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Smartphone Addiction in Preadolescents and Adolescents: Predictors and Consequences

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Abstract

The excessive use of smartphones can lead to significant physical, psychological, social, and academic problems and may create the conditions for the development of pervasive emotional and behavioral disorders. Over the past two decades, substantial scientific evidence has accumulated regarding the factors associated with smartphone addiction, as well as the consequences of this dysfunctional behavioral pattern. The correlational study presented here aimed to determine the predictive role of depression, anxiety, and psychological stress in explaining smartphone addiction among preadolescents and adolescents. Additionally, the study sought to identify the contribution of smartphone addiction to the occurrence of sleep disturbances. A standardized protocol (k = 71 items) was administered to 356 students in grades 5-8 to operationalize the main variables in regression models, with smartphone addiction and sleep quality as the criterion variables. Gender and participants' place of residence had statistically significant effects on sleep quality but not on smartphone addiction. Depression, anxiety, and psychological stress demonstrated moderate positive correlations with smartphone addiction. Smartphone addiction was positively associated with lower sleep quality. Regression models revealed significant predictive contributions from depression, anxiety, and psychological stress, which together explained 20.7% to 23.6% of the variance in students' smartphone addiction score. Conversely, smartphone addiction accounted for 20.2% of the variance in students' sleep quality. The study's findings are interpreted in relation to mechanisms that may explain the links between the factors contributing to smartphone addiction and the consequences of this problematic behavior.

Keywords: adolescents; anxiety; depression; preadolescents; psychological stress; sleep quality; smartphone addiction

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1. Introduction

For children and adolescents, digital tools (e.g., tablets, smartphones, game consoles, etc.) and the facilities provided by Internet-based applications are more than just means to help them meet many of their daily needs (e.g., school homework or accessing social networks). It is a lifestyle that shapes their thinking, social motivation, values, beliefs about the world and life, personal marketing strategies, attitudes, social behaviors, etc.

When used appropriately, these means of information, socialization, leisure, and entertainment can be useful resources for helping individuals cope with daily difficulties and developmental challenges. However, the abusive use of these means can lead over time to serious physical, mental, social, and academic problems and can create the conditions for the development of pervasive emotional and behavioral disorders (Brodersen Hammami & Katapally, 2022; Cha & Seo, 2018; Lee, Seo & Choi, 2016; Sohn *et al*., 2019). These include: physical fatigue, eye problems, headaches or musculoskeletal pain, sleep disturbances, anxiety when unable to access a smartphone or when it is lost, self-isolation and feelings of social inadequacy, feelings of loneliness, as well as significant interference with academic functioning (e.g., attention disorders or superficiality in managing information relevant to the learning process and in preparing for tests and exams).

For these reasons, we believe that studying the underlying factors and consequences of addiction to smart devices in general, including smartphones, provides researchers, psychological counseling practitioners, and specialists involved in the implementation of educational programs with valuable information from a conceptual and practical-applicative point of view. The study that we conducted among preadolescents and adolescents is motivated by the theoretical and practical importance of efforts to strengthen the conceptual framework and intervention tools useful for educational programs aimed at preventing problems among children and adolescents regarding the use of digital technologies.

Smartphones are electronic devices that many people of different ages use on a daily basis. There are over 6 billion smartphone owners worldwide, and this number is estimated to grow to over 7.5 billion by 2026 (*cf.* Brodersen, Hammami & Katapally, 2022). Smartphones can be used for online gaming, browsing online social networks (e.g., Facebook, Instagram, Twitter, WhatsApp, etc.), posting content (e.g., TikTok), accessing applications that leverage artificial intelligence (e.g., ChatGPT), online shopping, blogs, or entertainment-focused hosting sites. All these applications have turned smartphones into a veritable 'cornucopia' that exerts an undeniable attraction on all age groups.

Studies conducted among young schoolchildren, preadolescents, and adolescents have reported prevalence rates of 5% to 50% for problematic (addictive) smartphone use (Lopez-Fernandez, 2017). The findings of a meta-analysis show that over 23% of children, adolescents, and young people are at risk of excessive smartphone use (Sohn *et al*., 2019). Compared to adults, children and adolescents are more vulnerable to the risk of excessive smartphone use and the negative consequences of this unhealthy behavior (Cha & Seo, 2018; Lee Seo & Choi, 2016).

2. Depression, anxiety, and psychological stress as predictors of smartphone addiction

In a general sense, depression is a mental state characterized by a generally negative mood, low energy levels, loss of interest in everyday activities, pessimism, unrealistic negative thoughts about oneself, others, and the future, compounded by social isolation (Matsumoto, 2009). In many situations, short-term depressive states are normal after certain traumatic life events. Typically, people prone to depressive states lack confidence in their own abilities, tend to turn the inherent difficulties of everyday life into catastrophes, replay negative events/failures in their heads, reduce their social activity, are suspicious of others, have a negative self-image, feel

helpless, and resort to dysfunctional emotional and behavioral regulation strategies (Matsumoto, 2009).

X. Dou *et al*. (2024) surveyed 500 students from a university in northeastern China to determine the mediating role that anxiety and self-esteem play in the relationship between depression and smartphone addiction. According to their findings, higher levels of depression were associated with anxiety, which in turn was associated with a higher predisposition to smartphone addiction. Depression was also associated with lower self-esteem, which in turn was associated with smartphone addiction. The study's findings suggest that anxiety and depression lead to lower self-esteem, and smartphones may be used compulsively as a mechanism to compensate for self-esteem.

