

Impact of Frequent Mobile Phone Use on Cognitive Function and Stress Levels in Young Adults: A Comparative Cross-sectional Study

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ABSTRACT

Background: Mobile phones are integral to daily life among young adults, and excessive, unregulated use is increasingly linked to adverse effects on cognitive function and psychological well-being. Young adults are particularly vulnerable owing to ongoing prefrontal neurocognitive maturation and high digital dependence, yet the comparative impact of frequent versus limited use on objective cognition and stress among young Indian university students remains insufficiently explored.

Objective: To compare cognitive function, perceived stress, and mobile phone dependence between frequent and limited mobile phone users among young adults, and to examine the association between daily phone-use duration and these outcomes.

Methods: A comparative cross-sectional study was conducted among 120 students (aged 18–30 years) at Galgotias University, Greater Noida, recruited by convenience sampling with purposive group allocation based on verified daily usage: Group A (frequent users, ≥ 5 h/day, $n = 60$) and Group B (limited users, ≤ 2 h/day, $n = 60$). A standardized battery assessed working memory (Digit Span Test), processing speed and executive function (Stroop Colour-Word Test), verbal memory (Memory Recall Test), perceived stress (Perceived Stress Scale-10, PSS-10), and mobile phone dependence (Bergen Phone Addiction Scale, BPAS); a cognitive composite was derived. Analyses used independent-samples t tests, Pearson correlation, and Cohen's d (IBM SPSS v25.0; $\alpha = 0.05$).

Results: Groups were comparable in age, gender, and BMI ($p > 0.05$). Frequent users performed significantly worse on every cognitive measure and reported significantly higher stress and dependence (all $p < 0.001$; Cohen's d 2.63–4.89). Representative values (Group A vs B) were: Digit Span Total 8.3 ± 1.2 vs 13.2 ± 1.4 ; Stroop interference 72.5 ± 8.3 vs 44.8 ± 6.1 s; PSS-10 29.1 ± 4.6 vs 11.6 ± 3.5 ; BPAS 22.4 ± 3.1 vs 9.8 ± 2.4 . Daily phone-use duration correlated strongly with the cognitive composite ($r = -0.928$) and stress ($r = +0.921$); 91.7% of frequent users fell in the moderate-to-severe addiction categories versus none in the severe category among limited users.

Conclusion: Frequent mobile phone use is significantly associated with poorer cognitive performance and elevated stress in young adults. The findings support digital-wellness education, cognitive-health screening, and physiotherapy-led behavioural strategies targeting problematic mobile phone use in young adult university populations.

Keywords: Mobile phone use; cognitive function; perceived stress; young adults; mobile phone dependence; cross-sectional study; digital health.

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1. INTRODUCTION

Mobile phone technology has profoundly transformed how people communicate, obtain information, and interact with their environment, and young adults are now the most intensive and dependent users worldwide [1,2]. Average daily use of four to seven hours has become common since the widespread adoption of smartphones and high-speed connectivity, and a growing body of evidence links excessive, unregulated use to measurable reductions in cognitive performance, sleep quality, and psychological well-being [2,3].

Young adults (broadly 18–30 years) are a particularly susceptible group. This developmental window is critical for maturation of the prefrontal cortex, which governs executive function, impulse control, and working memory and continues developing into the mid-twenties. Habitual behavioural patterns such as heavy screen use during this period may therefore exert disproportionate effects on neurocognitive function, compounded by academic stress, social demands, and sleep disruption typical of university life [2].

Cognitive function encompasses attention, memory, processing speed, executive function, and learning. Sustained attention and working memory are especially vulnerable to interference from persistent smartphone use: constant task-switching fragments cognitive focus, and even the mere presence of a smartphone can consume limited cognitive capacity [1,4]. More broadly, pervasive digital technology use has been associated with shortened attention, diminished deep encoding, and impaired executive control [5].

Memory function is a further concern. Habitual reliance on digital devices for information storage—the “Google effect”—may reduce active engagement of hippocampal consolidation systems, producing measurable decrements in immediate and delayed recall, and heavy media multitasking is associated with reduced encoding efficiency [6,7]. For university students, whose academic success depends on encoding and retrieving large volumes of information, these effects are particularly salient.

