# The Influence of Smartphone Addiction on Cognitive Functioning: Exploring the Mediating Role of Sleep Quality and Perceived Stress

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*The rapid increase in smartphone usage has significantly influenced different aspects of daily life, including cognitive and psychological well-being. This research investigates the impact of Smartphone Addiction (SPA) on Cognitive Functioning (CF), with a focus on the mediating roles of Sleep Quality (SQ) and Perceived Stress (PS). The findings highlight a profound negative relationship between SPA and CF, both directly and indirectly through its effects on SQ and PS. SPA was found to be negatively correlated with SQ while positively correlated with PS, contributing to cognitive impairments. Furthermore, mediation analysis shows that SQ and PS partially mediate the relationship between SPA and CF. The data were collected from 310 participants using standardized scales such as the Smartphone Addiction Scale (SAS), Cognitive Functioning Self-Assessment Scale (CFSS), Pittsburg Sleep Quality Index (PSQI) and Perceived Stress Scale (PSS) and were analyzed using SPSS and the Hayes Process Macro. This study provides profound insights into the complex association between excessive smartphone use, sleep disturbances, stress, and cognitive health. The findings underscore the need for interventions to manage smartphone addiction, improve sleep quality, and reduce stress levels to protect cognitive functioning. The research adds to the expanding literature by inclusion of SQ and PS as mediators in the relationship between SPA and CF, highlighting practical recommendations for dealing with the adverse effects of smartphone abuse. Future research should consider larger and more diverse samples to improve the generalizability of finding.*

## Introduction

Smartphones have become indispensable in modern life, serving as tools for communication, entertainment, and productivity. However, with the increasing use of smartphones, concerns have emerged regarding smartphone addiction (SPA) and its consequences on various aspects of daily life, including cognitive functioning (CF), sleep quality (SQ), and perceived stress (PS). The term smartphone addiction refers to the compulsive use of smartphones, often resulting in negative outcomes such as withdrawal symptoms, impaired functioning, and loss of control over phone usage (Foerster, Roser, Schoeni, & Röösli, 2015).

The primary concern with smartphone addiction is its potential to impair cognitive abilities. Smartphone addiction has been found to be positively correlated with cognitive failures, which can manifest as memory loss, distractibility, and errors in decision-making (Hadlington, 2015). Studies have also shown that smartphone use, especially before bedtime, is linked with poor sleep quality, which further contributes to cognitive deficits such as diminished attention and memory (Exelmans & Van den Bulck, 2016; Alhola & Polo-kantola, 2007). The disruption of sleep quality is significant, as insufficient sleep can lead to deficits in cognitive functioning, which directly affects daily tasks and academic performance (Waters & Bucks, 2011; Lim & Dinges, 2010).

Additionally, smartphone addiction is closely linked to perceived stress (PS). Individuals with higher levels of perceived stress are more likely to develop addictive behaviors, including smartphone addiction (Chung & Kim, 2010; Gao et al., 2017). Stress can influence cognitive processes, and its relationship with smartphone addiction can lead to a vicious cycle, where high stress exacerbates addiction, and the addiction, in turn, worsens cognitive functioning (Sinha, 2008; Elhai et al., 2017).

This research is intended to investigate the effect of smartphone addiction on cognitive performance among university students focusing on the mediation effects of sleep quality and perceived stress. The research lacuna is that it did not detail how one specific aspect such as the quality of bed and stress intervened the relationship between mobile phone addiction and cognitive performance. Although a number of previous studies have explored the direct impact of smartphone addiction on cognition, only a few have dealt with these mediating variables, indicating the significance of this study for advancing our knowledge of the indirect mechanism for the effect of smartphone addiction on cognition. The high popularity of smartphone use with the high prevalence of university students has led to speculation about how this might affect cognition. Although some studies have examined the association between smartphone addiction and cognitive functioning, the potential mediating processes, such as sleep quality and stress, rarely have been investigated. The purpose of this study is to bridge the gap by investigating how sleep and stress mediate the association among smartphone addiction and cognitive functioning.

