JOURNAL OF MECHANICS OF CONTINUA AND MATHEMATICAL SCIENCES
www.journalimcms.org

ISSN (Online) : 2454 -7190 Vol.-21, No.-10, October (2026) pp 102-119 ISSN (Print) 0973-8975

PREDICTIVE MODELLING OF DIGITAL NOCTURNALITY ON SLEEP HYGIENE, COGNITIVE FUNCTIONS AND PHYSIOLOGICAL WELL BEING

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https://doi.org/10.26782/jmcms.2026.10.00008

(Received: July 11, 2026; Revised: September 18, 2026; Accepted: October 03, 2026

Abstract

Over the past few decades, the night-time use of digital devices has increased significantly among the young adult population While most of the existing studies examine only sleep outcomes associated with night-time digital use. This study aims to investigate three interconnected domains --sleeping habits, cognitive function, and physiological well-being within a single framework, providing a holistic understanding of digital nocturnality among young adults.

The study was conducted among 180 young adults aged 20–39 years residing in semi-urban areas of Bhubaneswar, Odisha. Participants were selected using simple random sampling. Data were collected using validated tools, including the Sleep Hygiene Index (SHI), Karolinska Sleepiness Scale (KSS), Stroop Test, and Digital Wellbeing/App Tracker. Descriptive statistics and correlation analysis were used for data interpretation.

Findings revealed that about half of the participants spent 1-2 hours of night-time digital activity (49.44%). Based on the Spearman correlation test, there was a significant positive relationship between night-time digital activity and physiological sleepiness ($\rho=0.215$, $p=0.0037$) and a moderate positive relationship with poor sleep hygiene ($\rho=0.504$, $p<0.001$). No significant relationship existed between night-time digital activity and cognitive wellbeing ($\rho=-0.051$, $p=0.494$).

Nighttime digital engagement was significantly associated with sleep habits and physiological well-being of young adults. Results of this study have highlighted the potential adverse effects of digital nocturnality.

Keywords: Digital nocturnality, night-time screen exposure, sleep quality, cognitive function, sleep hygiene, physiological well-being, young adults.

I. Introduction

One of the important health issues facing modern societies, which is of concern in the context of public health, is digital nocturnality due to its high prevalence and multi-faceted effects on the health of young adults. According to data from American Academy of Sleep Medicine (AASM), late-night "doom scrolling " and screen usage directly compromise sleep quality, with 38% of adults reporting worse sleep and 26% sacrificing sleep for screens. Furthermore, 91% of adults report losing sleep due to binge-watching, with 87% of Americans keeping smartphones in the bedroom. Transition to adult age is associated with a lot of autonomy regarding one's schedule and the emergence of academic or work-related demands that make people prone to digital night-time engagement [I, II] Data gathered by YouGov and Amazon reveals that **over 50% of Indian adults** experience chronic sleep-related issues driven by inconsistent bedtime routines and screen-based sleep procrastination. [I] According to the data from Indian medical journals show that **83.5% of surveyed young professionals and students** engage in bedtime screen use, with smartphones being the primary device for **91.2%**. Overuse of digital screens is often associated with delayed onset of sleep, reduction in the amount of sleep obtained per night, decreased sleep quality, and disrupted sleep rhythm [III]. Importantly, problematic usage of smartphones or social media that involves constant use during night-time and reluctance to put them down is strongly associated with the symptoms of insomnia [IV, VI]

In India, young people spend 4-6 hours of their time each day with digital devices, with most of it occurring with the help of smartphones (7). There are multiple mechanisms contributing to these problems; namely, device usage can take the place of sleeping, increase arousal (such as through worry and fear of missing something), as well as exposure to blue light that inhibits melatonin production, leading to sleep disruption [VIII, IX, X]

However, the negative effects do not stop there. Multiple studies showed that excessive nocturnal screen usage can lead to decreased executive functions [XI] impaired working memory [XII], higher impulsivity [XIII], depression and anxiety [XIV], as well as various metabolic and mood disorders, which are caused by disrupted circadian rhythm [X, XV].

