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Sleep-Related Problems and Problematic Smartphone Use in Young Adult Males: Findings from a Short-Term Behavioral Restriction Study

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Purpose: Problematic smartphone use is a prevalent behavioral issue in the digital age and is frequently associated with sleep disturbances. However, evidence on how different sleep domains respond to short-term behavioral restriction under natural conditions remains limited. This study aimed to examine smartphone use patterns in young adult males, evaluate their relationship with problematic smartphone use risk, and assess changes in sleep-related outcomes following short-term, institutionally mandated smartphone restriction.

Patients and Methods: This prospective pre–post observational study was conducted at a male police college during a 10-day institution-mandated smartphone restriction. Participants (n = 254) were classified into low-risk and high-risk problematic smartphone use groups based on the Smartphone Addiction Scale–Short Version (SAS-SV). Sleep quality, sleep hygiene, insomnia severity, and daytime sleepiness were measured before and after the restriction period. Associations between smartphone use characteristics (daily duration, timing of use, and usage purposes) and sleep outcomes were examined using group comparisons and multivariate analyses.

Results: At baseline, individuals classified as high-risk reported longer overall smartphone use, particularly during evening hours, together with poorer sleep hygiene, lower perceived sleep quality, and greater daytime sleepiness. After the restriction period, improvements were mainly observed in behaviorally related sleep measures, including sleep hygiene and subjective sleep quality. In contrast, insomnia severity and daytime sleepiness showed limited change and did not demonstrate a significant group-by-time interaction.

Conclusion: The findings suggest that intensive evening smartphone use may be associated with sleep difficulties that are largely behaviorally mediated. Improvements in sleep-related behaviors accompanied short-term reductions in device exposure, whereas sleep parameters linked to more stable physiological regulation appeared less responsive over this brief interval. Addressing the timing and intensity of smartphone use is a relevant behavioral target in strategies to improve sleep health in young adults.

Keywords: problematic smartphone use, sleep quality, sleep hygiene, insomnia, daytime sleepiness, behavioral restriction

Introduction

Smartphones have become an integral part of everyday life worldwide.[1] The convenience of online communication and the wide range of functions they offer have further increased their use in everyday activities. However, the behavioral aspects of this intensive use have also led to the emergence of individuals exhibiting signs of problematic or dysregulated smartphone use.[2] In the field of neuropsychiatry, behavioral addictions related to digital device use are receiving increasing attention, although evidence is reported to be limited.[3] Problematic smartphone use (PSU) has been described as sharing certain behavioral features with recognized behavioral addictions, such as compulsive use patterns and functional impairment.[4] In addition, PSU has been associated with various physical complaints (such as musculoskeletal pain and accidents) as well as psychological problems, including depression and anxiety.[3,5]

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Among the identified health problems are sleep disorders, and excessive smartphone use can make it challenging to get a good night's sleep.[6] Increased smartphone use has been associated with shorter sleep duration and lower sleep efficiency.[7] Studies examining the relationship between smartphone use and sleep disorders have suggested physiological mechanisms, including disruptions in the circadian rhythm, melatonin suppression, and increased cognitive arousal during smartphone use.[8–10] A recent meta-analysis reported that 39% of students demonstrated findings consistent with high-risk smartphone use and 57% suffered from sleep deprivation.[11] Numerous studies have investigated the factors influencing PSU and its relationship with sleep, but observational data examining changes in sleep parameters are limited.[12,13] In Turkey, studies conducted among university students have also reported notable levels of problematic smartphone use. For example, Demirci et al reported that higher smartphone use was associated with poorer sleep quality and increased daytime dysfunction among Turkish university students, highlighting the relevance of this issue among young adults.[14]

Throughout the study period, the institutional setting provided a natural context for observing the short-term effects of restricted smartphone access in real-world conditions and also for examining how reduced smartphone exposure might relate to sleep-related outcomes, as it stemmed from routine institutional practice rather than an intervention imposed by the researcher. Although the term "smartphone addiction" is frequently used in the literature, it is not a formally recognized clinical diagnosis in current diagnostic classification systems; therefore, the present study conceptualizes smartphone-related problems within a risk-based, operational framework of problematic smartphone use, consistent with contemporary conceptual discussions in the field. The study was conducted at a police college that admitted only male students; therefore, the sample consisted solely of young adult males. Based on this information, a prospective, pre-post observational study was conducted in a homogeneous group of young adult males living in similar environmental and lifestyle conditions, aiming to investigate factors influencing problematic smartphone use and to evaluate the relationship between problematic smartphone use and sleep-related parameters.

Materials and Methods

Participants and Procedure

This study was designed as a prospective pre–post observational study conducted in a naturalistic institutional setting at a police college that admits only male students. During the enrollment period, the use of personal electronic devices, including smartphones, tablets, and computers, was restricted in accordance with institutional regulations. This restriction was implemented by the school administration independently of the research protocol, and the research team neither introduced nor controlled this condition. Accordingly, the study aimed to evaluate sleep-related parameters before and after this institution-mandated restriction period.

All individuals applying for enrollment for the first time were informed about the study procedures, and written informed consent was obtained from those who agreed to participate. Of the 510 students who met the institution's admission criteria, 424 voluntarily agreed to participate and completed the baseline assessment (Test 1), while 86 declined to participate or did not complete the baseline questionnaires. The participant flow is illustrated in Figure 1.

Participation criteria included being between 19 and 25 years old, owning a smartphone, being willing to participate voluntarily, and completing the basic assessment forms. Exclusion criteria included a history of chronic medical conditions, psychiatric diagnosis or treatment, self-reported problematic smartphone or internet use requiring clinical evaluation or treatment, clinically diagnosed sleep disorders, incomplete baseline survey data, or withdrawal of consent.