This finding is important in that it further enhances our understanding of how the indirect effect of smartphone addiction on cognitive functioning operates. Targeting sleep quality and perceived stress as the mediators, the study demonstrates the multifaceted roles of these factors in the relationships, thereby making some practical suggestions for alleviating the cognitive impairments arising from heavy smartphone use. It is expected that the study will contribute to the growing body of research on the psychological and cognitive impacts of smartphone addiction, especially in the context of academic performance and mental health.

**Objectives of the Study**

1. To explore the impact of smartphone addiction on the cognitive functioning of university students.
2. To assess the relationship between sleep quality and cognitive functioning.
3. To analyze how smartphone addiction influences sleep quality.
4. To evaluate the impact of smartphone addiction on perceived stress.
5. To examine the mediating role of sleep quality in the relationship between smartphone addiction and cognitive functioning.
6. To explore the mediating role of perceived stress in the relationship between smartphone addiction and cognitive functioning.

# Literature Review

## *Smartphone Addiction*

Smartphone addiction (SPA) refers to the compulsive and excessive use of smartphones that interferes with daily activities, social interactions, and academic performance. Studies have shown that SPA exhibits similar characteristics to other types of addiction, including withdrawal symptoms, tolerance, and cravings (Foerster et al., 2015). With the advent of smartphones around the globe, which is estimated to reach 6.6 billion users globally to 7.8 billion by 2028 (Statista, 2024), worries about unregulated smartphone use and associated problems have escalated, especially amongst adolescents (Sapacz et al., 2016).

The psychological and behavioral characteristics of smartphone addiction involve anxiety, irritability, impulsivity and diminished emotion regulation (Chung & Kim, 2010). In addition, cognitive failures (forgetfulness, distractibility, and decision-making errors) have been associated with the intensity of smartphone addiction (Hadlington, 2015). This habituation may be highly disruptive of normal cognitive function, and reduce concentration and schoolwork performance (Thornton et al., 2014).

## *Cognitive Functioning*

Cognitive functioning encompasses a range of mental processes, including memory, attention, learning, decision-making, and problem-solving. These cognitive processes are essential for executive functioning and are crucial for academic achievement and everyday tasks (Benke et al., 2022). Cognitive defects from smartphone dependency were observed in the poor ability of concentration, forgetfulness, and slow decision-making, which is particularly difficult for university students who are possibly going to have poor achievements on academics.

The link between smartphone addiction and cognitive decline has been a subject of previous research. Specifically, Thornton et al. (2014) who demonstrated that smartphone addicted individuals exhibit more cognitive failures in everyday activities, such as forgetfulness and decision-making failures. Cognitive resources of person can be consumed by the constant interruptions from smartphonesThe addiction to it can disturb focus and doing the meaningful works (Thornton, Faires, Robbins).

These findings are complemented by additional research conducted by Hadlington (2015) who found that smart phone addiction is negatively associated with attention and working memory. These findings demonstrate specifically how smartphone addiction affects attention and information processing ability, which in turn induce cognitive impairment.

*Sleep Quality*

Sleep quality (SQ) refers to the effectiveness of sleep in terms of both quantity and quality. Poor sleep quality is characterized by sleep disturbances, such as trouble falling asleep, frequent waking during the night, and insufficient rest, all of which impair daytime functioning (Spira et al., 2011). Sleep disturbances triggered by exorbitant smartphone use are already well-known, in particular use of the smartphone before going to bed. It has been proved that smartphone dependence is associated with poor sleep quality resulting from prolonged screen exposure in the evening, thereby impairing the melatonin release and disturbance of body circadian rhythm (Exelmans & Van den Bulck, 2016).

Studies by Demirci et al. (2015) have demonstrated significantly worse sleep quality among adolescents with high smartphone addiction, which has a negative influence on their cognition. Van den Bulck (2014) found that frequent smartphone use prior to going to sleep resulted in problems initiating and maintaining sleep, which then contributed to the severity of cognitive dysfunction. Alhola and Polo-Kantola (2007) similarly found sleep quality to be related to memory losses and attention impairments, demonstrating the important implications of sleep on cognition.