Beyond cognition, mobile phone use is linked to elevated perceived stress. Constant connectivity generates “technostress”—a persistent, low-grade psychological load driven by the expectation of permanent availability—while bedtime phone use disrupts sleep through blue-light melatonin suppression and cognitive arousal, and poor sleep further elevates stress and impairs cognition, creating a self-reinforcing loop [8,9,10].

Although international evidence is accumulating, comparative data on the cognitive and stress profiles of frequent versus limited mobile phone users among young Indian university students are scarce; most prior studies rely on self-report alone, lack clearly defined exposure groups, or seldom incorporate mobile phone dependence alongside objective cognitive assessment [11,12]. The

present study therefore compared cognitive function (Digit Span Test, Stroop Colour-Word Test, Memory Recall Test), perceived stress (PSS-10), and mobile phone dependence (BPAS) between frequent and limited users, and examined the association between daily use duration and these outcomes. We hypothesised that frequent users would show significantly poorer cognition and higher stress, with a negative correlation between use duration and cognition and a positive correlation with stress.

2. MATERIALS AND METHODS

2.1 Study design and setting

This was a comparative cross-sectional study conducted at the School of Medical and Allied Sciences, Department of Physiotherapy, Galgotias University, Greater Noida, Uttar Pradesh, India. The study was carried out in four phases: participant recruitment, screening and informed consent, data collection, and statistical analysis.

2.2 Participants and group allocation

Young adults aged 18–30 years currently enrolled at the university were recruited by convenience sampling across multiple programmes (BPT, B.Pharm, MBBS, B.Sc, M.Sc and others). An initial screening questionnaire established daily mobile phone use using self-report corroborated by built-in screen-time data (photographed and verified by the researcher). Participants reporting ≥ 5 hours/day for at least the preceding six months were allocated to Group A (frequent users) and those reporting ≤ 2 hours/day to Group B (limited users); those with intermediate use (>2 and <5 hours/day) were excluded to maintain clear group separation. Eligible participants were able to read and respond in English or Hindi and had no known neurological, psychiatric, or cognitive disorder. Exclusion criteria comprised diagnosed neurological disorders, psychiatric conditions, current use of cognition- or stress-affecting medication, uncorrected visual or auditory impairment, recreational drug use or alcohol dependence, recent cognitive rehabilitation or brain training (within three months), and inability to complete the full assessment battery. Both sexes were included.

2.3 Sample size

Sample size was estimated using G*Power [13] for an independent-samples t test (two-tailed, $\alpha = 0.05$, power = 0.80) assuming a moderate effect size (Cohen’s $d = 0.50$) [14], yielding 51 participants per group; this was rounded up to 60 per group (total $N = 120$) to enhance reliability and allow for incomplete data (Table 1 reports the achieved sample).

2.4 Outcome measures

Five validated tools were administered individually in a fixed sequence by the same trained researcher in a standardized, quiet room (single session, ≈ 60 –75 minutes). Working memory was assessed with the Digit Span Test (forward + backward; total 0–16). Processing speed and executive function were assessed with the Stroop Colour-Word Test, with the colour-word interference time (seconds) as the primary index [15]. Verbal memory was assessed with a 15-word Memory Recall Test (RAVLT

format) yielding immediate and delayed recall (0–15) and a retention percentage. Perceived stress was measured with the 10-item Perceived Stress Scale (PSS-10; 0–40) [16], and mobile phone dependence with the six-item Bergen Phone Addiction Scale (BPAS; 6–30), based on established behavioral-addiction criteria [17]. A cognitive composite score was derived from the Digit Span, memory, and Stroop measures. All instruments have demonstrated good-to-excellent reliability and validity in young adult populations.

2.5 Statistical analysis

Data were analysed in IBM SPSS Statistics v25.0 (IBM Corp., Armonk, NY). Descriptive statistics (mean $\pm$ SD) were computed for continuous variables. Baseline comparability was assessed with independent-samples *t* tests (continuous) and chi-square tests (categorical). Between-group differences on all outcomes were tested with two-tailed independent-samples *t* tests, and Pearson correlation examined associations between daily phone-use duration and each outcome across the combined sample (*N* = 120). Cohen's *d* quantified effect sizes (small 0.2, medium 0.5, large 0.8) [14]. Significance was set at *p* < 0.05.

