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Brain Fog: The Impact of Excessive Smart Device Use on Subjective Cognitive Clarity Among Young Adults

Mohammed Looti*[1] and Marwa Abd-alazim[1]

1) College of Education for the Humanities, University of Kerbala, Karbala, Iraq
* **mohammed.jawad@uokerbala.edu.iq**

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ABSTRACT

This study investigated the relationship between excessive smart device use (smartphones, tablets) and subjective cognitive clarity, commonly referred to as "brain fog," among university students aged 18-30. Using a cross-sectional survey design (N=450), the smart device usage patterns, problematic use (modified Mobile Phone Problem Use Scale, MPPUS), brain fog (Brain Fog Scale, BFS), sleep quality (Pittsburgh Sleep Quality Index, PSQI), and perceived stress (Perceived Stress Scale, PSS) was assessed. Results indicated a significant positive correlation between excessive smart device use and BFS scores, signifying greater brain fog. Hierarchical regression analyses indicated that smart device use was a significant predictor of higher BFS scores. this held even when controlling for sleep quality. stress levels and demographic variables. Mediation analyses showed that the connection between total daily smart device use and brain fog was partially explained by both sleep quality and problematic smart device use. To be specific problematic smart device use fully mediated the effect of total use on brain fog whereas sleep quality and stress demonstrated partial mediation. These findings suggest an intricate network of influences among smart device use sleep psychological well-being and subjective cognitive function. The results bring into focus the need for promoting responsible technology use and digital wellness strategies particularly in young adult populations.

Keywords: Brain Fog, Cognitive Clarity, Smart Device Use, Stress, Problematic Use.

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Introduction

The increasing integration of smart devices into daily life has naturally prompted concerns about their potential impact on human cognitive function. Researchers are seeing more frequent reports of "brain fog" particularly among younger populations [1]. While not a clinical diagnosis, this term effectively describes a subjective experience of diminished mental clarity characterized by confusion forgetfulness and difficulty concentrating. Although it lacks a formal diagnostic label this experience of cognitive decline is a genuine phenomenon that impairs academic professional and personal functioning. For a demographic such as university students so reliant on this technology understanding its underlying factors is essential. The creation of the Brain Fog Scale (BFS) by Debowska and colleagues [2] provides a much-needed validated instrument to move beyond anecdotal reports and begin to systematically measure this issue. Several interrelated factors appear to be contributory. The most evident is cognitive overload. The continuous stream of notifications information and the unspoken expectation to multitask can simply overwhelm finite cognitive resources leaving individuals feeling mentally fatigued and less effective [3]. This cognitive drain may not even require active use; compelling research suggests that the mere presence of a personal smartphone can reduce available cognitive capacity as individuals subconsciously work to inhibit the automatic impulse to attend to it [4]. This concept is not new; it aligns directly with cognitive load theory a long-standing principle suggesting that working memory has a limited capacity before learning and performance decline sharply [5][6],then there is the issue of sleep or rather the lack of it. The biological pathway is well-documented at this point: blue light emitted from screens interferes with melatonin production disrupting natural sleep-wake cycles [7]. The evidence is clear that insufficient sleep is detrimental to cognition undermining an individual's attention memory and executive functions [8]. But it's a dual impact because beyond the biological effects the engaging and stimulating content people consume right before trying to rest also heightens cognitive arousal, making sleep more difficult to initiate and less restorative in quality [9]. The device itself is merely an object; psychological factors are pivotal. The connection between high levels of smart device engagement, especially on social media, and increased stress anxiety and depression is supported by a growing body of evidence [10].These

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mental health states are not separate from cognitive faculties; they directly compromise them diminishing attention and memory [11]. This is the environment where phenomena such as the "Fear of Missing Out" (FOMO) can emerge, driving the kind of compulsive checking behaviors that erode personal cognitive self-regulation [12]. This points to a vital distinction. It may not be the sheer duration of time spent on a device so much as the nature of that engagement. The concern is shifting toward problematic smart device use a pattern characterized by compulsion, a loss of control, and manifest negative consequences for the person [13]. This pattern has notable parallels with behavioral addictions. and very likely involves similar neural pathways governing reward and self-control. [14] And the "how" of a person's device use it seems may be far more consequential than the "how much". This study is designed to synthesize these different elements. By employing the BFS, the research aims to investigate the relationship between smart device use and the subjective experience of brain fog. More specifically, this investigation will examine how this relationship is mediated by sleep quality perceived stress and critically by patterns of problematic use.

