkler et al., 2014) and peer relationship (Lan, 2020). Thus, grit is an important skill for adolescents in that it benefits not only adolescent’s academic performance but also their overall development.

Although majority of grit studies investigated the predictive power of grit in academic success, recent studies associated grit with mental health and expanded its functions. For instance, gritty individuals experienced less depressive symptoms (Datu et al., 2019) and reported higher life satisfaction and positive affect (Li et al., 2018). Moreover, some studies confirmed the mediating and moderating effect of grit on the relationship between stress and negative outcomes, suggesting that grit could serve as a buffer against negative outcomes of stress (Blalock et al., 2015; Jung et al., 2020; Marie et al., 2019). For instance, Blalock et al. (2015) argued that people with grit are less influenced by stressful situations. They examined the moderating effect of grit on the relation between negative life events and suicidal ideation and revealed that individuals high in grit were less likely to have suicidal ideation in negative situations than individuals low in grit. This may be because gritty people focus more on long-term goals and minimize their attention to stress. Also, grit might enable people to reframe negative situations more positively and use more effective problem-solving strategies during highly stressful situations (Blalock et al., 2015). Similarly, another recent study (Marie et al., 2019) showed that individuals with high levels of grit had a weaker association of posttraumatic stress disorder (PTSD) symptoms and suicidal ideation. The study argued that grit may remediate the impact of PTSD symptoms and reduce the danger of suicide. Furthermore, according to Jung et al. (2020), grit partially mediated occupational stress and burnout among firefighters. This means that high occupational stress leads to lower grit, which in turn increases the occupational burnout. The study implied that high levels of grit could function as a protective factor against the negative consequences of occupational stress. These results suggest that grit might have a mediating effect on stress and various negative outcomes.

Furthermore, several studies have associated grit with maladaptive behaviors. For instance, grittier adolescents were less likely to be involved in alcohol use, drug use, fighting, and delinquent behavior (Guerrero et al., 2016). Although Guerrero et al. (2016) could not precisely determine the mechanism of grit and adolescent’s risky behaviors, they suggested some possible explanations. First, grit can contribute to the confidence and self-efficacy of teenagers, and motivate them to invest in the future through responsible decisions. Also, another possible explanation is that grit is closely associated with

self-control, which also pertains to delay of gratification and less engaging in risky behaviors (Guerrero et al., 2016). In addition, Knauft et al. (2019) showed that grit was negatively associated with bulimia and body dissatisfaction, which indicates that grit could serve as a buffer against disordered eating attitudes and behaviors. This might be because the concept of grit is opposite to impulsivity which is a well-known risk factor for eating disorders (Knauft et al., 2019).

Among various maladaptive behaviors, recent studies started to connect grit with addiction such as drug use, internet, and smartphone addiction and broaden the importance of grit (Brozikowsky & Bernhardt, 2019; Griffin et al. 2016; Yoo & Choi, 2019). According to Griffin et al. (2016), grit was related to the recovery of patients with substance use disorder, as patients who were unemployed, diagnosed with a co-occurring psychiatric disorder, or who had used heroin during the past month had lower grit score. Also, Brozikowsky and Bernhardt (2018) examined grit among online gamers. As a result, grittier people were less likely to become addicted to online games, which indicates that grit could be negatively associated with overall addiction and could operate as a protective factor for addiction. More recently, one study (Yoo & Choi, 2019) in South Korea related grit with smartphone addiction and discovered that grit was negatively associated with smartphone addiction. The researchers explained that this might be because smartphone addiction is related to a lack of patience, and the concept of grit encompasses the notion of perseverance (Yoo & Choi, 2019). However, studies about grit and addiction are still limited and therefore, more research in this area is necessary to fully understand how grit is associated with addictive behaviors (Brozikowsky & Bernhardt, 2018).