2.6 Ethics

The study was conducted in accordance with the Declaration of Helsinki [18] and approved by the institutional review board of Galgotias University. Ethical clearance for the study was obtained from the School Ethics Committee (Ref: SRC/PT/UG25-26/206/100), prior to commencement of the study. All participants received an explanation of the study's purpose, procedures, risks, and benefits in English or Hindi and provided written informed consent before data collection. Participants were not informed of their individual scores until data collection was complete, to avoid motivation-related bias.

3. RESULTS

One hundred and twenty participants (60 per group) completed the assessment battery. The two groups were comparable in age, gender distribution, and BMI (all *p* > 0.05) and differed, by design, in daily phone-use duration (7.4 ± 1.3 vs 1.4 ± 0.4 hours/day, *p* < 0.001); bedtime phone use was far more prevalent among frequent users (80% vs 25%, *p* < 0.001) (Table 1).

Table 1. Demographic and baseline characteristics of the study participants (*N* = 120).

Characteristic	Group A – Frequent (<i>n</i> = 60)	Group B – Limited (<i>n</i> = 60)	Test	<i>p</i> -value
Age, years (mean $\pm$ SD)	21.4 $\pm$ 2.1	21.8 $\pm$ 1.9	<i>t</i> = 1.12	0.264
Gender (male / female)	27 / 33	29 / 31	χ^2 = 0.14	ns
BMI, kg/m ² (mean $\pm$ SD)	22.6 $\pm$ 3.1	22.1 $\pm$ 2.8	<i>t</i> = 0.94	0.348
Daily phone use, h/day (mean $\pm$ SD)	7.4 $\pm$ 1.3	1.4 $\pm$ 0.4	<i>t</i> = 39.2	<0.001
Bedtime phone use, <i>n</i> (%)	48 (80)	15 (25)	χ^2 = 38.4	<0.001

SD = standard deviation; *BMI* = body mass index; *ns* = not significant. Groups were comparable on age, gender, and BMI.

3.1 Between-group comparison of outcomes

Frequent users (Group A) performed significantly worse than limited users (Group B) on every cognitive measure and reported significantly higher perceived stress and mobile phone dependence (all *p* < 0.001), with uniformly large effect sizes (Cohen's *d* 2.63–4.89; Table 2, Figure 1). Working memory (Digit Span Total) was markedly lower

in frequent users, Stroop interference time was substantially longer (indicating slower processing and weaker inhibition), and both immediate and delayed recall were reduced. PSS-10 scores placed frequent users in the high-stress band and limited users in the low-stress band, and the cognitive composite was substantially lower in frequent users.

Table 2. Between-group comparison of cognitive, stress, and dependence outcomes (independent-samples *t* test).

Outcome (tool)	Group A Mean $\pm$ SD	Group B Mean $\pm$ SD	<i>t</i>	<i>p</i>	Cohen's <i>d</i>
BPAS total (/30)	22.4 $\pm$ 3.1	9.8 $\pm$ 2.4	26.8	<0.001	4.89
Digit Span total (/16)	8.3 $\pm$ 1.2	13.2 $\pm$ 1.4	21.4	<0.001	3.76
Stroop interference (s)	72.5 $\pm$ 8.3	44.8 $\pm$ 6.1	21.6	<0.001	3.85
Immediate recall (/15)	9.2 $\pm$ 1.3	12.5 $\pm$ 1.2	14.9	<0.001	2.63
Delayed recall (/15)	7.3 $\pm$ 1.5	11.3 $\pm$ 1.2	16.7	<0.001	2.96
PSS-10 total (/40)	29.1 $\pm$ 4.6	11.6 $\pm$ 3.5	23.9	<0.001	4.36
Cognitive composite	47.9 $\pm$ 6.1	74.2 $\pm$ 5.7	25.3	<0.001	4.42

$df = 118$ for all comparisons. SD = standard deviation; BPAS = Bergen Phone Addiction Scale; PSS-10 = Perceived Stress Scale-10. Cohen's $d \geq 0.8$ = large effect; all effect sizes were large.