Research Questions and Hypotheses:

1. Is there a relationship between smart device use (total daily use and problematic use) and self-reported brain fog (BFS scores) among university students?
    - **Hypothesis 1:** Higher levels of smart device use (both total daily use and problematic use) will be associated with higher BFS scores (indicating greater brain fog).
2. Do sleep quality and/or perceived stress mediate the relationship between smart device use and brain fog?
    - **Hypothesis 2:** Sleep quality and perceived stress will partially mediate the relationship between smart device use and brain fog (BFS scores).
3. Does problematic smart device use mediate the relationship between total daily smart device use and brain fog?
    - **Hypothesis 3:** Problematic smart device use will mediate the relationship between total daily smart device use and brain fog (BFS scores). The authors hypothesize full mediation, such that the effect of total use is primarily through its influence on problematic use.

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Methods and Materials

Participants

To address the research questions, this study employed a cross-sectional survey design, sampling a highly relevant population of students at Kerbala University. Participant recruitment was conducted through a multifaceted approach utilizing official email lists, social media outreach, Telegram groups, and direct announcements in lecture halls. The criteria for participation were specific: individuals had to be aged 18-30, be currently registered students at the university, and identify as regular smartphone users. From an initial group of 500 volunteers, the researchers obtained 450 complete responses, resulting in a 90% completion rate that points to a high level of student interest in this topic.

Procedure

The procedure for participants was designed to be straightforward. Each individual completed an online questionnaire which required approximately 15 minutes of their time. After giving informed consent, the survey collected information on demographics and patterns of smart device use. This was followed by the administration of several established psychometric instruments: the modified MPPUS, the BFS, the PSQI, and the PSS.

Measures

- **Demographics.** The study collected basic data on age, gender, and academic standing (year and major field of study).
- **Smart Device Usage.** The research assessed device engagement in two ways. First, for Total Daily Use, students were asked to report their average daily hours on smartphones and tablets, summing the two for a single score. Second, to understand Usage Patterns, they were asked to estimate the percentage of that time they dedicated to distinct activities such as social media, gaming, direct communication, information seeking, and other miscellaneous tasks.
- **Problematic Smart Device Use.** To measure the compulsive dimension of device engagement, an adapted version of the Mobile Phone Problem Use Scale (MPPUS),[15] was used, modifying its language to explicitly include both smartphones and tablets. This 20-item scale probes for addictive-like behaviors (e.g., "I feel anxious if I haven't

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checked my devices in a while," "I find myself spending more time on my smart devices than I intend to") on a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree). The scale demonstrated good internal consistency in this sample, with a Cronbach's alpha of .89.

- **Brain Fog. The study's** key outcome was measured with the Brain Fog Scale (BFS),[16] a 23-item instrument assessing subjective cognitive impairments over the preceding two weeks. Items are rated from 0 ("never") to 4 ("nearly all the time") and load onto three subscales: Mental Fatigue (e.g., "My thinking has been slow"), Impaired Cognitive Acuity (e.g., "I have found it difficult to remember and understand new information"), and Confusion (e.g., "I have felt confused"). The total BFS score, ranging from 0 to 92, showed excellent internal consistency in this sample ($\alpha = .94$), as did the subscales (Mental Fatigue $\alpha = .88$; Impaired Cognitive Acuity $\alpha = .91$; Confusion $\alpha = .89$).
- **Sleep Quality. The Pittsburgh Sleep Quality Index** (PSQI),[17] was used as **the** measure of sleep disturbance over the past month. This well-validated tool generates a global score where higher values indicate poorer sleep quality. The scale's reliability in the present sample was good ($\alpha = .83$).
- **Perceived Stress.** To assess psychological stress, the 10-item Perceived Stress Scale (PSS)[18] was administered, which measures the degree to which life circumstances from the past month are appraised as stressful. Higher scores reflect greater perceived stress, and the scale showed good internal consistency ($\alpha = .86$).