In addition, while the majority of grit studies used the total score of grit in the past (Eskreis Winkler et al., 2014; Robertson-Kraft & Duckworth, 2014), recent studies argued that two components of grit can cause different consequences (Bowman et al., 2015; Disabato et al., 2019) and therefore should be investigated separately (Datu et al., 2016). For instance, Datu et al. (2016) discovered that the correlation between two factors of grit was very weak, and the perseverance of effort predicted academic engagement, life satisfaction, and positive affect more strongly than consistency of interest. Also, Bowman et al. (2015) separately examined the predictive utility of the two components and revealed that perseverance predicted greater academic adjustment, GPA, and sense of belonging than consistency among college students. Similarly, Disabato et al. (2019) found out that perseverance of effort was associated with goal-directed thinking, meaning in life, subjective happiness more strongly than consistency of interest. These prior findings indicate that positive academic and psychological outcomes are mostly driven by the perseverance of effort component of grit. In fact, consistency of interest dimension of grit is controversial due to its weak predictive function of positive outcomes (Bowman et al., 2015; Datu et al., 2016; Disabato et al., 2019). Also, the items measuring consistency of interest are all negative statements which require the reverse calculation of the scores, reducing the reliability of the measurements (Lim, 2019). However, Knauft et al. (2019) demonstrated that consistency of interest, not perseverance of effort, was related to lower bulimia and body dissatisfaction scores. The study could not identify the specific mechanism but explained that individuals with continued interest in enduring goals would focus on long-term goals even when immediate rewards are absent, which could lead to lower eating disorder-related attitudes and behaviors (Knauft et al., 2019). This result indicates that consistency of interest dimension of grit can

also contribute to positive outcomes. Therefore, two components of grit should be analyzed independently to better understand the functions of grit. However, most of the studies used the total score of grit in the past (Eskreis-Winkler et al., 2014; Robertson-Kraft & Duckworth, 2014). Thus, we planned to analyze the two facets of grit separately and complement the previous findings.

In sum, previous findings suggest that grit may operate as a buffer against stressful situations and be negatively related to addictions. Unfortunately, most of the studies associate grit with academic success and mental well-being, and limited studies examine the roles of grit in addictive behaviors. In fact, the study conducted by Yoo and Choi (2019) is the only study that examined the relationship between grit and smartphone addiction, which was done on limited community samples of college students. However, as smartphone addiction is increasing and can lead to detrimental consequences, it is important to identify the factors that contribute to smartphone addiction. Thus, the current study sought to investigate the association between grit and smartphone addiction among adolescents. Particularly, we tried to analyze whether grit has a mediating effect between stress and smartphone addiction. Also, as Yoo and Choi (2019) failed to separately analyze the effect of consistency of interest and perseverance of effort on smartphone addiction, we aimed to investigate how each component of grit is related to smartphone addiction.

Research Questions

As reviewed above, stress appeared to be related to smartphone addiction, and grit may influence the relationship between stress and smartphone addiction. Based on the previous findings, the current study aimed to examine the relationship between stress, grit, and smartphone addiction among Korean adolescents. In particular, this study focused on exploring the mediating effect of grit on the relationship between stress and smartphone addiction. The present study's three research questions are as follows:

1. Does stress predict smartphone addiction among adolescents?
2. Does grit predict smartphone addiction among adolescents?
3. Does grit and components of grit mediate the relationship between stress and smartphone addiction among adolescents?

Based on the previous findings, we expected that stress would positively predict smartphone addiction and grit would negatively predict smartphone addiction among adolescents. Also, we hypothesized that grit would partially mediate the relationship between stress and smartphone addiction. In other words, when levels of stress increase, grit would decrease, which will increase the risk of smartphone addiction. The research model of the current study is presented in Fig. 1.

Method

Participants

Participants were 605 adolescents (315 boys and 290 girls) from 12 to 16 years old and the mean age was 13.97 years. The participants consisted of 136 people aged 12, 101 people aged 13, 130 people aged 14, 121 people aged 15, 117 people aged 16. Most of the participants resided in Seoul and Gyeonggi province of the Republic of Korea.

Measures

Stress Stress was measured using the Daily Hassles Scales for Children in Korea, developed by Han and Yoo (1995) to measure daily stress that is generally experienced by children in Korea. The scale consists of 6 factors: parent-related stress, home environment stress, friend-related stress, academic stress, teachers & school related stress, and surroundings related stress. Among these factors, items of parent-related stress (8 items), home environment stress (7 items), and academic stress (7 items) were selected for this study. A 6-point Likert scale is used for each item (ranging from 1 = *strongly disagree*, 5 = *strongly agree*). Higher scores represented higher levels of stress. The Cronbach's alpha of the scale was .85 in Han and Yoo's (1995) study. The Cronbach's alpha for the items used in the current study was .91.