At baseline (Test 1), participants completed demographic and health-related forms, smartphone usage characteristics, the Smartphone Addiction Scale – Short Version (SAS-SV), and sleep-related scales. The SAS-SV was administered only at baseline to classify participants according to baseline PSU risk status (high-risk vs low-risk). It was not re-administered at follow-up because the primary aim was to evaluate changes in sleep-related parameters according to baseline PSU risk status. After the 10-day institution-mandated restriction period, follow-up assessments (Test 2) were conducted, during which the sleep-related scales were re-administered.

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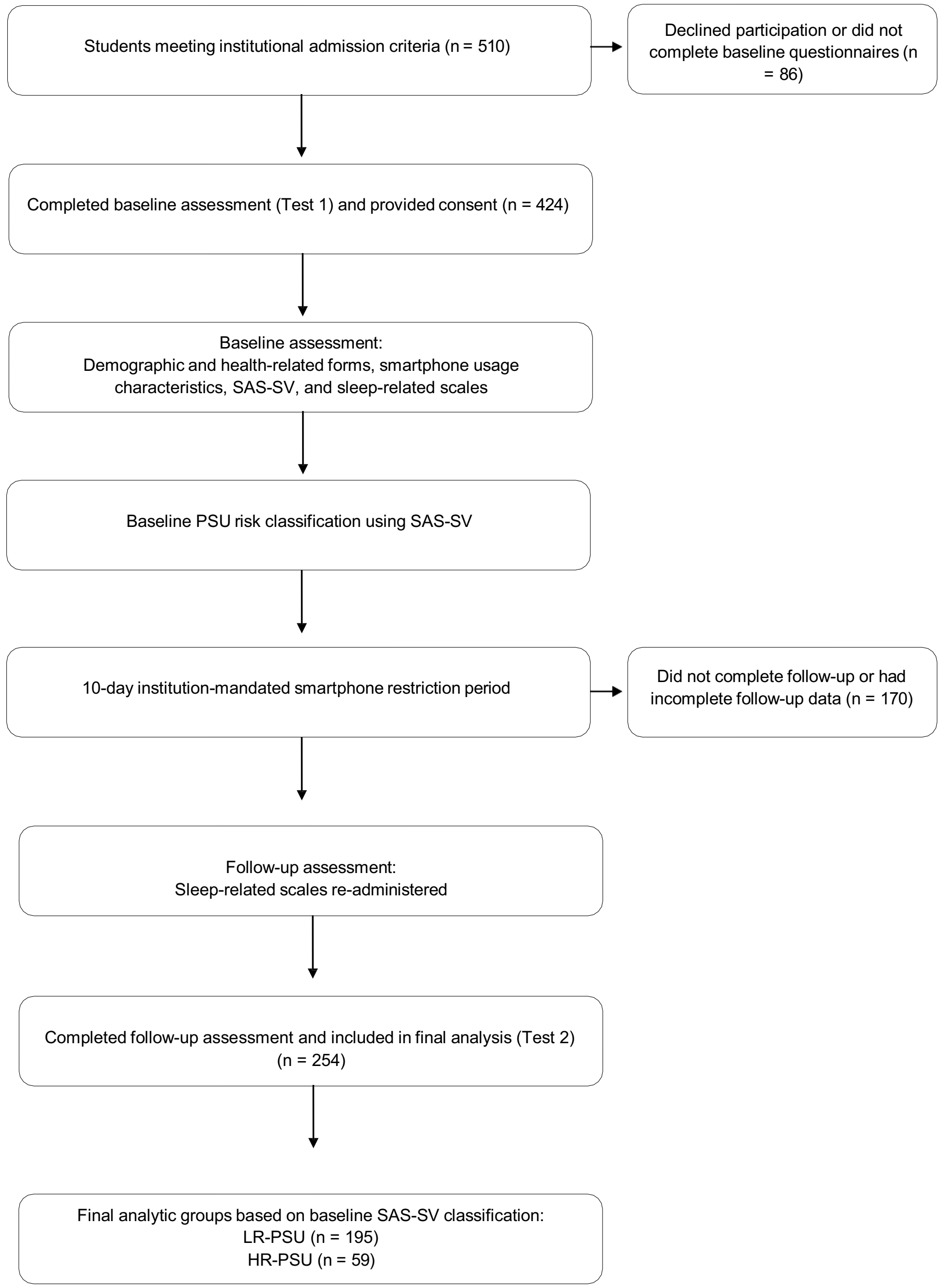

Figure 1 Study flow diagram showing participant recruitment, baseline assessment (Test 1), baseline classification of problematic smartphone use risk using the Smartphone Addiction Scale–Short Version (SAS-SV), the 10-day institution-mandated smartphone restriction period, follow-up assessment and completion, and the final analytic sample.
Abbreviations: PSU, problematic smartphone use; LR-PSU, low-risk problematic smartphone use; HR-PSU, high-risk problematic smartphone use; SAS-SV, Smartphone Addiction Scale–Short Version.

During the 10-day restriction period, participants remained within school buildings under comparable environmental conditions, including standard meal schedules, educational and physical activity routines, sleep schedules, and similar dormitory conditions (heat, light, and noise).

Additional information was collected at baseline regarding age, weight, height, smoking status and amount, exercise participation, health history, duration of smartphone ownership, total daily smartphone use time, and its temporal distribution. For analysis purposes, the 24 hours were divided into daytime (08:00–16:00), evening period (16:00–24:00), and sleep hours (00:00–08:00). In addition, participants estimated the time (in minutes) spent on various smartphone activities, including

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internet browsing, communication, social media use, gaming, entertainment, and educational purposes. During the follow-up phase, participants also confirmed that they did not use smartphones during the restriction period.

Measurements

All self-administered questionnaires were administered in Turkish. Sleep-related measures were assessed at two time points separated by a 10-day institution-mandated smartphone restriction period, whereas the SAS-SV was administered only at baseline.