X. Zhang *et al*. (2022) conducted a study in which they presumed that smartphone addiction and sleep quality mediate the relationship between school stress among high school students and depression. Study participants (N = 5.109 adolescents) showed a prevalence of depressive symptoms of approximately 29% and a frequency of sleep disturbances of approximately 28%. School stress was a significant predictor of smartphone addiction and sleep disturbances, variables that, in turn, predicted depression levels. This suggests that students who face challenges at school are more likely to use smartphones as a means of relaxation, which leads to disturbances in nighttime sleep. If these disturbances become chronic, they are a risk factor for depression.

Anxiety is conceptualized as a mood in which fear of an ill-defined object or an imaginary situation/event predominates, accompanied by somatic symptoms (Matsumoto, 2009). In many situations, anxiety may be based on possible events that the person expects based on previous experiences and current assessments. There is broad agreement on the following components: *cognitive* (e.g., intrusive thoughts about the anxiety-provoking stimulus, negative assessments of life situations, a person's lack of confidence in their own ability to overcome difficulties, negative expectations about possible unpredictable events, etc.); *emotional* (e.g., irritability, psychosomatic reactions, mood swings, etc.); *behavioral* (e.g., open conflict, disorganization in situations of psychological stress, resorting to substitutes that compensate for anxiety, etc.).

Anxiety is one of the factors that researchers have focused on in relation to addiction to modern information and communication technologies, including smartphone addiction. In a correlational study, 100 adolescents completed three questionnaires that operationalized anxiety, depression, and psychological stress, insomnia, and smartphone addiction (Choksi & Patel, 2021). Twenty-seven percent of participants were addicted to smartphones. Scores for smartphone addiction correlated positively with problems related to insomnia, depression, anxiety, and psychological stress levels. The association with sleep disturbances was more modest but statistically significant. The authors of the study conclude that extensive smartphone use may be a risk factor for impaired sleep quality and mental health in adolescents.

Elhai *et al.* (2019) conducted a review of the literature that investigated and explained the relationship between anxiety and problematic smartphone use. The authors used need satisfaction theory to explain that when an individual has various needs, they can satisfy them by using different means of face-to-face or online communication. For example, a person who feels lonely may turn to online social media to satisfy their need for social connection. Similarly, anxious people use their smartphones to access Internet-enabled technologies and calm their anxiety. After reviewing numerous studies, the authors suggested a theoretical pattern that explains the link between anxiety and smartphone addiction. According to this pattern, people who repeatedly experience anxiety tend to have recurring negative thoughts (ruminations), isolate themselves socially, be prone to boredom, and fear missing out on posts, messages, or calls from other people who are part of their social network or whom they use as a source of emotional support to compensate for their anxiety. In turn, these cognitive and behavioral factors contribute to an increase in smartphone use, which is strongly correlated with the risk of smartphone abuse. As this abusive behavioral pattern sets in, the person's desire to avoid face-to-face socialization,

including social anxiety, also increases. The pattern to which we have referred is conceptually valuable because it highlights the circularity of the relationship between anxiety and problematic smartphone use. In addition, the authors of the study that we cited suggest that the relationship between anxiety and smartphone addiction may be moderated by variables such as age, social support, or cultural background. For instance, older people may face a higher risk of isolation, which is why they are more prone to compulsive smartphone use when experiencing anxiety/depression. People who lack social support are at higher risk for smartphone addiction, as are people who live in isolated communities (large physical distances between residents) or in a cultural background that promotes individualism.

The meta-analysis published by G. Ran *et al*. (2022) investigated the relationship between social anxiety and smartphone addiction by synthesizing 82 empirical studies whose samples totaled nearly 49.000 subjects. Regardless of the positive correlation between social anxiety and smartphone addiction, the authors noted a moderating effect of the subjects' age. Thus, adolescents who experience social anxiety are more likely (compared to adults) to use smartphones compulsively, probably to compensate for their lack of interpersonal skills. This result could be explained by the fact that adults have more experience in social relationships, which offer numerous opportunities to practice verbal communication skills and attitudes/behaviors that contribute to increasing a person's popularity.

Psychological stress is a state of inner tension felt as a result of an imbalance between external demands and a person's ability to cope with them. When it becomes chronic and is not managed effectively, stress can negatively affect physical and mental health. Adolescents and young adults are particularly vulnerable to psychological stress due to the biological, psychological, and social changes they undergo during this period of life (Matsumoto, 2009).

Hong *et al.* (2021) examined the link between smartphone addiction and factors such as depression, ADHD-specific symptoms, perceived stress, interpersonal problems, and parental attitude among middle school students. The study revealed that excessive smartphone use is significantly associated with high levels of depression, ADHD-specific symptoms, and psychological stress. Moreover, interpersonal problems and inappropriate parental attitudes were correlated with a higher likelihood of developing smartphone addiction.

The study conducted by Tu *et al*. (2023) analyzed how stress influences different types of smartphone addiction (using it to access social media, online games, or web surfing) in a sample of 596 high school students. The results showed that stress has the strongest impact on social media addiction, followed by online gaming and web surfing addiction. Significant differences were also observed depending on the gender of the study participants. Thus, girls showed a stronger correlation between stress and social media addiction, while in boys, stress was more closely linked to gaming addiction.

Kim *et al*. (2022) examined the link between mental health indicators and smartphone addiction in a sample of 482 Korean adolescents. Of these, 241 were classified as being at high risk of smartphone addiction, and the rest (matched for gender and age) as non-problematic users. The results of quantitative analyses highlighted feelings of happiness, psychological stress, sadness and despair, and loneliness as predictors of compulsive smartphone use. The authors of the study conclude that mental health professionals should focus their efforts on preventing and managing emotional and/or behavioral disorders among adolescents who use smartphones too much.