Grit Grit was measured by the Korean version of the Original Grit Scale (Duckworth et al., 2007; Park et al., 2020). The scale consists of 12 items assessing consistency of interest (6 items) and perseverance of effort (6 items). Answers were given on a 5-point Likert scale for each item (ranging from 1 = *not at all like me*, 5 = *very much like me*). Items for consistency of interest factor were reverse calculated. The higher the total score, the higher the level of grit. The reported Cronbach's alpha in Duckworth et al. (2007) was .85. The Cronbach's alpha in the current sample was .74.

Smartphone Addiction Smartphone addiction was assessed by Smartphone Addiction Proneness Scale for Youth developed by the National Information Society Agency (2011). The scale consists of 15 items and includes 4 factors: disturbance of adaptive functions, virtual life orientation, withdrawal, and tolerance. Participants answered items on a 4-point Likert scale ranging from 1 = *not at all like me* to 4 = *very much like me*. The higher the score, the more likely participants are to be addicted to smartphones. The Cronbach's alpha demonstrated by National Information Society Agency (2011) was .88. The Cronbach's alpha in the current study was .88.

Procedures

Participants arrived at the laboratory and entered a private room. A brief explanation of the purpose of the study and storage of the data were informed to the participants. Then they signed the consent form and agreed to participate in the study. They answered the questionnaires measuring stress, grit, and smartphone addiction. It took approximately 10 minutes for the participants to complete the questionnaires. Before the study was conducted, all procedures and measurement tools for this study were reviewed and approved by Seoul National University's Institutional Review Board (IRB).

Results

For statistical analysis, we used the Statistical Package for Social Science version 25 (SPSS 25) to analyze the relationship between stress, grit, and smartphone addiction. To investigate the mediating effect of grit on the relationship between stress and smartphone addiction, we used model 4 of PROCESS macro version 3.5 developed by Hayes (2017). Finally, bootstrapping was performed to test the statistical significance of the mediating effect. Bootstrapping was based on 5,000 samples with 95% confidence intervals.

Descriptive statistics of the variables, including stress, grit, and smartphone addiction were as follows (see Table 1). The mean of stress was 54.57 ($SD = 16.93$) with range 22.00–106.00. The means of each subscale were as follows: parent related stress ($M = 17.80$, $SD = 7.80$), home environment stress ($M = 12.66$, $SD = 5.69$), and academic stress ($M = 24.09$, $SD = 7.26$). Moreover, the mean of grit was 36.70 ($SD = 5.95$) with range 13.00–56.00. The means of each subscale were as follows: consistency of interest ($M = 16.91$, $SD = 3.64$) and perseverance of effort ($M = 19.80$, $SD = 3.88$). Finally, the mean of smartphone addiction was 29.76 ($SD = 7.35$) with range 15.00–60.00. The means of each subscale were as follows: disturbance of adaptive functions ($M = 10.75$, $SD = 3.11$), virtual life orientation ($M = 3.17$, $SD = 1.09$), withdrawal ($M = 6.92$, $SD = 2.18$), and tolerance ($M = 8.91$, $SD = 2.52$).

The correlations between stress, grit, and smartphone addiction are presented in Table 2. Correlations among variables were analyzed using Pearson's correlation analysis. As shown in Table 2, all of the variables significantly correlated with each other. Stress positively correlated with smartphone addiction ($r = .37$, $p < .01$) and negatively correlated with grit ($r = -.35$, $p < .01$). Negative correlation was found between grit and smartphone addiction ($r = -.45$, $p < .01$). Likewise, consistency of interest ($r = -.37$, $p < .01$) and perseverance of effort ($r = -.35$, $p < .01$) both negatively correlated with smartphone addiction. Other variables also showed significant correlations with each other, which are summarized in Table 2.

To examine the mediating effect of grit on the relationship between stress and smartphone addiction, model 4 of PROCESS macro version 3.5 developed by Hayes (2017) and bootstrapping was conducted. As shown in Table 3, adolescent stress significantly influenced grit ($\beta = -.121$, $p < .000$), and grit significantly influenced smartphone addiction ($\beta = -.449$, $p < .000$), which means that grit mediated the relationship between stress and smartphone addiction. Also, the total effect of stress on smartphone addiction ($\beta = .158$, $p < .000$) was significant. When controlling for the mediation variable grit, the direct effect of stress and smartphone addiction became lower ($\beta = .103$, $p < .000$). Thus, grit appeared to partially mediate the relationship between stress and smartphone addiction. The results are summarized in Fig. 2. Also, the mediation effect of grit on the relationship between stress and smartphone addiction was statistically significant because the bootstrapped confidence intervals did not contain zero ($CI = .0371 - .0755$).