Data Analysis

- **Descriptive and Correlational Groundwork: The** initial step involved a preliminary analysis of the data. This process included calculating fundamental descriptive statistics such as means, standard deviations, and frequencies for all variables. Following this, Pearson correlation analyses were performed to gain a first look at the simple relationships between each pair of factors.
- **Hierarchical Multiple Regression:** Because simple correlations don't provide a complete explanation, the core of this study was a hierarchical multiple regression. This method allowed for the precise assessment of the unique impact of smart device use on

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total brain fog scores after statistically accounting for other influential factors like age, gender, sleep quality, and perceived stress.

- **Mediation Analyses:** To investigate the potential pathways of influence, the analysis then turned to mediation analyses using the well-known PROCESS macro for SPSS.[19] Two separate models were tested to evaluate competing ideas: one model looked at whether the effect of smart device use on brain fog was channeled through poor sleep and stress. Another model explored if problematic smart device use itself was the critical mechanism explaining the relationship. In both cases, a bootstrapping technique (with 5000 resamples) was employed to produce dependable estimates and 95% confidence intervals for the indirect effects identified.

Results

Descriptive Statistics

Table 1 presents the descriptive statistics for the sample. The average age of participants was 21.9 years (SD = 2.6), and 65% of the sample identified as female. The average daily smart device use was 6.2 hours (SD = 2.4), with a range from 1 to 14 hours. The mean BFS total score was 38.2 (SD = 13.5), indicating a moderate level of brain fog in the sample. The mean modified MPPUS score was 56.8 (SD = 8.7), the mean PSQI score was 8.5 (SD = 2.7), and the mean PSS score was 23.5 (SD = 6.6).

Table 1. Descriptive Statistics for Study Variables (N = 450)

Variable	Mean	SD	Range
Age	21.9	2.6	18-30
Daily Smart Device Use (hrs)	6.2	2.4	1-14
BFS Total Score	38.2	13.5	2-85
Modified MPPUS Score	56.8	8.7	28-98
PSQI Score	8.5	2.7	2-20
PSS Score	23.5	6.6	8-45
Gender (% Female)	**65%**		

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Correlations

Table 2 presents the Pearson correlation coefficients. Total daily smart device use was significantly and positively correlated with BFS total scores (r = 0.53, p < .001), modified MPPUS scores (r = 0.72, p < .001) PSQI scores (r = 0.30, p < .001) and PSS scores (r = 0.33, p < .001). BFS total scores were also significantly and positively correlated with modified MPPUS scores (r = 0.67, p < .001) PSQI scores (r = 0.39, p < .001) and PSS scores (r = 0.48, p < .001).

Table 2. Pearson Correlations Among Study Variables

Variable	1	2	3	4	5
1. Daily Smart Device Use (hrs)	-				
2. Modified MPPUS Score	0.72***	-			
3. BFS Total Score	0.53***	0.67***	-		
4. PSQI Score	0.30***	0.38***	0.39***	-	
5. PSS Score	0.33***	0.45***	0.48***	0.28***	-

*** p < .001

Hierarchical Regression

Table 3 presents the results of the hierarchical multiple regression analysis predicting BFS total scores. In Step 1, age and gender were entered as control variables, but this step was not statistically significant (R^2 = 0.00). In Step 2, sleep quality (PSQI) and perceived stress (PSS) were added to the model, and this step was significant (R^2 = 0.27, p < .001). Both PSQI (β = 0.25, p < .001) and PSS (β = 0.37, p < .001) were significant positive predictors of BFS scores. In Step 3, total daily smart device use was entered into the model, and this step was also significant (ΔR^2 = 0.12, p < .001). Smart device use (β = 0.38, p < .001) remained a significant positive predictor of BFS scores, even after controlling for age, gender, sleep quality, and perceived stress. The final model accounted for 39% of the variance in BFS total scores (R^2 = 0.39, p < .001).