Smartphone Addiction Scale-Short Version (SAS-SV)

PSU was assessed using the SAS-SV, a 10-item self-report test developed to screen for maladaptive smartphone use patterns, which was administered at the beginning of our study.[3] Although the scale's title includes the term "addiction," the instrument functions as a screening measure and does not provide a clinical diagnosis. It is a commonly used tool to screen for the risk of PSU in similar research in epidemiological and behavioral fields.

Each item was rated on a 6-point Likert scale (1 = strongly disagree to 6 = strongly agree); higher total scores indicate more problematic smartphone use. In line with previous validation studies, a cutoff score of ≥31 for males was used to classify participants as high risk for problematic smartphone use, rather than establishing a formal diagnosis[15,16] Participants who scored below this threshold were classified as low risk.

Epworth Sleepiness Scale (ESS)

This self-report scale consists of eight items that assess daytime sleepiness and the likelihood of falling asleep in various daily situations. Each item is rated from 0 (low likelihood of falling asleep) to 3 (high likelihood of falling asleep), with a total score ranging from 0 to 24; a score above 10 indicates excessive daytime sleepiness. The Turkish version of the scale has been previously validated, and Cronbach's alpha coefficients reported in the literature range from 0.73 to 0.88.[17,18]

Pittsburgh Sleep Quality Index (PSQI)

The PSQI is a 19-item self-assessment questionnaire that evaluates seven components of sleep quality over the past month. Each component is scored between 0 and 3, and the global score ranges from 0 to 21. Scores higher than 5 indicate poor sleep quality. The Turkish version of the PSQI has demonstrated acceptable validity and reliability, with reported Cronbach's alpha coefficients generally above 0.70.[19,20]

Insomnia Severity Index (ISI)

This self-report questionnaire, which assesses the severity of insomnia symptoms, consists of 7 items with responses ranging from 0 (none) to 4 (extremely severe), yielding a total score of 0 to 28. To demonstrate clinically significant insomnia symptoms, we divided our participants into two groups based on ISI threshold values: those scoring below 15 (no clinically significant insomnia symptoms) and those scoring 15 or higher (moderate to severe insomnia symptoms). The Turkish version of the ISI has also shown good psychometric properties in previous studies, with Cronbach's alpha values ranging from 0.74 to 0.90.[21]

The Sleep Hygiene Index (SHI)

The Sleep Hygiene Index is a 13-item self-report scale that assesses behavioral and environmental factors affecting sleep quality. Each item is scored from "Never" (0) to "Always" (4). The scale covers both appropriate sleep habits and behaviors related to a suitable sleep environment. An increase in the total score is associated with worse sleep hygiene. No valid threshold value has been reported for sleep hygiene problems in Turkey.[22,23]

As the study was conducted within an institutional data-collection framework, only total-scale scores were recorded, and item-level responses were not retained. Therefore, internal consistency coefficients could not be recalculated for the present sample.

Statistical Analysis

Statistical analyses were conducted using IBM SPSS Statistics version 23 and R statistical software. Demographic variables (eg, age, smoking status, exercise participation) were summarized using descriptive statistics. In contrast, study variables related to smartphone use patterns and sleep-related parameters were analyzed using inferential statistical methods. Participation was voluntary, and all individuals who met the eligibility criteria during the study period were included in the analyses.

Pilot Study and Sample Size Estimation

Before the main study, a pilot study involving 30 participants was conducted to evaluate the feasibility of the study procedures and to obtain a preliminary estimate of the expected effect size for sample size planning. Pilot data were not included in the final dataset used in the main analyses. Because of the small sample size in the pilot phase, normality was evaluated using the Shapiro–Wilk test, and exploratory between-group comparisons were performed using the Mann–Whitney *U*-test. Based on the effect size estimated from the pilot study (Cohen's d = 0.82), the minimum required sample size was calculated as 42 participants per group, corresponding to 95.4% statistical power at a 95% confidence level for comparisons between the high-risk problematic smartphone use (HR-PSU) and low-risk problematic smartphone use (LR-PSU) groups. Because pilot studies provide only approximate estimates of effect size, this value was used as a provisional parameter for sample size planning rather than a definitive estimate of the true effect size.

Assessment of Distributional Assumptions

For the main dataset (N = 254), the distribution of continuous variables was examined using the Kolmogorov–Smirnov test. Since several variables deviated from normality, nonparametric statistical methods were used when appropriate.

Descriptive Statistics and Baseline Comparisons

Participant characteristics, smartphone usage variables, and sleep-related measures were summarized using descriptive statistics. Continuous variables are presented as mean ± standard deviation and median (minimum–maximum), whereas categorical variables are reported as frequencies and percentages. Baseline differences between the HR-PSU and LR-PSU groups were evaluated using the Mann–Whitney *U*-test for continuous variables and the Pearson chi-square test for categorical variables.

Regression Analysis

To examine behavioral variables associated with PSU risk, binary logistic regression analysis was performed with SAS-SV classification (HR-PSU and LR-PSU) as the dependent variable. Smartphone usage time and participants' reported phone usage purposes were included as explanatory variables in the analysis.

ROC Curve Analysis

Receiver operating characteristic (ROC) curve analysis was performed to evaluate the ability of smartphone usage time variables to differentiate between HR-PSU and LR-PSU participants. Potential threshold values were estimated using the Youden index.

Pre–Post Analysis of Sleep Parameters

Changes in sleep-related measures during the 10-day institution-mandated smartphone restriction period were analyzed using a robust repeated-measures ANOVA based on the Q statistic. This model examined the effects of time (baseline and follow-up), group (HR-PSU and LR-PSU), and time × group interaction, and effect size measures were calculated to measure the magnitude of observed differences. For nonparametric between-group comparisons using the Mann–Whitney *U*-test, the effect size was reported as **r**. For repeated-measures analyses, effect sizes were expressed as partial eta squared (η^2). All statistical tests were two-sided, and $p < 0.05$ was considered statistically significant.