3. Sleep disturbances as a consequence of smartphone addiction

Sleep disorders refer to a variety of sleep disturbances that occur over an extended period of time, have diagnosable causes or are difficult to decipher etiologically, and lead to significant stress because they interfere with daily functioning (Matsumoto, 2009). These include insomnia (difficulty falling asleep and staying asleep), hypersomnia (a person’s tendency to oversleep and

difficulty staying awake during the active period of the daily cycle), sleep apnea (temporary cessation of breathing during sleep), circadian rhythm disorder (people who fall asleep and wake up at inappropriate times), nightmares, etc. For clinicians, sleep quality is an important construct because many people complain of nighttime sleep disturbances that lead to impairments in other areas of functioning, such as emotional or behavioral functioning. Sleep quality is defined both by quantitative aspects (e.g., total duration of nighttime sleep, time needed to fall asleep, or number of awakenings) and qualitative aspects of a subjective nature, such as sleep depth or perceived feeling of restfulness upon awakening (Buysse *et al*., 1989).

Researchers have conceptualized sleep disorders/quality as both possible explanatory factors and consequences of addictive smartphone use. Some studies investigated the effect that smartphone addiction has on sleep quality among adolescents/young people. For example, Acikgoz *et al.* (2022) started from the premise that internet and smartphone addiction affect sleep quality. The researchers that we cited surveyed 910 adolescents aged 13 to 18 and found that approximately 59% of them had sleep problems, especially those who compulsively used the Internet, including via their smartphones. They were 1.83 times more likely to have sleep disorders than adolescents who used the internet rationally, and 1.99 times more likely than those who had a healthy relationship with their smartphones. The authors of the study analyzed the results by highlighting the factors that contribute to the deterioration of sleep quality, namely older age, female gender, negative perception of health status, and problematic use of the Internet and smartphones.

A. Al-Shoaibi *et al*. (2021) analyzed the link between online social media use, sleep quality, and mental health indicators among adolescents. A literature review revealed that smartphone use before bedtime, especially for accessing social media, is a risk factor that contributes to circadian rhythm disruption through exposure to blue light and emotional stimulation (especially in terms of anxiety about missing out on messages or notifications). The same meta-synthesis concluded that girls aged 12 to 15 who have difficulty sleeping tend to be at higher risk of experiencing anxiety and depression. The authors of the study conclude that excessive use of smartphones for social networking can have a negative effect on sleep quality, especially among adolescent girls.

K. Lange *et al*. (2017) dwelt on the connection between time spent on various electronic devices (television, computer/Internet, video games, smartphones, and music playing devices) and reports of insomnia among 7.533 German adolescents aged 11 to 17. The binary logistic regression models, in which the dependent variable was complaints of insomnia, included age, socioeconomic status, emotional problems, anxiety/depression, and the presence of a medical condition. The analyses were performed separately for girls and boys. Girls who spent more than 3 hours/day listening to music had a 4.24 times higher risk of sleep disorders than those who were less involved in this activity. Boys who spent more than 3 hours/day on the computer/internet had a 2.56 times higher risk of insomnia, and a 2.45 times higher risk when the total time spent in front of the screen was more than 8 hours/day. Another significant predictor was playing video games for 0.5 to 2 hours/day.

S. Lemola *et al*. (2015) surveyed 362 adolescents using items that targeted sleep disorders, depressive symptoms, and the use of electronic devices before sleep. Compared to adolescents who owned conventional mobile phones, those who enjoyed smartphones tended to use electronic devices more frequently before bedtime, especially to call/send messages and spend time on the internet. Owning a smartphone was also associated with a later bedtime. The use of electronic devices was negatively associated with sleep duration and positively associated with sleep difficulties, which in turn were associated with higher levels of depression (especially sleep difficulties). The findings of this study suggest that smartphone abuse is a risk factor for sleep disorders and should be taken into account in educational programs designed to guide adolescents toward healthy behaviors that contribute to sleep hygiene.

Sohn *et al*. (2019) conducted a systematic review based on recent research focusing on problematic smartphone use among adolescents. The studies analyzed used scales such as *The Problematic Use of Mobile Phones (PUMP)* and *The Smartphone Addiction Scale (SAS-SV)* to measure addiction to this information, communication, and entertainment tool. They noted that excessive smartphone use was correlated with various indicators of sleep disorders, psychological stress, and predisposition to depression. Thus, adolescents who spend a lot of time on their smartphones, especially at night, tend to report lower sleep quality due to reduced melatonin levels and cognitive overstimulation. Moreover, smartphone addiction is associated with insomnia and decreased mental well-being.

L. Vernon, K. L. Modecki and B. L. Barber (2017) conducted a study on a sample of 1.101 high school students from 29 Australian schools and analyzed smartphone use behavior over three years. It revealed a significant association between smartphone use at night and reduced sleep quality in adolescents. The authors concluded that the blue light emitted by screens suppresses the secretion of melatonin, the hormone responsible for regulating sleep, and that the content of messages can generate negative emotions or anxiety, affecting the quality of falling asleep. The study also showed a positive correlation between excessive smartphone use and behavioral disorders, decreased self-esteem, and difficulties in coping with mentally demanding situations. Therefore, smartphone use at night harms mental health and sleep quality and contributes to sleep deprivation, a factor that affects the physical and mental development of adolescents.

4. The current study

4.1. Aim and design

Concern about the potential development of smartphone addiction has grown significantly among researchers, teachers, and parents. For this reason, numerous studies have been published in international literature that have sought to identify the individual characteristics associated with smartphone addiction, profiles in terms of problematic consumption of this means of information, communication, socialization, and entertainment, as well as the consequences that addictive patterns can have for individuals. Given the growing prevalence of this problematic behavior and its negative implications, smartphone addiction needs to be addressed not only as a social phenomenon but as a mental health issue that deserves unceasing scientific attention (WHO, 2023).