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Table 3. Hierarchical Regression Analysis Predicting BFS Total Scores (N = 450)

Predictor	Step 1 (β)	Step 2 (β)	Step 3 (β)
Age	-0.03	-0.01	0.00
Gender (Female=1)	0.05	0.03	0.01
PSQI Score		0.25***	0.18***
PSS Score		0.37***	0.28***
Smart Device Use			0.38***
R^2	0.00	0.27***	0.39***
ΔR^2		0.27***	0.12***

*** p < .001

Mediation Analyses

- **Mediation by Sleep and Stress:** The indirect effect of total daily smart device use on BFS total scores through sleep quality (PSQI) was statistically significant (b = 0.10, 95% CI [0.07, 0.14]). The indirect effect of total daily smart device use on BFS total scores through perceived stress (PSS) was also statistically significant (b = 0.13, 95% CI [0.09, 0.18]). The direct effect of smart device use on BFS scores remained significant after controlling for both mediators (b = 0.30, p < .001), indicating partial mediation.
- **Mediation by Problematic Use:** The indirect effect of total daily smart device use on BFS total scores through problematic smart device use (MPPUS) was statistically significant (b = 0.49, 95% CI [0.43, 0.55]). The direct effect of total daily smart device use on BFS scores was no longer significant after including MPPUS in the model (b = 0.04, p = .15) indicating full mediation.

Discussion

The data indicate a conclusion that is on its face quite clear: the more time university students devoted to their smart devices the more they reported subjective cognitive impairment as measured by the BFS. This was not a minor association. The positive correlation is robust and importantly. the predictive capacity of device utilization remains significant even when controlling confounding variables such as sleep quality, stress and demographics. Hypothesis 1 is

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therefore supported. The amount of screen time appears to directly influence perceived cognitive clarity. The total duration of use is not the complete picture. The mediation analysis helps to illuminate the mechanisms involved and here the analysis identifies two established mediators: sleep and stress. The finding that both partially mediate the relationship between device use and brain fog aligns with a substantial body of existing research. The disruptive effect of blue light on circadian rhythms [19] the heightened cognitive arousal from late-night engagement [20] and the well-documented psychological costs of social media-induced stress and Fear of Missing Out (FOMO) [21][22] are all well-established principles. This aspect of the findings while important for confirmation is not entirely novel. Deficient sleep and elevated stress contribute to cognitive difficulties. The most clinically significant finding emerges with Hypothesis 3. In this analysis it was observed that problematic smart device use fully mediated the association between total screen time and brain fog. To state it more directly the number of hours a student spends on a device is no longer a direct predictor of cognitive impairment once the quality of that use is considered. The critical factor, it appears is not the duration itself but what that duration facilitates: compulsive checking the anxiety when disconnected and a diminished sense of control. It is the pathology of the engagement not the time spent. This is consistent with studies showing that specific design features of smartphones Such as push notifications and variable reward schedules on social media are engineered to promote these very patterns of habitual use [23] .This reframes the issue entirely. It becomes less a matter of time management and more a question of behavioral addiction a perspective long advocated by researchers such as Billieux and Kuss & Griffiths [24][25]. Total screen time then functions less as a direct cause of cognitive impairment and more as the context in which these problematic habits are formed. What are the implications for the contemporary student population? The recommendation to 'simply reduce phone use' may be an overly simplistic approach. These young adults are in a difficult position; their academic and social worlds are now deeply integrated with these devices making disconnection a significant challenge. This environment creates a heightened risk for the transition from high levels of use to compulsive problematic engagement which leaves them particularly susceptible to these negative cognitive consequences.