Results

The study included 254 male participants aged 18–25 years, initially divided into two groups based on baseline SAS-SV scores: LR-PSU (n = 195) and HR-PSU (n = 59). Age, body mass index (BMI), smoking status, and duration of smartphone ownership did not differ significantly between groups, and effect size estimates showed negligible group differences (Table 1).

Table 1 Comparison of Demographic Characteristics and Smartphone Use Variables According to Problematic Smartphone Use Risk (SAS-SV)

	Low-Risk PSU N:195	High-risk PSU N:59	p	ES
Age	20 (18–25)	20 (18–24)	0.927	0.011
BMI	22.6 (16.9–30.3)	22.7 (18.5–27.4)	0.860	0.022
Daily Amount of Cigarettes	0 (0–30)	0 (0–40)	0.304	0.113
Phone Ownership Period (Years)	6 (2–15)	7 (2–14)	0.482	0.088
Sleep Period (00:00–08:00, Minutes)	20 (0–300)	15 (0–215)	0.929	0.011
Daytime Period (08:00–16:00, Minutes)	60 (0–480)	70 (0–400)	0.498	0.084
Evening Period (16:00–00:00, Minutes)	100 (0–500)	120 (0–400)	**0.046**	0.251
Daily Total Usage Time (Minutes)	200 (30–780)	240 (30–800)	**0.030**	0.274

Notes: Data are presented as median (minimum–maximum). Comparisons between groups were performed using the Mann–Whitney *U*-test. ES denotes effect size (r) for Mann–Whitney U comparisons. Bold values indicate statistical significance (p < 0.05).
Abbreviations: SAS-SV, Smartphone Addiction Scale–Short Version; PSU, problematic smartphone use; BMI, body mass index.

Factors Associated with Problematic Smartphone Use Risk

When independent variables associated with the risk of PSU were examined using logistic regression, univariate models showed that longer total daily smartphone use time was associated with a higher risk of PSU (OR = 1.002; 95% CI: 1.000–1.004; p = 0.042). Regarding usage purposes, internet browsing (p = 0.022), social media use (p = 0.013), and gaming (p = 0.018) were significantly associated with the risk of PSU. Other usage purposes were not significantly associated (p > 0.050). When the parameters examined in the univariate model were simultaneously included in the multivariate logistic regression model, none remained significantly associated with the risk of PSU (p > 0.050), and this decrease may partly reflect overlap between smartphone usage time and usage purpose. The low overall explanatory power of the model (Nagelkerke R^2 = 0.033) suggests that only a small portion of the variance in PSU risk is explained by the included variables, and that PSU may also be influenced by additional behavioral and contextual factors not addressed in our analysis. The results of the logistic regression analyses are presented in Table 2.

Table 2 Logistic Regression Analysis of Factors Associated with Problematic Smartphone Use Risk

Variable	LR-PSU	HR-PSU	Univariate OR (95% CI)	*p*	Multivariate OR (95% CI)	*p*
Age (years)	19.9 ± 1.6	19.8 ± 1.4	0.97 (0.81–1.18)	0.779	0.93 (0.74–1.16)	0.526
Phone ownership period (years)	6.8 ± 2.5	7.1 ± 2.4	1.04 (0.92–1.17)	0.526	1.04 (0.90–1.20)	0.575
Daily total usage time (min)	236.9 ± 121.9	276.2 ± 143.8	1.00 (1.00–1.00)	0.042	1.02 (0.99–1.05)	0.203
Sleep period (00:00–08:00, min)	39.3 ± 53.7	38.8 ± 51.0	1.00 (0.99–1.01)	0.950	0.98 (0.95–1.01)	0.186
Daytime period (08:00–16:00, min)	85.0 ± 72.2	99.7 ± 92.6	1.00 (1.00–1.01)	0.203	0.98 (0.95–1.01)	0.222
Evening period (16:00–00:00, min)	113.9 ± 85.6	135.9 ± 87.5	1.00 (1.00–1.01)	0.090	0.98 (0.95–1.02)	0.290
Smoking						
No	124 (79.0)	33 (21.0)	Reference	—	Reference	—
Yes	71 (73.2)	26 (26.8)	1.38 (0.76–2.49)	0.290	1.39 (0.73–2.64)	0.323
Regular exercise						
No	64 (71.1)	26 (28.9)	Reference	—	Reference	—
Yes	131 (79.9)	33 (20.1)	0.62 (0.34–1.12)	0.115	0.60 (0.31–1.17)	0.131
Internet surfing						
No	48 (88.9)	6 (11.1)	Reference	—	Reference	—
Yes	147 (73.5)	53 (26.5)	2.88 (1.17–7.13)	0.022	2.27 (0.80–6.42)	0.123

(*Continued*)

Table 2 (Continued).

Variable	LR-PSU	HR-PSU	Univariate OR (95% CI)	*p*	Multivariate OR (95% CI)	*p*
Communication						
No	11 (78.6)	3 (21.4)	Reference	—	Reference	—
Yes	184 (76.7)	56 (23.3)	1.12 (0.30–4.14)	0.870	0.61 (0.14–2.69)	0.517
Listening to music						
No	53 (81.5)	12 (18.5)	Reference	—	Reference	—
Yes	142 (75.1)	47 (24.9)	1.46 (0.72–2.97)	0.293	1.09 (0.44–2.69)	0.845
Social media use						
No	51 (89.5)	6 (10.5)	Reference	—	Reference	—
Yes	144 (73.1)	53 (26.9)	3.13 (1.27–7.72)	0.013	2.49 (0.90–6.86)	0.079
Learning purposes						
No	81 (77.1)	24 (22.9)	Reference	—	Reference	—
Yes	114 (76.5)	35 (23.5)	1.04 (0.57–1.87)	0.906	0.54 (0.25–1.17)	0.117
Watching movies						
No	101 (81.5)	23 (18.5)	Reference	—	Reference	—
Yes	94 (72.3)	36 (27.7)	1.68 (0.93–3.05)	0.086	1.41 (0.62–3.24)	0.417
Playing games						
No	120 (82.2)	26 (17.8)	Reference	—	Reference	—
Yes	75 (69.4)	33 (30.6)	2.03 (1.13–3.66)	0.018	1.43 (0.69–2.94)	0.335