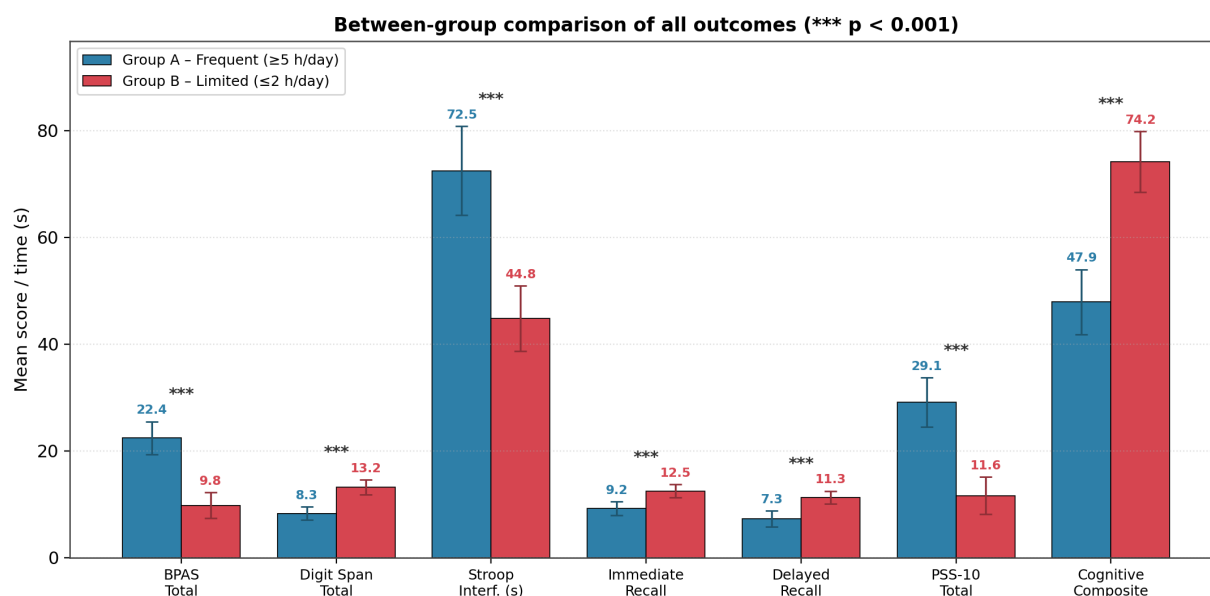


Figure 1. Between-group comparison of all outcomes (mean $\pm$ SD). Group A = frequent users (≥ 5 h/day); Group B = limited users (≤ 2 h/day). Error bars show one SD; *** indicates $p < 0.001$. Note that outcome scales differ (BPAS 6–30; Digit Span 0–16; Stroop in seconds; recall 0–15; PSS-10 0–40; cognitive composite arbitrary units).

3.2 Correlation between phone-use duration and outcomes

Across the combined sample, daily phone-use duration was strongly correlated with all outcomes (all $p < 0.001$; Table 3, Figure 2). Use duration showed very strong positive correlations with BPAS dependence ($r = +0.952$) and PSS-10 stress ($r = +0.921$) and a strong positive

correlation with Stroop interference time ($r = +0.897$), alongside strong negative correlations with Digit Span ($r = -0.889$), immediate recall ($r = -0.832$), delayed recall ($r = -0.851$), and the cognitive composite ($r = -0.928$). This consistent gradient is compatible with a dose-response pattern between phone-use duration and cognitive and stress outcomes.

Table 3. Pearson correlations between daily phone-use duration and outcome variables ($N = 120$).

Outcome	r	r^2	p	95% CI	Interpretation
BPAS total	+0.952	0.906	<0.001	0.931 to 0.966	Strong positive
Digit Span total	-0.889	0.790	<0.001	-0.916 to -0.853	Strong negative
Stroop interference (s)	+0.897	0.805	<0.001	0.863 to 0.923	Strong positive
Immediate recall	-0.832	0.692	<0.001	-0.872 to -0.783	Strong negative
Delayed recall	-0.851	0.724	<0.001	-0.888 to -0.806	Strong negative
PSS-10 total	+0.921	0.848	<0.001	0.895 to 0.942	Strong positive
Cognitive composite	-0.928	0.861	<0.001	-0.947 to -0.903	Strong negative

CI = confidence interval. Positive r = higher phone use associated with a higher score (greater dependence/stress or longer—worse—Stroop time); negative r = higher phone use associated with poorer cognitive performance.