For this reason, we believe that rigorous scientific investigation of the phenomenon of smartphone addiction is essential to understand the psychological mechanisms involved, the risk/protective factors, but also to ground appropriate educational and psychotherapeutic approaches. Scientific research can also contribute to efforts aimed at designing and implementing effective public policies in the field of healthy use of modern digital technologies among children and adolescents. The correlational study that we conducted on a sample of preadolescents and adolescents aimed to determine the role that depression, anxiety, and psychological stress play in predicting smartphone addiction. We also aimed to determine the contribution of smartphone addiction to explaining individual differences among preadolescents/adolescents in terms of sleep quality.

The investigation was based on a correlational design. Data were collected from the Romanian preadolescent and adolescent population (middle school students in grades 5-8) using standardized questionnaires. The independent variables on which we focused were depression, anxiety, and psychological stress for smartphone addiction (dependent variable). Other independent variables that were taken into account in predicting smartphone addiction were the gender and age of the study participants, as well as their place of residence. On the other hand, smartphone addiction was considered an independent variable for sleep disturbances. The dependent variables were smartphone addiction and sleep quality.

4.2. Participants and procedure

The data come from processing the responses that 356 preadolescents and adolescents gave to the standardized questionnaire that was administered to them using the *Google Forms* online platform. The sample included 191 girls (53.7% of the total) and 165 boys (46.3% of the total). At the time of completing the questionnaires, respondents were 11 to 15 years old (M = 12.98; SD = 1.13). The distribution of respondents by residence included urban areas – 224 (68.5% of the total) *vs.* rural areas – 112 (31.5%).

Study participants were recruited through a non-random sampling strategy (convenience sample) from the population of middle school students enrolled in four pre-university educational institutions. The students were approached during their regular school time and asked to access the link for the standardized protocol implemented on the *Google Forms* platform using their smartphones. The protocols with eligible responses were used for all respondents who agreed to participate in the study by reading the informed consent form. Participation in the study was voluntary. To encourage honest responses, the responses were anonymous. Data collection from the school population was carried out between December 2022 and March 2023. One of the criteria for inclusion in the study was ownership of a smartphone.

4.3. Instrumentation

Respondents completed a standardized protocol that included four instruments, with a total of 71 items. In the personal data section, respondents were asked to indicate their gender, age, residence, and the educational institution where they were studying.

Digital Addiction Scale for Children (DASC). The preadolescents and adolescents who took part in the study filled out the Romanian version of the DASC tool (Hawi, Samaha & Griffiths, 2019). It includes 25 items (examples: "When I am not at school, I spend a lot of time using my device", "I feel upset when asked to stop using my device", "Using my device makes me feel better when I feel bad", etc.), to which a subject can respond on a Likert scale with five verbal anchors distributed gradually from 1 – *never* to 5 – *always.* The total score is obtained by adding up the item scores (possible range: 25-125). High scores are indicative of an increased level of dependence on digital devices, including smartphones. This is a device that is frequently and often excessively used by children and adolescents.

The authors of the tool designed the content of the items to operationalize the nine criteria for clinical diagnosis described in DSM-5^{TR} (American Psychiatric Association, 2022) for Internet gaming disorder. These include: constant preoccupation with using the digital device; increased tolerance (increasingly intense use); feelings of psychological tension when the device cannot be used; use of the device as a means of compensating for negative emotional states; conflicts with other people (e.g., parents) caused by efforts to stop compulsive use of the device; relapse into addictive behavior. The authors added three more criteria to these, namely: a) problems that device addiction causes in everyday life (e.g., sleep disturbances or poor academic performance); b) the child/adolescent's tendency to lie to their parents about the time spent on the device and the purposes of its use; c) replacing participation in family activities with time spent on the device. For each of these criteria, the authors formulated 2 to 4 items. These were created based on the definitions of each of the criteria for digital technology/online gaming addiction. In the present study, internal consistency was very good (α = 0.92).

Pittsburgh Sleep Quality Index (PSQI). Sleep quality was measured using the Romanian translation (and adaptation) of the *Pittsburgh Sleep Quality Index* (Buysse *et al*., 1989). The tool includes 19 items that operationalize seven characteristics to assess sleep quality, namely: subjective assessment of sleep quality (item 6), sleep latency – i.e., the time a person needs to fall asleep (items 2 and 5a), sleep duration (item 4), usual sleep efficiency – the percentage of time a person spends sleeping *vs.* the total time the person spends in bed (items 1, 3, and 4), nocturnal

sleep disturbances (items 5b-5j), use of medication to improve sleep (item 7), and daytime dysfunction due to sleep problems (items 8 and 9).

The PSQI was designed to provide researchers and clinicians with a standardized, reliable, and valid measure of sleep quality, which is specifically assessed in several mental disorders or somatic conditions. The PSQI score should be easy to interpret by researchers and clinicians. The authors of the tool also aimed to construct a measure that would discriminate between individuals with sleep problems and those with a normal sleep profile. In the instructions, the subject is prompted to evaluate the quality of their sleep over the past month. Items 1-4 have open-ended answers, and the rest have closed-ended answers (for example, for items 5a-5j, the answer options are distributed gradually on a scale from 0 – *not at all in the last month* to 3 – *three or more times/week)*. Each of the seven characteristics of sleep quality can be scored from 0 to 3. The total score is obtained by adding up the characteristics scores (possible range: 0-21). A high score indicates major problems with the quality of nighttime sleep. In the present study, the correlation between the scores on the seven characteristics of sleep quality ranged from 0.03 to 0.45, with an internal consistency of 0.71.