Notes: Data are presented as mean ± standard deviation or n (%). Odds ratios (ORs) for continuous variables represent the change in odds associated with a one-unit increase in the corresponding variable. Model fit indices: Cox & Snell R^2 = 0.022; Nagelkerke R^2 = 0.033. Problematic smartphone use risk was defined based on the Smartphone Addiction Scale–Short Version (SAS-SV) scores and does not constitute a formal clinical diagnosis.
Abbreviations: OR, odds ratio; CI, confidence interval; LR-PSU, low-risk problematic smartphone use; HR-PSU, high-risk problematic smartphone use; SAS-SV, Smartphone Addiction Scale–Short Version.

Smartphone Use Patterns and Risk Classification

Total daily smartphone use (p = 0.030) and evening smartphone use (16:00–00:00; p = 0.046) were significantly longer in the HR-PSU group compared to the LR-PSU group, but the effect sizes were small (Table 1). ROC analyses showed that a daily smartphone use threshold of ≥190 minutes had limited discriminatory ability for identifying HR-PSU (AUC = 0.593; 95% CI: 0.513–0.673). Similarly, an evening smartphone use duration of ≥100 minutes also showed limited discriminatory ability (AUC = 0.585; 95% CI: 0.502–0.668). ROC curves illustrating these findings are shown in Figure 2, and the corresponding numerical results are summarized in Table 3.

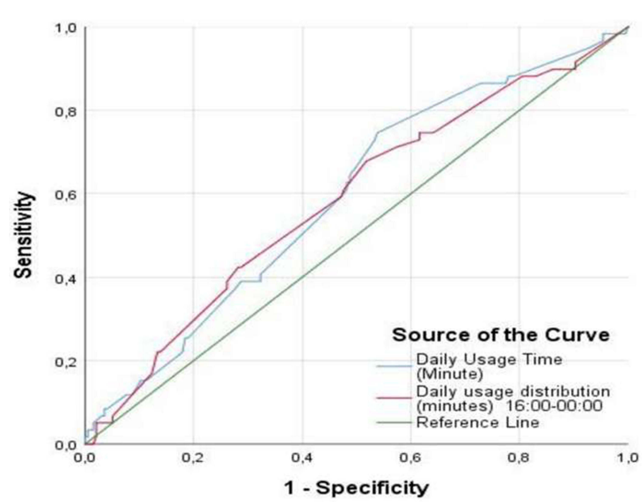

Figure 2 Receiver operating characteristic (ROC) curves showing the discriminatory performance of total daily smartphone use duration and evening period smartphone use duration (16:00–00:00) for identifying high-risk problematic smartphone use, as measured by the Smartphone Addiction Scale–Short Version (SAS-SV).

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Table 3 Cut-off Values of Smartphone Use Duration for Identifying Participants at High Risk of Problematic Smartphone Use

	Cut-off	AUC (95% CI)	p	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Daily usage time(minutes)	≥ 190	0.593 (0.531–0.673)	**0.031**	74.58%	46.15%	29.53%	85.71%
Sleep period (00:00–08:00)	-	0.496 (0.41–0.582)	0.932	-	-	-	-
Daytime period (08:00–16:00)	-	0.529 (0.439–0.619)	0.503	-	-	-	-
Evening period (16:00–00:00)	≥100	0.585 (0.502–0.668)	**0.047**	67.80%	48.21%	28.37%	83.19%

Notes: ROC analyses were performed to identify cut-off values for smartphone use duration using the Youden index. Data are presented as AUC with 95% confidence intervals. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) are reported for statistically significant cut-off points. - indicates that no statistically significant cut-off value was identified, and corresponding diagnostic performance measures were not reported. Bold values indicate statistical significance ($p < 0.05$).
Abbreviations: ROC, receiver operating characteristic; AUC, area under the curve; CI, confidence interval; PPV, positive predictive value; NPV, negative predictive value.

Sleep Parameters

Sleep-related variables were assessed at two measurement points: baseline (Test 1) and after a 10-day period during which smartphone use was institutionally restricted (Test 2).

Daytime Sleepiness (ESS)

ESS scores were higher in the HR-PSU group than in the LR-PSU group (p = 0.005), but the corresponding effect size was small (Table 4). ESS values did not change significantly over time (p = 0.347), and the time × group interaction was not statistically significant (p = 0.094).

Sleep Quality (PSQI)

At baseline, participants in the HR-PSU group showed higher PSQI scores (p = 0.001). The decrease in PSQI scores observed over time after the restriction period was significant (p = 0.001), with a small to moderate effect size (Table 4). This decrease was observed in both groups, and the magnitude of the change was comparable between HR-PSU and LR-PSU participants (Table 4 and Figure 3).