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Limitations:

It is important to consider certain limitations. First the study's cross-sectional nature precludes the establishment of definitive causal relationships. Although the mediation analyses suggest potential pathways it is equally possible that individuals experiencing significant cognitive fatigue are more inclined toward extensive smart device engagement or that an unobserved variable influences both factors. Future longitudinal research is essential to clarify the temporal sequence of these variables and to move beyond mere correlation. A second consideration involves the use of self-report instruments which are susceptible to well-known biases such as social desirability effects memory imperfections and individual response styles, each of which can compromise data validity. To address these subsequent studies would benefit greatly from incorporating more objective data collection methods for example screen-time monitoring applications to corroborate or perhaps contest participant reports. Third the generalizability of these findings is limited by the sample which was composed exclusively of university students from a single institution; it remains unclear whether similar patterns would emerge in older adults individuals in different professional contexts or those from diverse cultural backgrounds. While this analysis controlled for several key variables including age gender sleep quality and perceived stress it is possible that other unmeasured factors are also exerting an influence. These factors could conceivably include dietary patterns underlying physiological or psychological conditions personality traits and even the nature of the digital content being consumed for instance the distinction between passive social media consumption versus engagement with cognitively stimulating material.

Future Research Directions:

The critical next step involves longitudinal observation to understand how smart device behaviors, subjective cognitive fog, sleep patterns and general stress levels are interrelated. This type of study is necessary to truly comprehend the dynamics and temporal sequence of these factors potentially revealing what influences what. To confirm causation however research must shift to experimental designs deliberately reducing smart device use perhaps for a week or by eliminating specific applications to gather definitive evidence of its impact on cognitive performance and psychological well-being. But it is also important to acknowledge the profound

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value of the human experience. Exploring people's personal stories through in-depth qualitative interviews with those who struggle with cognitive fog and more importantly how they connect it to their screen time, offers invaluable insight. It is in these narratives that one can often uncover the specific usage habits, the nature of the content they engage with, and the situations that seem to trigger these adverse effects; these are the vital nuanced details. And it is absolutely essential to consider who is most susceptible and why. What about an individual's natural disposition for attention difficulties or their capacity for self-regulation? Or what about those who possess effective coping mechanisms or a robust support system? These individual differences these moderating factors aren't secondary considerations; they are likely fundamental to understanding why some people appear to navigate the digital landscape more successfully than others. Then there is the brain's role. Neuroimaging, for all its sophistication, could uncover the physical basis of cognitive fog. showing how constant digital input might be altering the structure and function of neural pathways. Pinpointing these neural correlates would provide an objective biological anchor for what is a widely felt and unpleasant subjective state. In the end the aim is to find real solutions developing and testing interventions that provide tangible benefits. Researchers must think beyond just advising people to use devices less and instead consider educational frameworks for more mindful use structured digital breaks or even cognitive exercises designed to enhance attentional focus. There is a need for practical evidence-based strategies that people can actually use.

Conclusion

The findings from this study have practical applications not just for individuals. but also for educator's clinicians and policymakers. Public health efforts should increase awareness about the potential cognitive outcomes of excessive smart device use. focusing on the risk that problematic habits will develop. Encouraging "digital hygiene" is therefore fundamental for preserving cognitive health. this includes things such as setting time limits. taking regular breaks from technology using devices mindfully and prioritizing sleep. Institutions for instance universities and workplaces. could find value in programs geared towards responsible technology use and digital well-being. Such initiatives might involve providing educational resources on healthy tech habits. Designated technology-free zones are another avenue. offering support for individuals experiencing challenges with their device use is a crucial element. Clinicians are encouraged to assess technology use in patients presenting with brain fog or similar cognitive difficulties the BFS is a practical and straightforward tool for this. If problematic use is identified. clinicians can provide guidance and support or refer individuals to specialized treatment where necessary. Interventions that target sleep quality stress management and cognitive behavioral strategies appear quite effective in managing the underlying factors that contribute to brain fog. In summary this research offers substantial evidence using validated scales for a significant link between smart device overuse and the experience of brain fog among university students. These results indicate a complex interaction between device use duration problematic usage styles sleep quality stress and cognitive function. This highlights a pressing need for greater awareness. mindful technology habits and proactive strategies to advance digital wellness especially for young adults deeply enmeshed in a digital world. The observation that problematic use entirely explains the connection suggests interventions ought to focus less on merely cutting screen time and more on altering the quality of that engagement to cultivate a healthier relationship with technology.

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