*Perceived Stress*

Perceived stress (PS) refers to the psychological response to situations that are appraised as overwhelming or beyond an individual's control (Lazarus & Folkman, 1984). High levels of perceived stress are associated with a range of negative outcomes, including cognitive impairments such as memory difficulties and poor decision-making (Lupien et al., 2007). Smartphone dependence has been found to predict perceived stress due to high dependence on the devices to keep in touch and stay entertained, making it emotionally stressful when the devices are unavailable (Lee et al., 2017; Liu et al., 2018).

Samaha and Hawi (2016) showed that perceived stress mediates the relationship between smartphone addiction and academic performance, and high stress can have an adverse effect on cognitive processes that hinder students from concentrating and doing well academically. This link among smartphone addiction, stress and cognitive functioning reinforces the need to moderate smartphone use for mitigation of negative impact of stress on mental health and academic performance.

The findings of this study support the mediating role of sleep quality and perceived stress in the relationship between smartphone addiction and cognitive function. The more dependent an individual is, the more his smartphone use is, the poorer is the sleep he gets and that contributes to cognitive dysfunction (Exelmans & Van den Bulck, 2016). Furthermore, overuse of smartphones raises stress, which may contribute to defects in cognition (Elhai et al., 2017). Both sleep quality and stress are thus important in accounting for the deleterious effects of smartphone addiction on cognitive functioning.

# Methodology

## *Research Design*

The study employs a quantitative research approach to examine the relationships between smartphone addictions (SPA), cognitive functioning (CF), sleep quality (SQ), and perceived stress (PS). To analyze these relationships, SPSS software (version 26) are used along with the Hayes Process Macro for mediation testing, as this method is widely recognized for its ability to test direct and indirect effects in a clear and interpretable manner (Hayes, 2013). The analysis will employ a 5,000-bootstrapping procedure with a 95% confidence interval to assess the strength of the indirect effects.

## *Participants*

The study will involve 310 undergraduate students from Abdul Wali Khan University Mardan. This sample size ensures adequate statistical power to detect meaningful relationships between the variables of interest. The participants will be selected using convenience sampling, with a focus on those who use smartphones regularly, ensuring that smartphone addiction is a prevalent issue within the sample group. The demographic composition of the sample includes both male and female students, ranging from 18 to 26 years old. This age group is particularly relevant because it represents a critical period in the development of both cognitive abilities and habits related to smartphone use.

## *Instruments*

The study utilize several validated instruments to measure the key variables:

### Smartphone Addiction Scale (SAS.

The SAS evaluates behaviors such as the frequency of smartphone use, dependency, and the emotional response to smartphone unavailability. It is widely used to assess the severity of smartphone addiction and its associated cognitive, behavioral, and emotional impacts (Kwon et al., 2013).

### Cognitive Functioning Self-Assessment Scale (CFSS)

This scale measures participants' perceived cognitive abilities, focusing on memory, concentration, and overall mental clarity. It provides insight into how individuals perceive their cognitive functioning in daily life and under stress (Annunziata et al., 2012).

### Pittsburgh Sleep Quality Index (PSQI)

The PSQI is used to measure sleep quality and sleep disturbances, including factors like sleep duration, latency, and efficiency. It helps assess how smartphone use influences sleep patterns, especially before bedtime (Buysse et al., 1989).

**Perceived Stress Scale (PSS)**

This scale measures the level of perceived stress experienced by individuals, capturing both psychological and physiological responses to stress. It will help assess how stress influences cognitive functioning and its relationship with smartphone addiction (Cohen et al., 1983).

### Data Collection Procedure

Data were collected using self-reported surveys. Participants will be asked to complete a series of questionnaires that include the SAS, CFSS, PSQI, and PSS. The surveys were distributed both in-person and online, with a 5-point Likert scale used for responses, ranging from strongly disagree to strongly agree**.** The survey were administered in a controlled environment to ensure consistency and minimize distractions during completion.