Table 4 Changes in Sleep-Related Parameters Before (Test 1) and After (Test 2) the 10-Day Smartphone Restriction Period According to Problematic Smartphone Use Risk

	Time	PSU		Total		Q	p	ES
		High Risk	Low Risk					
ESS	Test 1	5 (0–14)	3 (0–18)	4 (0–18)	Group	7.962	**0.005**	0.016
	Test 2	5 (0–22)	4 (0–15)	4 (0–22)	Time	0.885	0.347	0.002
	Total	5 (0–22)	4 (0–18)	4 (0–22)	Group*Time	2.804	0.094	0.006
PSQI	Test 1	6 (1–16)[a]	4 (0–15)[b]	5 (0–16)	Group	10.600	**0.001**	0.021
	Test 2	4 (0–11)[b]	4 (0–13)[b]	4 (0–13)	Time	10.600	**0.001**	0.021
	Total	5 (0–16)	4 (0–15)	4 (0–16)	Group*Time	10.600	**0.001**	0.021
ISI	Test 1	7 (0–19)	5 (0–25)	5 (0–25)	Group	2.360	0.125	0.005
	Test 2	4 (0–16)	4 (0–21)	4 (0–21)	Time	9.440	**0.002**	0.018
	Total	6 (0–19)	4 (0–25)	5 (0–25)	Group*Time	2.630	0.105	0.005
SHI	Test 1	20 (3–52)[a]	13 (0–44)[b]	14 (0–52)	Group	14.150	**<0.001**	0.027
	Test 2	15 (0–52)[ab]	14 (0–49)[b]	15 (0–52)	Time	3.540	0.060	0.007
	Total	18 (0–52)	14 (0–49)	14 (0–52)	Group*Time	8.370	**0.004**	0.016

Notes: Data are presented as median (minimum–maximum). Bold values indicate statistical significance ($p < 0.05$). Different superscript letters (a, b) indicate statistically significant differences between group–time combinations in post hoc pairwise comparisons; values sharing the same superscript letter are not significantly different. Q denotes the ANOVA-type statistic (ATS) obtained from rank-based robust repeated-measures analysis. ES denotes effect size (partial eta squared, η^2).
Abbreviations: LR-PSU, low-risk problematic smartphone use; HR-PSU, high-risk problematic smartphone use; ESS, Epworth Sleepiness Scale; PSQI, Pittsburgh Sleep Quality Index; ISI, Insomnia Severity Index; SHI, Sleep Hygiene Index.

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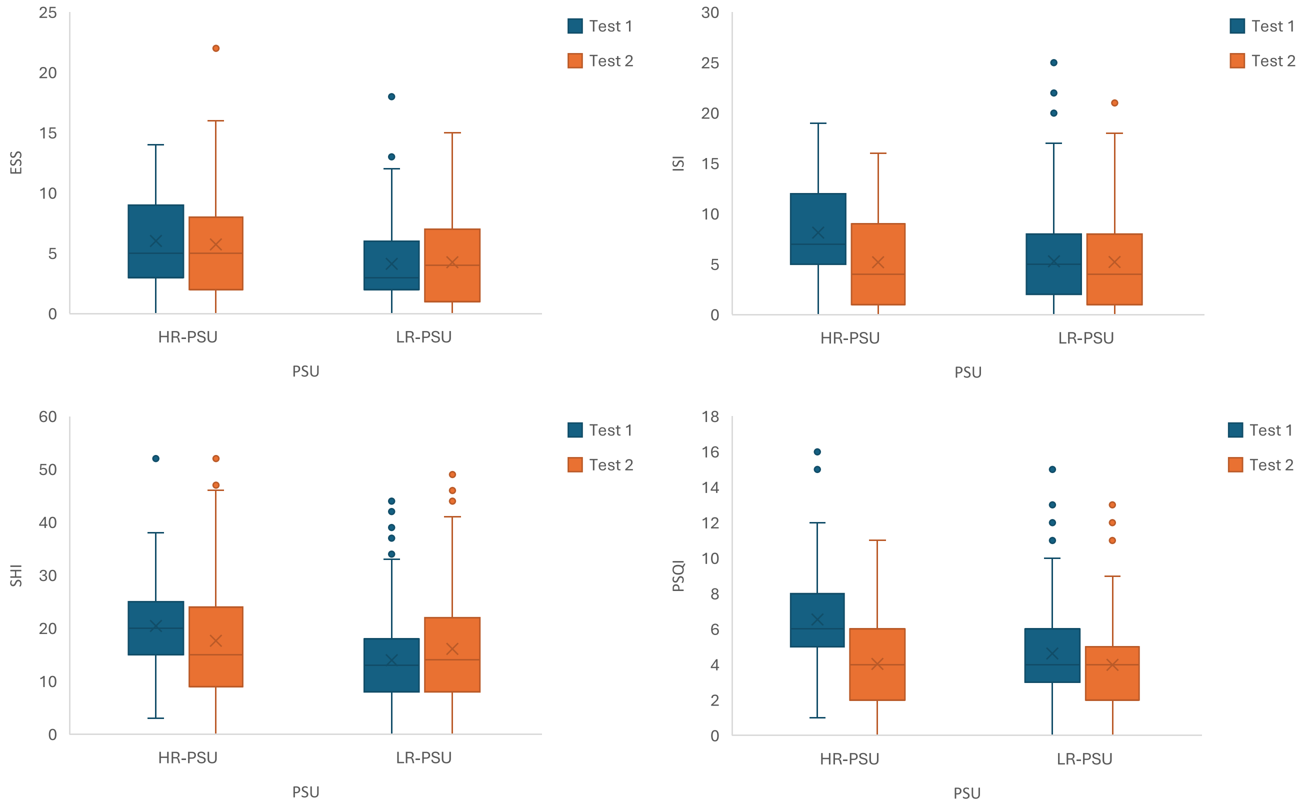

Figure 3 Changes in sleep-related parameters between baseline (Test 1) and follow-up (Test 2) after the institution-mandated smartphone restriction period in participants with low-risk problematic smartphone use (LR-PSU) and high-risk problematic smartphone use (HR-PSU). The figure displays scores for the Epworth Sleepiness Scale (ESS), the Pittsburgh Sleep Quality Index (PSQI), the Insomnia Severity Index (ISI), and the Sleep Hygiene Index (SHI). Within each parameter, blue boxes represent baseline values (Test 1) and Orange boxes represent follow-up values (Test 2) for the LR-PSU and HR-PSU groups. Boxes indicate medians and interquartile ranges, and whiskers represent minimum and maximum values. Group, time, and group × time effects were assessed using rank-based robust repeated-measures ANOVA, and the results are presented in Table 4.