Depression Anxiety Stress Scales-21 (DASS-21). The DASS-21 scales (Lovibond & Lovibond, 1995) comprise 21 items that operationalize anxiety (7 items), depression (7 items), and psychological stress (7 items). For each item, a subject can respond on a Likert scale with four verbal anchors distributed gradually from 0 – *not at all* to 3 – *almost all the time.* The subject is prompted to respond to the items by reporting on the negative emotional states they have experienced in the last week or in the last six months. In our study, high school students completed scales related to anxiety (example items – "I found myself in situations that made me so anxious that I was most relieved when they ended", "I got scared for no serious reason"), depression (example items – "I felt that life was not worth living", "I felt quite worthless"), and psychological stress (example items – "I felt that I was quite irritable" or "I couldn't stand being interrupted from what I was doing"). The instructions asked them to indicate what they had thought and felt or how they had behaved in the last six months. The total score for each of the three scales was obtained by adding up the scores for the corresponding items (possible range: 0-21). High scores correspond to high levels of anxiety, depression, and psychological stress. In the present study, the internal consistency of the DASS-21 scales was good: 0.83 – *Anxiety,* 0.81 – *Depression*, and 0.84 – *Psychological stress.*

4.4. Strategy for raw data analysis

Quantitative data were analyzed using *SPSS for Windows 20.0* (IBM SPSS, Chicago, IL). For the distributions of the scores obtained by the participants on the questionnaires administered to them, skewness and kurtosis indicators were calculated to assess normality. For a quantitative variable whose values are normally distributed, skewness and kurtosis should be zero (if the distribution is analyzed with statistical software that takes this into account). Some authors (Labăr, 2008) suggest the [- 1.00; 1.00] range as critical benchmarks.

Comparisons of the means for the distributions of scores on the DASC (smartphone addiction) and PSQI (sleep quality) questionnaires according to the gender and residence of the respondents were performed using *Student's t-test* for two independent samples. The statistical significance of the differences noted was interpreted against the reference 0.05 (bilateral) value. Correlations between the DASC score, age, DASS-21 scale scores, and the global sleep quality index were calculated using the *Pearson correlation coefficient*. To interpret the statistical significance of a correlation, the critical threshold was set at 0.05 (bilateral).

Multiple linear regression analyses were performed using the *enter* method. All the independent variables considered were entered in a single step (Labăr, 2008). The individual contributions of the independent variables that emerged as predictors in explaining the variance of

the DASC score were estimated by calculating the square of the semipartial correlation (r^2_{sp}) and turning the results into percentage values.

5. Results

Table 1 shows the descriptive statistical indicators for the distributions of the variables on which we focused in this study. Considering the possible ranges for the variation in scores on the questionnaires completed by the students, the following trends were noted in the analyzed sample: a) students tended to report a moderate level of smartphone addiction; b) respondents tended to report low levels of anxiety, depression, and psychological stress; c) in our sample, a low level of sleep disturbances was found (i.e., a fairly high level of sleep quality).

Table 1. Descriptive statistical indicators for the distributions of the variables considered

Variables	***M***	***SD***	***Skewness***	***Kurstosis***
1. Smartphone addiction	63.73	18.49	0.23	- 0.41
2. Anxiety	6.45	4.67	0.82	0.03
3. Depression	6.54	4.72	0.74	- 0.20
4. Psychological stress	5.68	4.81	0.96	0.20
5. Sleep quality	5.43	2.85	0.92	1.00

The absolute values of the skewness indicator ranged between 0.23 and 0.96. The absolute values of the kurtosis indicator ranged between 0.03 and 1.00. In conclusion, taken as a whole, the data on the shape of the distributions of the variables considered did not indicate significant distortions from the condition of normality of a univariate distribution. These findings justified the use of parametric statistical tests (*Student's t-test* for comparing the means of two independent samples, linear correlation, and multiple linear regression analysis, respectively).

The gender of the students who participated in the study did not have a statistically significant impact on the DASC score used to measure smartphone addiction (Table 2). Both girls and boys tended to report a moderate level of smartphone addiction. Similarly, the students' place of residence (urban *vs.* rural) had no statistically significant impact on smartphone addiction scores.

Table 2. Comparative data (DV = smartphone addiction)

Independent variables	**Compared subsamples**	***M***	***SD***	$t_{Student}/F_{Anova}$	***p***
Gender	Female	64.42	19.20	0.75	0.451
	Male	62.93	17.65		
Residence	Urban	64.07	18.34	0.50	0.612
	Rural	63.00	18.85		

Table 3 summarizes the comparative data for the dependent variable related to sleep quality according to the gender and residence of the study participants.

Table 3. Comparative data (DV = sleep quality)

Independent variables	**Compared subsamples**	***M***	***SD***	$t_{Student}/F_{Anova}$	***p***
Gender	Female	5.91	2.91	3.47	< 0.001
	Male	4.87	2.69		
Residence	Urban	5.63	3.03	2.14	0.033
	Rural	4.99	2.39		

The gender of the study participants had a statistically significant impact on their PSQI scores. Compared to boys, girls reported poorer sleep quality. Compared to (pre)adolescents who were residents of rural areas, those who lived in urban areas reported higher levels of sleep disturbances.

Given these findings, the gender of the students and their place of residence were not taken into account in the regression analyses in which the dependent variable was smartphone addiction. Instead, they were considered as independent variables in the regression analyses in which the dependent variable was sleep quality.

Table 4 shows the correlations between the variables considered. Smartphone addiction correlated positively, statistically significantly, but with relatively modest intensity, with the age of the students surveyed. Thus, older students tended to report higher scores on the DASC questionnaire.