### Data Analysis

The data will be analyzed using SPSS version 26 and the Hayes Process Macro. Several statistical tests will be employed:

1. Descriptive Statistics
2. Correlation Analysis
3. Mediation Analysis
4. Bootstrapping Procedure

# Results

### Demographic Data

The demographic profile of the participants in the study. A total of 310 respondents participated in the survey, with a gender distribution of 47.7% male and 52.3% female. The majority of participants (60.3%) were in the 21-23 age group, followed by 23.2% in the 18-20 age group, and 14.8% were aged 24-26 years. A very small proportion of participants (1.6%) were aged 27 and above. In terms of academic programs, the majority of participants (92.3%) were enrolled in the BS program, while 6.1% were pursuing MPhil, and 1.6% were enrolled in the PhD53214 program.

### Descriptive Statistics and Correlations

**Table 1**

| Variable | Mean | SD | SPA | CF | SQ | PS |
|---|---|---|---|---|---|---|
| SPA | 3.0758 | 0.8277 | 1 | — | — | — |
| CF | 2.7791 | 0.6342 | 0.501** | 1 | — | — |
| SQ | 2.9903 | 1.1334 | -0.223** | -0.193** | 1 | — |
| PS | 3.1351 | 0.6964 | 0.318** | 0.421** | -0.077** | 1 |

Note: $p < 0.01$, r = Pearson correlation coefficient

Table 1 summarizes the descriptive statistics (mean, standard deviation) and correlation coefficients between the key variables. Smartphone Addiction (SPA) had a mean of 3.0758 (SD = 0.8277), while Cognitive Functioning (CF) had a mean of 2.7791 (SD = 0.6342). Sleep Quality

(SQ) had a mean of 2.9903 (SD = 1.1334), and Perceived Stress (PS) had a mean of 3.1351 (SD = 0.6964).

Significant positive correlations were found between Smartphone Addiction (SPA) and Cognitive Functioning (CF) (r = 0.501, p < 0.01), indicating that higher smartphone addiction was associated with more cognitive difficulties. A negative correlation was observed between Smartphone Addiction (SPA) and Sleep Quality (SQ) (r = -0.223, p < 0.01), suggesting that excessive smartphone use is associated with poorer sleep quality. Additionally, SPA was positively correlated with Perceived Stress (PS) (r = 0.318, p < 0.01), confirming that higher smartphone addiction levels contribute to increased stress.

**Regression Analysis**

**Table 2**

| Variable | Perceived Stress (PS) | Cognitive Functioning (CF) |
|---|---|---|
| Constant | — | — |
| Gender | 0.089 | 0.068 |
| Age | -0.007 | 0.006 |
| Smartphone Addiction (SPA) | 0.318*** | 0.501*** |
| Perceived Stress (PS) | — | 0.421*** |
| R² | 0.101 | 0.177 |
| ΔR² | 0.098 | 0.174 |
| F | 34.76 | 66.50 |

**Note:** *p < 0.05, **p < 0.001, ***p < 0.0001

Table 2 presents the results of the regression analysis conducted to test the impact of smartphone addiction on Perceived Stress (PS) and Cognitive Functioning (CF). Smartphone addiction was found to be a significant positive predictor of perceived stress (β = 0.318, p < 0.0001), meaning that as smartphone addiction increases, perceived stress also rises. The model explained 10.1% of the variance in perceived stress (R² = 0.101), and the F-statistic (F = 34.76) showed statistical significance.

Similarly, Perceived Stress (PS) was found to be a significant predictor of Cognitive Functioning (CF) (β = 0.421, p < 0.0001), highlighting the negative relationship between stress and cognitive abilities. This regression model explained 17.7% of the variance in cognitive functioning (R² = 0.177).