Insomnia Severity (ISI)

ISI scores were comparable between groups and did not differ significantly. After the restriction period, median ISI values decreased in both HR-PSU and LR-PSU participants ($p = 0.002$). However, there was no significant interaction between time and group. The effect size of this change was small, indicating that the observed decrease in ISI scores was modest.

Sleep Hygiene (SHI)

HR-PSU participants initially had higher SHI scores, reflecting poor sleep hygiene ($p < 0.001$). While temporal change was limited during the 10-day restriction period, the time × group interaction was statistically significant ($p = 0.004$). Following the restriction period, SHI scores in the HR-PSU group approached those observed in the LR-PSU group. The effect size associated with this interaction indicated a modest behavioral change. Changes in sleep-related outcomes before and after the restriction period are shown in Figure 3.

Discussion

This prospective pre-post observational study, conducted in a homogeneous cohort of young adult males, showed a clear association between problematic smartphone use and multiple sleep-related problems. Participants at higher risk exhibited lower subjective sleep quality, less favorable sleep hygiene practices, and greater daytime sleepiness at baseline. Following a 10-day institution-mandated smartphone restriction, positive outcomes were observed in the examined sleep parameters, particularly behaviorally driven parameters such as sleep hygiene and perceived sleep quality. Minimal changes were observed in sleep parameters, with neurophysiological processes more dominant in the

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pathophysiology of insomnia severity and daytime sleepiness during this short period. A key feature of the present study is the naturalistic context in which the behavioral restriction occurred. The temporary smartphone restriction was implemented as part of institutional regulations rather than being introduced by the research team. This circumstance created a naturalistic observational context in which participants were exposed to a uniform institutional condition without investigator-imposed intervention. Because participants followed similar daily schedules and lived under comparable environmental conditions within the institution, several external factors that commonly influence sleep patterns—such as daily routines, activity schedules, and dormitory environments—were relatively consistent across the study period. This context allowed the observation of behavioral and sleep-related changes under conditions that closely reflect real-life settings.

High prevalence rates of problematic smartphone use have been reported across various populations. A recent meta-analysis estimated the global prevalence of problematic smartphone use at approximately 26.99% (95% CI: 22.73–31.73).[24] In addition to prevalence, usage intensity appears to distinguish individuals at higher risk. Dissing et al reported that average daily smartphone use among at-risk individuals approached 5 hours, and use exceeding 4 hours per day was frequently associated with poorer sleep quality.[25] In our study population, participants classified as HR-PSU reported longer total daily smartphone use, with a pronounced peak in the evening. ROC analyses showed threshold values of approximately ≥190 minutes for total daily use and ≥100 minutes for evening use; however, their discriminative performance was limited. In this respect, we believe that the values should be interpreted as indicators of intense use patterns rather than clinically significant cutoff points. The temporal profile we identified in phone use suggests that both the duration and timing of smartphone exposure—especially evening use—may reflect behavioral patterns associated with higher sleep-related disturbances. Intensive smartphone use in the evening may increase cognitive and emotional arousal through the intensity of online interaction and potentially delay sleep onset. Additionally, late-night screen exposure and light exposure have been suggested to affect circadian rhythm regulation and melatonin secretion, mechanisms previously linked to sleep disturbances.[8–10]

Research examining smartphone use among individuals with problematic use patterns has shown that many report messaging, social networking, and entertainment-focused apps as their most preferred activities. Common characteristics of these purposes include rapid feedback loops and constant social interaction, which can reinforce repeated interaction with the device.[26] In our high-risk smartphone user group, the most frequently used activities were identified as browsing the internet, using social media, and playing games; however, the precise duration of individual activities could not be determined because engagement times were based on participants' self-reported smartphone use rather than digital metrics. Nevertheless, the concentration of entertainment and social interaction-focused apps in the evening hours supports the view that both the content and timing of smartphone engagement use may contribute to vulnerability to sleep-related disturbances.

Research on the association between problematic smartphone use and sleep has increased substantially in recent years. Poor sleep quality has been one of the most consistently reported correlates, and it is commonly assessed using PSQI, which captures both quantitative features, such as sleep duration and latency, and subjective aspects of sleep quality.[13,27] In a study from India, longer smartphone use, particularly during daytime hours and shortly after waking, was associated with poorer sleep quality, and higher SAS-SV scores were linked to greater sleep disturbance and poorer daytime functioning.[28] The relationship between smartphone use and sleep-related problems is unlikely to depend on a single mechanism. Instead, several behavioral and biological pathways have been proposed, including increased light exposure at biologically inappropriate times, delayed behavioral preparation for sleep, altered melatonin-related regulation, changes in brain activity, and physical discomfort associated with prolonged device use.[8–10] Although these mechanisms remain speculative, they may help explain why higher PSU risk was associated with poorer sleep-related outcomes in our sample.

Subjective sleep quality differed between PSU risk groups at baseline, with the HR-PSU group showing less favorable PSQI scores than the LR-PSU group. After the 10-day restriction period, both groups showed lower PSQI values than at baseline. This shared downward shift suggests that reduced smartphone exposure during the institutional restriction period was associated with improved perceived sleep quality at the cohort level, even though the absolute decrease was greater in the high-risk group. Because the study design was observational, these findings cannot establish a causal relationship. However, the findings are compatible with the possibility that the timing and intensity of smartphone use are related to subjective sleep quality.

Excessive daytime sleepiness (EDS), typically assessed with the ESS, refers to daytime drowsiness and its resulting impairment in daily functioning. Sathe et al reported a strong association between PSU and poor sleep quality and EDS in university students. At the same time, Kadian et al showed that intensive pre-sleep smartphone use was associated with higher ESS scores, possibly due to delayed sleep onset and disruption of deep sleep stages.[29,30] In the present study, however, ESS scores did not show a significant change after the short-term smartphone restriction period. This finding may indicate that daytime sleepiness is influenced by more stable physiological sleep–wake regulatory processes and therefore may be less responsive to short-term behavioral modifications.