Table 4. Correlational analysis

Variables	**1.**	**2.**	**3.**	**4.**	**5.**
1. Smartphone addiction	-				
2. Age	0.17 ***	-			
3. Sleep quality	0.46 ***	0.18 ***	-		
4. Anxiety	0.49 ***	0.05 ***	0.56 ***	-	
5. Depression	0.47 ***	0.11 ***	0.51 ***	0.86 ***	-
6. Psychological stress	0.47 ***	0.10 ***	0.54 ***	0.87 ***	0.83 ***

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed)

Smartphone addiction showed a positive, statistically significant, and moderately intense correlation with the overall sleep quality index (PSQI score). Respondents who scored higher on smartphone addiction also tended to report poorer sleep quality. The score obtained by the surveyed students on the DASC questionnaire was positively associated, statistically significant, and with comparable moderate intensities ($r = 0.47$-0.49) with the scores on the DASS-21 questionnaire scales. In other words, higher levels of smartphone addiction correlated with higher levels of anxiety, depression, and psychological stress.

Table 5 shows the data from the multiple linear regression analyses in which the independent variables were the age of the students who participated in the study and their scores on the questionnaires used to operationalize depression, anxiety, and psychological stress, and the dependent variable was smartphone addiction.

Table 5. Multiple linear regression analysis data (DV = smartphone addiction)

Independent variables	**β**	**p**	**r^2_{sp}**
Model 01			
Age	0.12	0.009	0.0151
Depression	0.46	< 0.001	0.2079
Model 02			
Age	0.14	0.001	0.0217
Anxiety	0.48	< 0.001	0.2362
Model 03			
Age	0.12	0.007	0.0156
Psychological stress	0.46	< 0.001	0.2134

Note: The model included the constant in the equation

Testing multiple regression models was justified by the high correlation values between the scores on the DASS-21 questionnaire scales (see Table 3). Thus, anxiety correlated strongly with both depression ($r = 0.86$; $p < 0.001$) and psychological stress ($r = 0.87$; $p < 0.001$). Depression also correlated strongly with psychological stress ($r = 0.83$; $p < 0.001$). One of the conditions that contributes to the accuracy of a regression model is the absence of multicollinearity between the independent variables to be included in the model (Labăr, 2008). Multicollinearity means correlations greater than 0.60-0.70 between any two of the independent variables that a researcher uses in a regression model. Multicollinearity analysis is necessary to increase the accuracy of the regression model in terms of predictors and the individual explanatory power that independent variables have within the overall model. For this reason, in the present study, anxiety, depression, and psychological stress were considered separately in three regression models.

The first of the regression models that we tested was statistically significant ($R = 0.48$; $F_R = 55.05$; $p < 0.001$) and accounted for 23.3% of the variance in the DASC score. Age was a positive predictor of smartphone addiction, accounting for 1.5% of the differences among the students surveyed. Depression was also a positive predictor of smartphone addiction, accounting for 20.7%.

The second regression model was also statistically significant ($R = 0.51$; $F_R = 63.80$; $p < 0.001$) and accounted for 26.1% of the variance in the smartphone addiction scores obtained by the students who participated in the study. Age was a predictor of the DASC score and accounted for 2.1% of its variance. Anxiety was also a positive predictor and accounted for 23.6% of the variance in the smartphone addiction scores obtained by the students who participated in the study.

The third regression model was statistically significant ($R = 0.49$; $F_R = 56.80$; $p < 0.001$) and accounted for 23.9% of the variance in the score obtained by the students who participated in the study for smartphone addiction. The contribution of age to the prediction of the DASC score was statistically significant ($p = 0.007$). Psychological stress was also a positive predictor and accounted for 21.3% of the differences between the students surveyed in terms of smartphone addiction.

Table 6 summarizes the data from the multiple linear regression analysis in which the independent variables were the gender and residence of the students who participated in the study, and the score that they obtained on the DASC questionnaire (smartphone addiction), respectively, and the dependent variable was sleep quality (total score for PSQI).

Table 6. Multiple linear regression analysis data (DV = sleep quality)

Independent variables	**β**	**p**	**r^2_{sp}**
Gender	- 0.16	< 0.001	0.0282
Residence	- 0.10	0.032	0.0100
Smartphone addiction	0.45	< 0.001	0.2025

Note: The model included the constant in the equation

The regression model was statistically significant ($R = 0.50$; $F_R = 38.70$; $p < 0.001$) and accounted for 24.2% of the variance in the sleep quality scores obtained by the students who participated in the study. The contribution of respondents'gender to the prediction of sleep quality was statistically significant ($p < 0.001$). Gender (1 = girls) accounted for 2.8% of the individual differences in sleep quality. Residence (2 = rural) was also a positive predictor and accounted for 1% of the PSQI score. Finally, smartphone addiction was a positive predictor and accounted for 20.2% of the variance in sleep quality scores.

6. Discussion and practical implications

Recent investigations (based on cross-sectional or longitudinal designs) indicate that excessive smartphone use is associated with reduced academic performance (Domoff, Foley & Ferkel, 2020; Seo *et al*., 2016), deterioration in the quality of interpersonal relationships (Seo et al., 2016), and increased symptoms of anxiety (Buabbas, Hasan & Buabbas, 2021; Liu *et al*., 2018) and depression (Coyne, Stockdale & Summers, 2019; Liu *et al*., 2018; Seo *et al*., 2016). It is also linked to symptoms characteristic of attention-deficit/hyperactivity disorder (Schoeni, Roser & Röösli, 2017), behavioral problems (George *et al*., 2018), sleep disturbances (Acikgoz *et al*., 2022; Girela-Serrano *et al*., 2022; Lange *et al*., 2017; Lemola *et al*., 2015; Sohn *et al*., 2019), and a decline in overall well-being (Poulain *et al*., 2019).