Moreover, the mediating effects of two components of grit were separately analyzed. Similar to the previous result of the mediating effect of grit, consistency of interest and perseverance of effort both significantly mediated the relationship between stress and smartphone addiction (see Table 4). First, stress negatively predicted consistency of interest ($\beta = -.052$, $p < .000$), and consistency of interest

negatively predicted smartphone addiction ($\beta = -.598, p < .000$). Thus, consistency of interest component of grit was found to mediate the relationship between stress and smartphone addiction. Also, the total effect of stress on smartphone addiction ($\beta = .161, p < .000$) decreased when the mediation variable consistency of interest was controlled ($\beta = .130, p < .000$). These results indicate that consistency of interest partially mediated the relationship between stress and smartphone addiction. In addition, the mediation effect was statistically significant because the bootstrapped confidence interval (CI = .0186 – .0461) excluded zero.

Furthermore, perseverance of effort mediated stress and smartphone addiction. First, stress significantly influenced perseverance of effort ($\beta = -.073, p < .000$), and perseverance of effort significantly influenced smartphone addiction ($\beta = -.486, p < .000$). These results indicate that perseverance of effort mediated the relationship between stress and smartphone addiction. In addition, the effect of stress on smartphone addiction ($\beta = .159, p < .000$) decreased when perseverance of effort was controlled ($\beta = .123, p < .000$). Therefore, a partial mediation effect of perseverance of effort in stress and smartphone addiction was observed. Also, the mediation effect was statistically significant as the bootstrapped confidence intervals (CI = .0215 – .0529) did not include zero.

Discussion

The current study was conducted to shed light on the prevention and intervention of smartphone addiction among adolescents. In particular, we focused on grit, which is defined as “working strenuously toward challenges, maintaining effort and interest over years despite failure, adversity, and plateaus in progress” (Duckworth et al., 2007, p.1087–1088) and investigated its association with stress and smartphone addiction. Based on the previous findings (Brozikowsky & Bernhardt, 2018; Griffin et al., 2016; Yoo & Choi, 2019), we hypothesized that grit would be negatively associated with smartphone addiction and mediate the relationship between stress and smartphone addiction. The main findings were as follows.

First, adolescents’ daily stress (parent-related stress, home environment stress, and academic stress) was significantly associated with smartphone addiction. This means that the higher the stress, the higher the possibility of smartphone addiction. This is consistent with previous studies, which reported that stress positively predicted smartphone addiction (Liu et al., 2018; Wang et al., 2015). When people experience high levels of stress, they were more likely use the internet or smartphones to relieve stress and escape from internal discomfort (Wang et al., 2015). In line with these findings, our study revealed that high levels of stress can lead to increased possibility of smartphone addiction among adolescents.

Second, the adolescent's grit negatively predicted smartphone addiction. This result indicates that the lower the grit level, the higher the tendency for smartphone addiction. Also, both components of grit – consistency of interest and perseverance of effort – were negatively related to smartphone addiction. As reviewed earlier, previous studies reported that grit was negatively related to maladaptive behaviors such as delinquent behaviors among adolescents, substance use disorder, online game addiction, and more

(Brozikowsky & Bernhardt, 2018; Griffin et al., 2016; Guerrero et al., 2016; Knauff et al., 2019). As grit refers to perseverance and sustained effort despite failure and adversity, it can contribute to focusing on long-term goals and making responsible life choices (Guerrero et al., 2016). Thus, grit may lead to less engaging in risky and maladaptive behaviors. The current result corroborates these previous findings in that lower grit was related to higher possibility of being addicted to smartphones, adding to a growing body of literature about the relationship between grit and addictive behaviors.

Furthermore, grit partially mediated the relationship between stress and smartphone addiction among adolescents. This finding showed that as levels of stress increased, grit decreased, which in turn increased the risk of smartphone addiction. In other words, higher stress led to smartphone addiction through lower grit. This is consistent with the previous finding (Yoo & Choi, 2019) that demonstrated the mediating effect of grit on the relationship between academic stress and smartphone addiction among college students. However, unlike Yoo and Choi's (2019) study, which was conducted on a limited community sample of college students, our study targeted adolescents (12 to 16 years old) who are more vulnerable to smartphone addiction (Haug et al., 2015). According to the current study, adolescents' daily stress can not only directly lead to smartphone addiction but also lower the level of grit, which may lead to increased smartphone addiction. This result implies that high levels of grit can serve as a protective factor against smartphone addiction even under stressful situations. As gritty people minimize their attention to stress and focus on success, not failure, they are less influenced by stressful situations and tend to use more effective problem-solving strategies (Blalock et al., 2015; Marie et al., 2019). The salient presence of long-term goals may also motivate gritty people to engage in more effortful and less enjoyable activities toward long-term goals (Blalock et al., 2015; Duckworth et al., 2011). Thus, high grit may motivate adolescents not to indulge themselves in smartphones and to focus more on constructive behaviors for long-term goals.