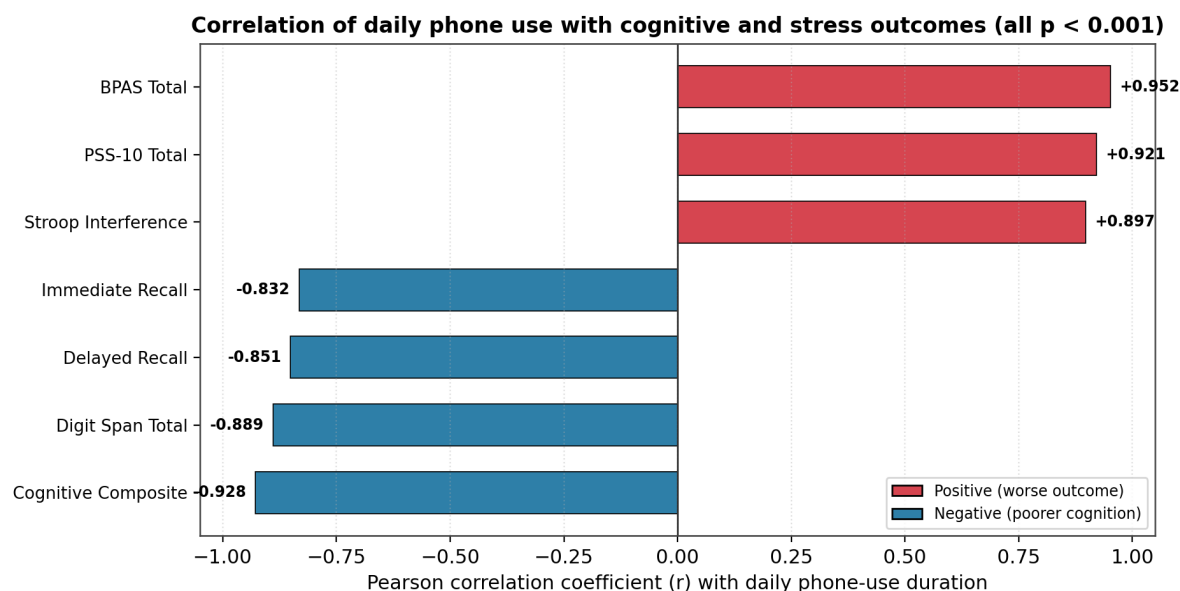


Figure 2. Pearson correlation coefficients between daily phone-use duration and each outcome ($N = 120$; all $p < 0.001$). Red bars denote positive correlations (higher dependence, stress, or interference time); blue bars denote negative correlations (poorer cognitive performance).

3.3 Mobile phone dependence and Stroop components

The distribution of BPAS categories differed sharply between groups ($\chi^2 = 78.4$, $p < 0.001$; Table 4, Figure 3): 91.7% of frequent users fell in the moderate or severe addiction categories (51.7% moderate, 40.0% severe) with none classified as not addicted, whereas 63.3% of limited users were not addicted and none reached the severe

category. Component analysis of the Stroop test showed that all three timed components—word reading, colour naming, and interference—were significantly slower in frequent users (all $p < 0.001$; Table 5). Memory retention (delayed/immediate $\times 100$) was lower in frequent users (79.3% vs 90.4%), indicating poorer consolidation in addition to reduced encoding.

Table 4. BPAS addiction-category distribution by group.

BPAS category	Score range	Group A, n (%)	Group B, n (%)
Not addicted	6–11	0 (0)	38 (63.3)
Mild addiction	12–17	5 (8.3)	19 (31.7)
Moderate addiction	18–23	31 (51.7)	3 (5.0)
Severe addiction	24–30	24 (40.0)	0 (0)

Chi-square test for category distribution between groups: $\chi^2 = 78.4$, $p < 0.001$. BPAS = Bergen Phone Addiction Scale.

Table 5. Stroop Colour-Word Test — component analysis (time in seconds).

Stroop component	Group A Mean $\pm$ SD	Group B Mean $\pm$ SD	t	p
Word reading	22.1 $\pm$ 3.2	15.4 $\pm$ 2.8	12.23	<0.001
Colour naming	43.8 $\pm$ 6.1	28.6 $\pm$ 4.9	15.04	<0.001
Interference	72.5 $\pm$ 8.3	44.8 $\pm$ 6.1	21.60	<0.001

Longer completion time indicates slower processing speed and weaker executive control. SD = standard deviation.