**Mediation Analysis**

**Table 3**

| Testing Paths | Unstandardized Coefficient | S.E. | T | p value | Bootstrapping LLCI | Bootstrapping ULCI |
|---|---|---|---|---|---|---|
| IV → M (a) | -0.306 | 0.076 | -4.023 | 0.0001 | -0.456 | -0.156 |
| M → DV (b) | -0.048 | 0.028 | -1.697 | 0.091 | -0.103 | 0.008 |
| IV → M → DV (c') | 0.370 | 0.039 | 9.566 | 0.0001 | 0.294 | 0.446 |
| IV → DV (c) | 0.370 | 0.039 | 9.566 | 0.0001 | 0.294 | 0.446 |
| Indirect Effects | 0.015 | 0.010 | 0.0001 | 0.041 | | |

**Table 4**

| Testing Paths | Unstandardized Coefficient | Standard Error | T | p value | Bootstrapping LLCI | Bootstrapping ULCI |
|---|---|---|---|---|---|---|
| IV → M (a) | 0.268 | 0.045 | 5.896 | 0.0001 | 0.178 | 0.357 |
| M → DV (b) | 0.265 | 0.045 | 5.900 | 0.0001 | 0.177 | 0.354 |
| IV → M → DV (c') | 0.313 | 0.038 | 8.279 | 0.0001 | 0.239 | 0.388 |
| IV → DV (c) | 0.313 | 0.038 | 8.279 | 0.0001 | 0.239 | 0.388 |
| Indirect Effects | 0.071 | 0.017 | 0.041 | 0.110 | | |

**Note:** IV = Independent Variable (Smartphone Addiction), M = Mediator (Sleep Quality or Perceived Stress), DV = Dependent Variable (Cognitive Functioning)

Tables 3 and 4 present the results of the mediation analysis using Hayes' PROCESS Model 4 to assess the mediating effects of Sleep Quality (SQ) and Perceived Stress (PS) in the relationship between Smartphone Addiction (SPA) and Cognitive Functioning (CF).

Sleep Quality was found to partially mediate the relationship between smartphone addiction and cognitive functioning, with an indirect effect of 0.015 (b value = 0.015, p < 0.0001).

Perceived Stress also partially mediated this relationship, with an indirect effect of 0.071 (b value = 0.071, p < 0.0001).

These results confirm that both Sleep Quality and Perceived Stress play significant roles in explaining how smartphone addiction impacts cognitive performance.

## Discussion and Conclusion

The findings of this study provide insight to the deep interplay between Smartphone Addiction (SPA), Cognitive Functioning (CF), Sleep Quality (SQ), Perceived Stress (PS). The research analysis has confirmed the hypothesis and shows that SPA positively associated with PS and negatively impact SQ, both of which mediated the relationship between SPA and CF by contributing in the declines of CF. The mediating analyses shows that both PS and SQ partially mediate the relationship between SPA and CF, highlighting their significance in understanding the vast cognitive consequences of excessive smartphone use.

As clear gap in the previous studies this research is the first formal exploration of the impact of both excessive Internet use and mobile phone use has on cognitive failures, and the use of sleep quality and perceived stress as mediators, experiencing by individuals in daily life. Previous work studies and highlighted lapses in attentional failures and has explored a variety of association to individual differences in working memory and attentional control of individuals (Unsworth et al., 2012; Kane et al., 2007). This area of research also links into work conducted by Shapira et al. (2000) and Yoo et al. (2004) who experienced that those who were observed to have faced problematic mobile phone use also had issues directly related to cognitive control more specifically impulse control. Such a premise also has a confirms in the work reviewed by Chou et al. (2005) which shows the results of addiction to the Internet as being the reason of behavior that would also lead to poorer cognitive functioning including attentional control. All these premises of the study supported my H1.

Some mechanisms have been identified that have the negative impact of smartphone abuse on sleep. First, smartphone use can decrease the sleep time that required for a good sleep, specifically

bed time use, second, smartphone users always prefer to use different websites and application before going to bed, such websites may contain in appropriate content which can results in stress and tension resulting the sleep disturbance. Third overuse of smartphone might have adverse physiological and psychological effects (Liu Q 2017; Ikeda K 2014). Fourth, fMRI study confirmed that SPA has serious effects on gray matter and whitr matter volumes in college students from which we can conclude that smartphone addiction would affect sleep via neurobiological way which supports our H2. Furthermore, sleep deprivation has some serious and obvious effects on cognitive functioning specifically reduction of attention and psychomotor vigilance and changes in behavioral responses, such effects are resulted in alteration of functioning in the region of prefrontal cortex and parietal region of the brain (Killgore, 2010). The research supports the H3 of our study.