Moreover, as discussed earlier, recent studies revealed the mediating and moderating effect of grit on the relationship between stress and negative outcomes (Jung et al., 2020; Marie et al., 2019). Jung et al. (2020) argued that firefighters with high grit were more likely to strengthen their identity and expertise, and thus they were less likely to be frustrated by adversity or failure. They tend to use failures as opportunities for growth and cope with job burnout under occupational stress. Therefore, the study considered grit as an important internal capacity that could reduce job burnout among firefighters. Likewise, grit appeared to function as a resilience factor in the relationship between posttraumatic stress disorder symptoms and suicidal ideation (Marie et al., 2019). The present study supports these findings and indicates that although high levels of stress can lead to smartphone addiction among adolescents, grit can serve as a personal factor that may prevent stress from leading to smartphone addiction. Furthermore, recent study revealed that gritty college students tended to engage in greater health care management skills such as managing medication, keeping an appointment, and managing daily activities, which led to better health-related quality of life (Sharkey et al., 2017). This means that grit can contribute to more responsible decisions and behaviors. As gritty individuals tend to focus on long-term goals and make more responsible choices rather than seeking immediate reward and satisfaction, gritty

adolescents might not indulge in maladaptive coping behavior such as excessively using smartphones to relieve stress.

In addition, when two components of grit (consistency of interest and perseverance of effort) were analyzed separately, they both partially mediated stress and smartphone addiction. As reviewed earlier, several studies argued that consistency of interest and perseverance of effort may bring different results (Datu et al., 2016; Disabato et al., 2019). However, our study found that consistency of interest and perseverance of effort were both negatively related to smartphone addiction and mediated the relationship between stress and smartphone addiction. This means that adolescents' daily stress can reduce consistent passion and continued effort for long-term goals, which might subsequently lead to engaging in excessive use of smartphones. Thus, these results indicate that possessing high levels of grit might block the path of stress leading to smartphone addiction.

This study has following limitations and suggestions for further research. First, our study was based on self-reported questionnaires, which assume that participants answered the questions truthfully. However, participants' emotional state, social desirability, and other factors may have influenced the response. Second, this study relied on non-experimental cross-sectional data, and findings were based on data from one period. Therefore, future longitudinal or experimental studies should be conducted to examine a more direct causal relationship between stress, grit, and smartphone addiction. Third, our study only focused on grit as a mediating factor of stress and smartphone addiction. However, several previous studies suggested the mediating effect of self-control (Liu et al., 2018) and resilience (Park & Kwon, 2019) on the relationship between stress and smartphone addiction. Thus, we recommend future research to comprehensively explore the mediating functions of personal factors, including not only grit but also self-control and resilience on the relationship between stress and smartphone addiction. Finally, as the importance of grit was found to extend beyond academic performance, it would be meaningful to investigate the predictive factors of grit. For instance, a recent longitudinal study by Park et al. (2020) demonstrated that the ability to delay immediate gratification at age four predicted greater grit at age 14. Unfortunately, most studies have rarely examined the predictive factors of grit in a longitudinal study. Thus, it is necessary for more studies to explore the predictors of grit in longitudinal settings (Park et al., 2020).

However, despite these limitations, as the first empirical study to investigate the relationship between stress, grit, and smartphone addiction among adolescents, the current study has following implications. First, by exploring grit in relation to smartphone addiction, our study went one step further than relating grit with academic success and contributed to a growing body of literature that highlighted the protective function of grit against maladaptive behaviors (Brozikowsky & Bernhardt, 2018; Griffin et al., 2016; Guerrero et al., 2016; Knauft et al., 2019). As previously discussed, grit has significant implications for adolescents in that it leads to better academic performance (Duckworth et al., 2011) and mental health (Blalock et al., 2015; Marie et al., 2019). However, to the best of our knowledge, this is the first empirical study that examined the influence of grit on adolescent's smartphone addiction. Thus, the present study is meaningful in that we showed the negative relation between grit and smartphone addiction of

adolescents and contributed to expanding the function of grit among adolescents. Moreover, by exploring the mediating effect of grit on stress and smartphone addiction, our study revealed the mechanism of how stress influences smartphone addiction and provided a personal factor that can prevent the path of stress leading to smartphone addiction. Therefore, to reduce adolescents' smartphone addiction due to daily stress, educational programs fostering grit among adolescents would be helpful for the prevention and intervention of smartphone addiction.