The quantitative study that we conducted among students aged 11 to 15 aimed to investigate the connection between negative emotional states (depression, anxiety, and psychological stress) and smartphone addiction, on the one hand, and between extensive smartphone use and sleep disorders, on the other. It is well known that smartphones offer a wide range of opportunities for solving everyday problems, overcoming emotional and social difficulties, or enriching personal experiences. Especially when the applications used by preadolescents give them the impression that they have a social support network and multiple sources of information or entertainment, smartphones can be perceived as a "savior" which is why their addictive potential increases. The risk of developing an unhealthy relationship with smartphones is also increased by parental educational deficiencies, including behavioral modeling by adults.

Given that the age group in question is undergoing numerous physical, cognitive, emotional, and social changes, as well as deviations from normal functioning, it is understandable why preadolescents are at high risk of experiencing psychosomatic problems, eating and sleeping disorders, anxiety, depression, negative self-image, lack of confidence in their own abilities and in adults, social isolation, or prolonged psychological stress. All of these dysfunctions may be tackled using various strategies through which preadolescents try to self-regulate their inner balance and remain anchored in the daily responsibilities specific to their age. One such strategy may be to intensify the search for instrumental or emotional support through online social media. Thus, the smartphone becomes an indispensable tool for most preadolescents; however, its excessive use brings about numerous risks to physical and mental health.

Our study found statistically significant, moderately intense positive correlations between scores for depression, anxiety, and psychological stress, and those for smartphone addiction, respectively. Various research findings (Dou *et al*., 2024; Elhai, Levine & Hall, 2019; Kim *et al.*, 2022; Ran *et al.*, 2022; Tu *et al.*, 2023; Zhang *et al.*, 2022) show that impaired emotional functioning tends to be associated with excessive smartphone use as a means of tackling these unpleasant states. This phenomenon is noted not only among children and adolescents, but also in the adult population. Thus, anxious individuals are prone to ruminative thoughts about the unfavorable evolution of situations/events in their lives, failure to achieve their own goals, the intentions of others, or the predictability of everyday life. To these are added psychosomatic manifestations and maladaptive behaviors with which anxious people try to cope by excessively relying on the informational and social resources offered by smartphones connected to the Internet. The device may be used compulsively for online gaming or frequent and prolonged conversations through which an anxious or depressed individual attempts to diminish unpleasant cognitive and emotional states and obtain the support needed to overcome difficulties. Over time, compulsive smartphone use, especially for browsing online social media and to the detriment of building and strengthening face-to-face interpersonal relationships, can have negative effects on an individual's communication and interaction skills. Thus, it can contribute to the onset and/or intensification of social anxiety. The anxiety and stress caused by losing contact with one's smartphone (a phenomenon known in the literature as nomophobia) add to this mechanism. Such

a critical threshold should alert the person to the risk of developing a pathological attachment to the virtual world mediated by their own smartphone. For all the reasons listed above, we believe that a reflective effort is needed to invest the smartphone with a value that does not jeopardize personal initiatives and active efforts aimed at overcoming everyday difficulties. The smartphone is not an "alter ego" of our own person, but only a tool that can contribute to optimizing daily functioning in various contexts (personal, family, school/academic, social, or professional).

Among (pre)adolescents, depression is a significant factor contributing to vulnerability in various areas of functioning. At this stage of development, which is characterized by emotional instability, increased social pressures, and an acute need for external validation, depression often manifests itself through social withdrawal, feelings of worthlessness, and a persistent search for emotional relief in specific social groups (Twenge *et al.*, 2018). Thus, the smartphone can become an accessible "outlet" through which (pre)adolescents try to avoid the negative emotions associated with depression, taking refuge in social media, online games, or passive content consumption. All these dysfunctional behaviors can degenerate into compulsive smartphone use (Elhai *et al*., 2017).

According to researchers, adolescents who report high levels of depression also tend to overuse their smartphones to avoid social relationships or confronting their own problems rather than as a means of communication (Rozgonjuk *et al*., 2019). Such an attitude contributes to reinforcing the vicious cycle: as depression increases, the need for "digital escape" intensifies, while heavy smartphone use exacerbates depressive symptoms through sleep deprivation and real social isolation (Woods & Scott, 2016). Especially among preadolescents, who have not yet fully developed mechanisms for emotional regulation and critical thinking, depression can directly influence vulnerability to smartphone addiction. Studies have shown that preadolescents are more sensitive to online social exclusion and rely more on feedback from the virtual environment to form and/or maintain their self-image (George & Odgers, 2015). In this sense, smartphones become a substitute for the emotional support they could get in the real world, but this is a dangerous phenomenon when depression becomes chronic and is not treated (Riehm *et al*., 2019).

Depression also affects the circadian rhythm, a phenomenon that leads to sleep disturbances. Thus, depressed adolescents are more likely to use their smartphones at night to distract themselves from negative thoughts, and this behavior can lead to exacerbation of depressive symptoms and the onset of addictive patterns (Lemola *et al*., 2015). Under these conditions, depression can be seen not only as a consequence of smartphone addiction but also as a cause that often contributes to the onset of addiction by affecting cognitive, emotional, and behavioral self-regulation, as well as by diminishing resilience in the face of stressful life demands.

Both correlational data and data obtained through multiple linear regression modeling showed a significant association between compulsive smartphone use and poor sleep quality. The findings of our study are consistent with those reported by other studies (Lange *et al*., 2017; Lemola *et al*., 2015; Liu *et al*., 2017, 2018; Sohn *et al*., 2019; Vernon, Modecki & Barber, 2017; Xiao *et al*., 2024). This relationship can be circular. Often, nighttime sleep disturbances are caused by unhealthy behaviors related to the pre-sleep routine (e.g., late bedtimes, heavy use of digital devices that overstimulate the brain, or excessive attention to smartphones, which interrupts sleep sessions). Over time, the chronic nature of these problems leads to increasingly long periods during which preadolescents cannot fall back asleep and focus their attention on various activities carried out in the virtual environment with the help of their smartphones. In turn, excessive attachment to smartphones increases nighttime alertness, leading to insomnia and difficulty falling asleep, often even despite the use of medication.