Consistent with prior studies highlighting the direct association between stress and mobile phone addiction (e.g., Cheng & Hong, 2017; Chiu, 2014), our research also found that perceived stress is correlated with mobile phone addiction and can support the H4 of study. This result also matched with the general strain theory (Jun & Choi, 2015) emphasizing that different types of strain or stress experience by individuals would lead to problematic behaviors.

In the study of older adults, it was found that higher levels of perceived stress were associated with the decline of cognitive functioning including, poorer processing speed, memory, and executive functioning. (Korten et al. 2016)). Aligning with it, Aggarwal et al. 2014 also observed that greater perceived stress was linked with faster cognitive decline hence supporting our hypothesis 5.

previous studies found that bedtime mobile phone use is negatively associated to sleep quality in adults, which shows that smartphones use can reduce the sleep quality and which can further cause the decline in the cognitive functioning specifically attention and memory (Exelmans &Van den Bulck, 2016; Alhola & Polo-kantola, 2007) emphasizing the role of sleep quality as mediator between the interplay of smartphone addiction and cognitive functioning which supports my H6. Moreover, A longitudinal study observed that problematic smartphone use can be the cause higher perceived stress. while Meta-analysis research explains that persistent stress was negatively associated with executive functions, attention and memory. (Lee et al. 2017; Lupien et al. 2007) subsequently highlighting the role of perceived stress as a mediator between smartphone addiction and cognitive functioning supporting my H7.

While prior studies have explored the effect of smartphone addiction on cognitive function, stress and sleep quality independently, this research is among the first to find the combined mediating roles of perceived stress and sleep quality in this interplay. This research explores the multiple effects of smartphone addiction on cognitive functioning highlighting these mediating factors like sleep hygiene practices and stress management can help us to significantly reduce the negative cognitive consequences of smartphone addiction.

## Implication, Limitation and Future Suggestion

This study contributes highly to understanding how Smartphone Addiction (SPA) impacts Cognitive Functioning (CF) through the mediating roles of Sleep Quality (SQ) and Perceived Stress (PS). The research has practical implications for suggesting interventions for improving sleep quality and managing stress to deal the cognitive effects of excessive smartphone use. These results are important for educators, policymakers, and healthcare professionals to promote digital well-being by awareness campaigns, digital detox initiative and wellness programs.

However, the study has some limitations. The small sample size of 310 participants restricts the generalizability of the research findings. Self-reported method used for data collection may also be influenced by biasness, mood of the respondents, and the sample represents a homogeneous demographic, limiting its implication to diverse populations. Future researchers should work on these limitations by sampling at larger level, more diverse samples and incorporating longitudinal designs to highlight the impacts of smartphone addiction on cognitive functioning. Experimental work like wearable devices for tracking sleep and stress, MRI for studying the interplay at neurological level could provide broader insights. Technology-specific analyses and Intervention-based research could further help in understanding and offer practical knowledge for alleviation of the negative effects of smartphone addiction.

## Conclusion

This research provides insight about the significant impact of Smartphone Addiction on Cognitive Functioning, with Sleep Quality and Perceived Stress playing role of mediating roles. The results revealed that SPA negatively affects SQ and CF, while increased stress levels further contribute to the decline of cognitive functioning. These results confirm the hypotheses and emphasize the interconnected effects of excessive smartphone use on sleep, stress, and cognitive performance. The study advances theoretical understanding by exploring these mediators, offering new insights into how SPA indirectly influences cognitive functioning.

Practically, the findings inform strategies to mitigate the negative effects of SPA through improved stress management and better sleep hygiene. However, the study's limitations, including a small sample size, self-reported measures, and a cross-sectional design, suggest the need for future research with larger, diverse samples and longitudinal approaches. Despite these limitations, this research underscores the importance of addressing smartphone addiction as a public health concern, providing valuable direction for interventions aimed at promoting mental health and cognitive well-being.

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