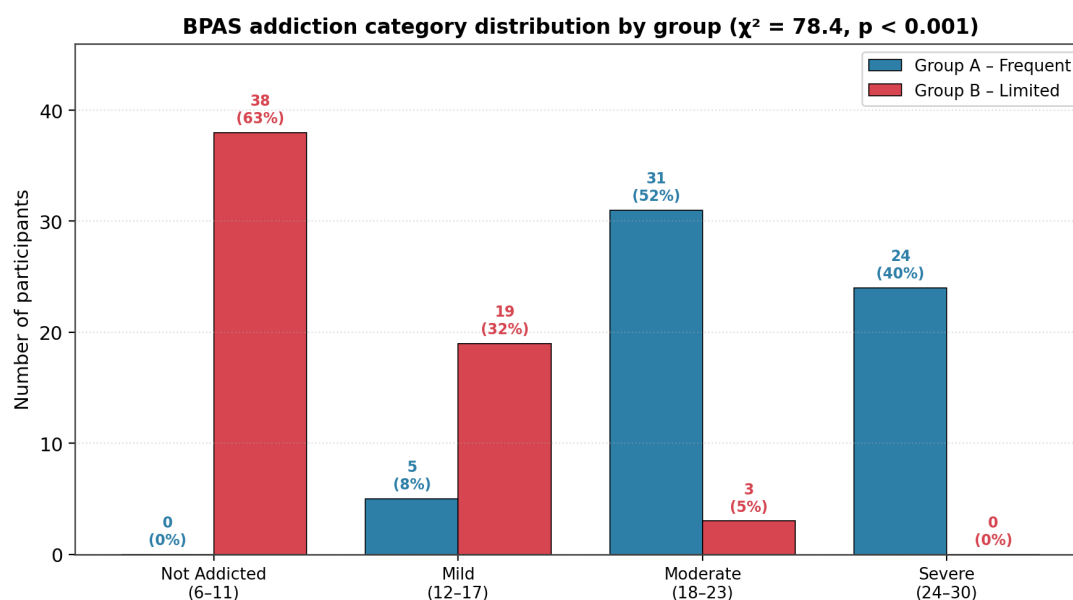


Figure 3. Distribution of participants across Bergen Phone Addiction Scale (BPAS) categories by group ($\chi^2 = 78.4, p < 0.001$). Bars show participant counts with percentages in parentheses.

4. DISCUSSION

This comparative cross-sectional study found that young adults who used mobile phones frequently (≥ 5 h/day) performed significantly worse than limited users (≤ 2 h/day) across every cognitive domain assessed and reported substantially higher perceived stress and mobile phone dependence. Because the groups were comparable in age, gender, and BMI, these differences are unlikely to reflect demographic confounding and are consistent with the hypothesised effects of heavy phone use; the alternative hypothesis was supported for all outcomes.

Frequent users showed significantly lower Digit Span scores, indicating reduced working memory capacity. This is consistent with evidence that habitual smartphone engagement fragments attention and that even the device's mere presence consumes limited cognitive resources through the ongoing effort of inhibition [1,4]. Constant task-switching between phone and other demands is thought to impose a chronic cognitive load that gradually erodes the efficiency of the phonological loop underlying working memory.

Stroop interference time was significantly longer in frequent users, indicating slower processing speed and weaker executive control—specifically reduced ability to inhibit prepotent responses, a function subserved by the still-maturing prefrontal cortex. These findings align with reviews linking excessive smartphone use to structural and functional prefrontal changes and reduced cognitive inhibition [19], and with experimental work reporting impaired executive performance and altered top-down attentional control in high users [20].

Both immediate and delayed recall were lower in frequent users, and memory retention was poorer, suggesting deficits in both encoding and consolidation. This pattern is consistent with the “Google effect,” whereby habitual

reliance on external digital storage reduces engagement of hippocampal consolidation systems [6], and with evidence that heavy media multitasking is associated with reduced encoding efficiency and poorer delayed recall [7]. Disrupted sleep from bedtime phone use—reported by 80% of frequent users—may further impair the slow-wave-sleep-dependent transfer of information to long-term stores.