Therefore, self-education to acquire healthy behaviors related to bedtime, the activities that precede this important moment, and the physical conditions of sleep is one of the areas in which parents, school counselors, and teachers must intervene systematically. A lesson dedicated to sleep health should be included in the curriculum of subjects such *as Health Education* or

Counseling and Personal Development. Healthy behaviors that preadolescents can adopt to prevent sleep problems include those related to smartphone use (e.g., stopping online activities well before bedtime or placing the smartphone in a room other than the bedroom to prevent waking up due to the sounds or visual signals associated with notifications).

7. Limitations and further research directions

The main strength of our study of middle school students is the relatively large sample size, combined with the use of instruments recognized in the academic community as having solid psychometric properties to operationalize the variables. Furthermore, although data collection was carried out using a standardized protocol on the *Google Forms* platform, the response behavior of the study participants was carefully monitored by the author of this paper, who answered the questions that respondents asked about the content of the items.

However, the results of the correlational study that we conducted among preadolescents and adolescents should be analyzed taking into account certain limitations that suggest directions for further research. Thus, the main variables of interest were operationalized using standardized questionnaires. This is based on self-reporting and hence bears the risk of distorting the results through the subjectivity of the responses or the lack of sincerity of the study participants, either as a result of the intervention of defensive mechanisms to protect their image/self-esteem, or due to the effect of the social desirability of their responses (Demetriou, Uzun Ozer & Essau, 2015). Our further research would be aimed at supplementing the responses to standardized instruments targeting the addictive potential of new information, communication, and socialization technologies (including smartphones) with individual interviews with subjects from the target population. The interview method allows us to create a richer picture of a wide range of factors that may contribute to an increased risk of unhealthy smartphone use.

Another limitation is the correlational nature of the study design (Carlson & Morrison, 2009). The variables on which we focused were measured simultaneously, and the working hypotheses were tested using multiple linear regression analysis. These two methodological issues limited our ability to interpret the relationships between the variables that were assumed to be possible determinants of smartphone addiction in terms of cause and effect. In a future investigation, we propose to use a longitudinal design and appropriate statistical methods that allow us to highlight the temporal dynamics of the relationships between risk factors for addictive smartphone use, this behavior, and its consequences.

In the present study, we focused on a limited set of independent variables that may contribute to the prediction of smartphone addiction in the target population. In our future studies, we plan to focus our attention on other variables that could explain the relationship between sleep disturbances, anxiety, or depression, on the one hand, and smartphone addiction, on the other. For example, the subjective feeling of loneliness could mediate the relationship between depressive states and addictive behavior. A preadolescent/adolescent experiencing depressive states may feel loneliness, especially when their own social network (which could provide emotional or instrumental support) is reduced/unavailable. In turn, feelings of loneliness may intensify the preadolescent's efforts to seek out potential virtual friends on various online social media, thus constituting a risk factor for excessive smartphone use.

8. Conclusions

Over the past two decades, modern digital technologies have progressed exponentially and deeply changed human society, the pace of individual existence, and the opportunities for self-affirmation that people pursue in various fields. Information and communication technologies have penetrated various fields and optimized both people's daily and professional activities and the way they manage interpersonal relationships. Among these, the smartphone has undergone a rapid evolution in terms of both technical improvements and the applications it facilitates. The

appeal of the smartphone may be attributed to the immediate satisfaction it offers to all age groups.

Our study aimed to identify the role that depression, anxiety, and psychological stress play in predicting smartphone addiction. We also set out to determine the contribution that smartphone addiction has in explaining individual differences among (pre)adolescents in terms of sleep quality. The results of multiple regression analyses supported all the working hypotheses that guided our research. Thus: a) along with the age of the respondents, anxiety, depression, and psychological stress emerged as predictors of the high scores that the surveyed students obtained on the DASC questionnaire; b) also, along with the gender and residence of the study participants, smartphone addiction emerged as a predictor of poor sleep quality. These findings confirm the findings of numerous studies that have focused on determining the factors that contribute to the development of digital technology addiction among (pre)adolescents, as well as the consequences of this addictive behavior.

The negative consequences of excessive mobile phone use have attracted the attention not only of researchers across various fields, psychoeducational counseling specialists, psychiatrists, and clinical psychologists, but also of mental health professionals, school counselors, and parents. Coordinated efforts by all these stakeholders can contribute to equipping children and adolescents with healthy attitudes toward their engagement with new digital technologies. Such attitudes reduce the risk of physical, mental, and social health problems. Mental health practitioners can benefit from the findings of scientific investigations that highlight the complex relationships among a range of individual variables, characteristics of social and virtual environments, attitudes and behaviors related to smartphone use, and the impact of abusive use of this technological innovation.

From a theoretical point of view, the study we conducted complements other research conducted both in Romania and in other countries around the world. These studies have focused on smartphone or video game addiction – a phenomenon considered among the risk factors for quality of development in early childhood or adolescence. From a practical point of view, the study's findings suggest the need to intensify efforts aimed at raising awareness among parents and other educational factors about the harmful effects that abusive smartphone use can have on children and adolescents. Since psychological stress, anxiety, or depression can lead to an unhealthy attachment to this digital device, educators should also focus on monitoring changes specific to puberty and adolescence. When these are not tackled in time, they can lead to emotional and behavioral problems, including an unhealthy relationship with smartphones.

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