Recently, several studies investigated how grit can be developed and improved. For instance, recent studies discovered that school environment (Park et al., 2018) and parent's mindset about failure (An et al., 2020) influenced the development of grit. As grit appeared to mediate the relationship between stress and smartphone addiction in the current study, further research could investigate how to encourage grit in adolescents to prevent smartphone addiction and alleviate the negative effects of stress.

Declarations

Note

On behalf of all authors, the corresponding author states that there is no conflict of interest.

Data availability statement. The datasets generated during and/or analyzed during the current study are not publicly available due to privacy issues but are available from the corresponding author on reasonable request.

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Tables

Due to technical limitations, the tables are only available as a download in the supplemental files section.

Figures

Figure 1.

Research Model for Stress, Grit, and Smartphone Addiction

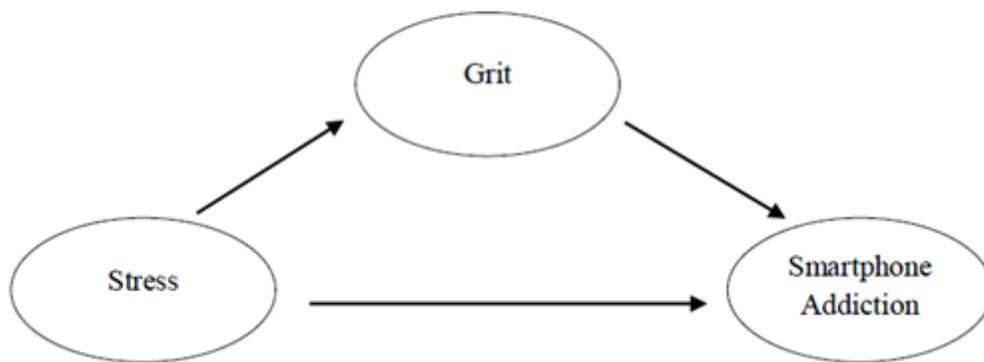


Figure 1

Research Model for Stress, Grit, and Smartphone Addiction

Figure 2.

Mediation Model for Stress, Grit, and Smartphone Addiction

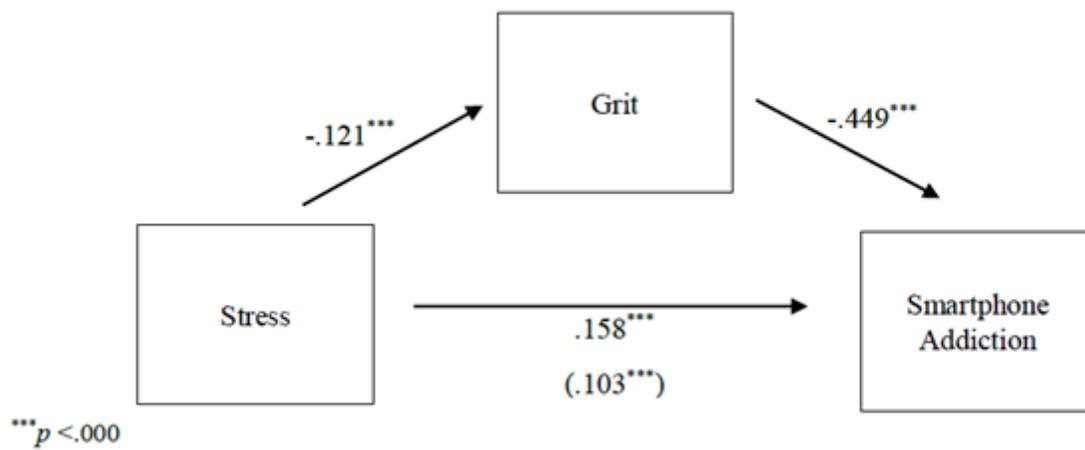


Figure 2

Mediation Model for Stress, Grit, and Smartphone Addiction

Supplementary Files

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