Problematic patterns of smartphone use have been discussed as a potential contributor to insomnia-related complaints in recent literature. Daraj et al (2023), for instance, described a significant relationship between nomophobia and insomnia severity, emphasizing the broader link between smartphone-related behavioral patterns and disturbed sleep.[12] In the current sample, however, insomnia severity at the beginning of the study did not differ between participants categorized as high-risk and low-risk for problematic smartphone use. Following the 10-day smartphone restriction period, ISI scores decreased in both groups; however, no significant difference in the magnitude of change was observed between PSU risk categories. This pattern may indicate that short-term reductions in smartphone exposure are accompanied by a general improvement in insomnia symptoms rather than a change specifically related to PSU risk status. One possible interpretation is that the institutional environment and the temporary reduction in evening device use may have lowered pre-sleep cognitive stimulation across the entire cohort, contributing to modest improvements in sleep initiation or perceived sleep duration. Nevertheless, because the restriction period was relatively short and the study design was observational, this interpretation should be considered with caution.

Initially, SHI was administered to our participants to assess sleep hygiene, and significant differences in sleep hygiene were observed between our groups. The high-risk smartphone user (HR-PSU) group showed higher SHI scores and worse sleep hygiene practices than the low-risk smartphone user (LR-PSU) group. After the smartphone restriction period, SHI scores in the HR-PSU group decreased, approaching those of participants in the LR-PSU group; this suggests a short-term behavioral adjustment following reduced smartphone exposure. This change we observed is consistent with previous research reporting a correlation between prolonged smartphone use and worsening sleep hygiene behaviors.[31] A possible explanation for this relationship is that reducing smartphone use, especially in the evening hours, may reduce interaction with stimulating activities before bedtime and facilitate healthier pre-sleep routines. These results highlight the importance of addressing sleep hygiene when evaluating the sleep-related consequences of PSU.

The findings of this study indicate that PSU, particularly during the evening period (16:00–00:00), is more closely associated with behaviorally driven sleep parameters such as sleep hygiene and subjective sleep quality. The pattern observed after the 10-day restriction suggests that the timing and intensity of smartphone engagement may play an important role in sleep-related complaints, although these observations should not be interpreted as evidence of a direct causal relationship. While sleep hygiene and PSQI scores showed measurable changes over the short observation period, insomnia severity and daytime sleepiness did not demonstrate comparable group-specific differences. This contrast may reflect the distinction between modifiable behavioral sleep routines and more stable physiological sleep–wake regulatory processes.Further research with longer follow-up and controlled designs is needed to clarify the durability and mechanisms of these associations.

Limitations

Several limitations must be considered when interpreting the findings of this study. First, the initial study was conducted at a police college with only male students enrolled. This resulted in a sample composed solely of young adult males, limiting the generalizability of the results to female or mixed populations. Furthermore, this reflects the study's institutional structure.

Second, all measurements relied on self-report questionnaires, which can lead to recall bias and potential inaccuracies in reporting, and digital measurement methods were not used. Moreover, the data collection format involved aggregate scale scores rather than item-level responses; therefore, internal consistency indices such as Cronbach's alpha could not be recalculated for the current sample. Instead, the psychometric properties of the instruments are based on previously validated versions reported in the literature.

Third, although participants were exposed to similar environmental conditions during the restriction period, other behavioral or psychological variables that could affect sleep (eg, stress levels, adaptation to institutional routines, or individual coping strategies) were not systematically measured during follow-up.

The relatively brief duration of the restriction period is another important limitation. A 10-day observation window may be adequate for detecting short-term changes in behaviorally influenced sleep measures, but it is less likely to capture slower physiological adaptations, especially those related to insomnia severity and daytime sleepiness. Moreover, adherence to smartphone restriction was confirmed by self-report rather than objective digital monitoring. Studies with longer follow-up, objective verification of device use, and more diverse samples will be necessary to determine whether these patterns are reproducible and sustained over time.

Conclusion

Our study, conducted in a cohort of young adult males living under similar institutional conditions, investigated the relationship between problematic and daily smartphone use patterns and sleep-related problems. Individuals classified as having a higher risk of problematic smartphone use were observed to use their smartphones for longer periods, particularly in the evenings. After temporary restrictions on smartphone access were imposed, improvements were observed in sleep-related behaviors, particularly sleep hygiene and perceived sleep quality, while parameters reflecting the severity of insomnia and daytime sleepiness remained largely unchanged during the short observation period. Given our results, we suggest that the behavioral components of sleep may respond more quickly during this short phone-free period, while sleep outcomes dependent on more stable physiological regulation may require longer-term behavioral changes. In clinical practice, we believe that limiting intensive smartphone use in the evenings could be a potential target when addressing sleep complaints in young adults. Future research involving longer observation periods, objective measures of smartphone use, and more heterogeneous study populations will be important to clarify the long-term significance of the relationship between PSU and sleep.

Abbreviations

PSU, Problematic smartphone use; SAS-SV, Smartphone Addiction Scale – Short Version; ESS, Epworth Sleepiness Scale; PSQI, Pittsburgh Sleep Quality Index; ISI, Insomnia Severity Index; SHI, Sleep Hygiene Index; BMI, Body Mass Index; EDS, Excessive daytime sleepiness; ROC, Receiver operating characteristic.

Data Sharing Statement

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics Approval and Informed Consent

Ethical approval for the study was obtained from the Kastamonu University Clinical Research Ethics Committee (approval number: 2024-KAEK-118). The study was conducted in accordance with the principles of the Declaration of Helsinki. Written informed consent was obtained from all participants prior to their participation in the study. Individuals who did not provide consent were excluded from the study.

Author Contributions

All authors made a significant contribution to the work reported, whether in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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The authors report no conflicts of interest in this work.

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