Perceived stress was markedly higher in frequent users, who scored in the high-stress band while limited users scored in the low-stress band. Plausible mechanisms include “technostress” from the pressure of constant availability, exposure to social comparison and fear of missing out via social media, and sleep disruption from bedtime use. These results accord with prospective and cross-sectional evidence linking high mobile phone use to stress, sleep disturbance, and depressive symptoms in young adults [8], with reports of a positive association between smartphone-use severity and perceived stress in students [21], and with findings that problematic use relates to stress and reduced academic performance [22].

The distribution of BPAS categories—over nine in ten frequent users in the moderate-to-severe range versus a majority of limited users classified as not addicted—supports the validity of the exposure grouping and indicates clinically meaningful dependence in heavy users. Problematic smartphone use is consistently associated with anxiety and depressive symptomatology [23], and the co-occurrence of high dependence with cognitive and stress impairment here suggests that the cognitive cost of heavy use may be driven partly by the addictive quality of the usage pattern rather than duration alone.

Across the combined sample, daily phone-use duration correlated strongly with all outcomes, including a very strong association with dependence ($r = +0.952$) and a

strong inverse association with the cognitive composite ($r = -0.928$), consistent with a dose-response relationship. These correlations reinforce experimental findings that phone-related interruptions and mere device presence reduce cognitive performance [1,4]. They should, however, be interpreted alongside evidence that the motivation for use moderates harm—avoidance-driven use being more strongly linked to poor mental health than recreational use [24]—and within a literature in which causal direction remains uncertain given the predominance of cross-sectional designs [25]. The magnitude of academic and cognitive impact reported here is also consistent with meta-analytic evidence of a negative association between mobile phone use and academic performance [26].

4.1 Clinical implications

Physiotherapists working in neurological rehabilitation, community health, and wellness settings are increasingly positioned to address cognitive-health concerns linked to lifestyle behaviours such as mobile phone overuse. Frequent users may benefit from structured cognitive training, sleep-hygiene education, graded reduction or “digital detox” strategies, and stress-management delivered within a physiotherapy framework. Universities and health-promotion bodies could integrate screen-time awareness and cognitive-health education into student wellness curricula, and clinicians could screen for problematic use with validated tools such as the BPAS and PSS-10 to identify at-risk individuals before significant impairment develops.

4.2 Limitations

Several limitations should be noted. The cross-sectional design permits inference of association but not causation. Convenience sampling from a single university limits generalisability, and group allocation relied partly on self-reported use despite screen-time verification, introducing possible recall bias. Potential confounders—sleep duration, academic workload, physical activity, diet, and socioeconomic status—were not controlled, and the single-session assessment may be affected by day-to-day fatigue or test anxiety. The type and content of phone use (e.g., social media versus academic use) were not analysed separately, and no long-term follow-up was undertaken.

4.3 Future research

Longitudinal and randomised controlled designs are needed to establish causal direction and to test whether structured phone-reduction or digital-wellness programmes improve cognition and stress. Multi-centre studies across diverse Indian universities, objective data-logging of phone use, and neuroimaging of structural and functional brain change would strengthen the evidence base. Future work should control for sleep, physical activity, academic pressure, and diet; analyse use content separately; examine sex- and course-specific differences; and develop and evaluate physiotherapy-led cognitive-rehabilitation and behavioural interventions for young adults with problematic phone use.

5. CONCLUSION

Frequent mobile phone use among young adults was significantly associated with poorer performance across all cognitive domains, higher perceived stress, and greater mobile phone dependence compared with limited use, and daily use duration correlated strongly with all outcomes in a dose-response pattern. Frequent, unregulated use thus represents a modifiable lifestyle risk factor with measurable consequences for cognitive health and psychological well-being during a critical developmental period. The findings support the integration of mobile phone-use assessment, digital-wellness education, and behavioural intervention into routine health promotion and physiotherapy practice for young adult populations.

Declarations

Ethics approval and consent to participate. The study was approved by the institutional review board of Galgotias University and conducted in accordance with the Declaration of (Ref:SRC/PT/UG25-26/206/100). Written informed consent was obtained from all participants.

Consent for publication. Not applicable; no individually identifiable personal data or images are included.

Availability of data and materials. The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests. The authors declare that they have no competing interests.

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Authors' contributions. SS conceived and designed the study, recruited and assessed participants, collected and analysed the data, and drafted the manuscript. AS supervised the study, contributed to design and interpretation, and critically revised the manuscript. DK, MD, AS, PD read and approved the final manuscript.

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