Today, digital technology forms an inseparable part of people's everyday existence, specifically young adults. Smartphones, tablets, social networking, gaming online, and video streaming have redefined the way humans communicate, acquire knowledge, earn their livelihoods, and spend their leisure time. A notable effect of the modern technology revolution has been increased exposure to digital media during nighttime. Digital nocturnality refers to the increased exposure to digital media in late-night hours and just before going to bed. With increasing internet connectivity and developments in digital technology, young adults have been found spending a significant amount of time on their mobile phones and other digital gadgets browsing social media sites, playing games, sending messages to friends, and indulging in other online activities.

The fast pace of development in digital technology has completely transformed the ways in which people spend their time and nighttime among young adults across the

globe. A new trend of engaging in digital media in late-night hours till the time one goes to sleep has come to be known as "digital nocturnality," meaning prolonged exposure to digital media just before sleeping during the night. In other words, digital technology allows for merging nighttime and daytime. There are many studies indicating that using digital media during nighttime and before sleeping can have negative effects on young adult sleep and cognition [I, II]

Exposure to digital media devices during nighttime may cause interference with the biological clock of an organism due to several factors. The blue light from the screen on smartphones, tablets, and computers interferes with the melatonin levels in the body, a hormone responsible for regulating the sleep-wake process and initiating the process of falling asleep. Apart from this, engaging in activities such as chatting, playing games, and watching videos online might increase the arousal levels and cause a delay in sleep onset. Hence, young adults are often unable to fall asleep easily, have shorter periods of sleep, and experience sleep fragmentation.

Numerous cross-sectional studies and systematic reviews show that using digital media at night correlates with delayed bedtimes, shortened duration of sleep, poor sleep quality, excessive daytime sleepiness, disruption in sleep-wake cycle [I, III, IV]. This correlation is especially evident when considering the use of smartphones and problematic media habits [V, VI]. Using digital devices at nighttime is associated with increased anxiety, as well as poor psychological well-being of young people. In addition to that, people who spend a lot of time online before sleeping feel drowsy during the day and have difficulties concentrating.

Aside from affecting the quality of sleep, digital nocturnality could also have negative effects on the ability of an individual to perform his or her cognitive tasks, including attending, remembering, learning, problem-solving, and decision making. The sleep disruption resulting from engaging too much in digital activities at night could disrupt one’s ability to process information and be productive during the day. Additionally, engaging for long periods in screen time could be associated with various physical symptoms, such as strained eyes, headaches, feeling tired, and low physical activity levels. As more young adults depend on technology, it has become important to understand the effects of digital nocturnality in terms of their sleep behaviors, cognitive performance, and physiological health.

II. Need for the study

While there are many scientific publications on negative effects of digital nocturnality amongst youth around the world, several aspects deserve additional attention.

Firstly, despite the wealth of data on this issue, the available literature comprises mainly observational research. For further understanding of the interrelation between digital nocturnality and health risks, longitudinal research involving objective measurements should be conducted. Most currently published findings are based on subjective self-reports by respondents on their sleep schedule and usage of electronic gadgets. Longitudinal studies that will consider the objective measures – including digital activity measurements and physiologic parameters of subjects' sleep and general state – will be much more credible in establishing causation links.

Another important aspect that requires further research is that while certain trends of late-night gadget activity of young people can be established in Western countries, insufficient information exists about this issue in other parts of the globe, especially in developing countries like India and even individual states of India, due to peculiarities of sociocultural life in these countries. Differences in educational load, family structure, lifestyle, access to internet, and attitude towards gadgets and technologies could influence the results significantly.

Moreover, scientific literature on the topic at hand largely focuses on the effects associated with physical well-being and neglects the possibilities of any adverse implications connected with poor cognitive functioning, learning outcomes, emotional health, and other aspects of physiological well-being. Lastly, only a few studies examine possible intervention programs that aim to minimize such risky behaviors and encourage healthy habits concerning the use of technology in the nighttime.

In light of these challenges and the increasing prevalence of smartphone addiction among young Indian adults, the importance of conducting in-depth research concerning not only the prevalence rates of nocturnal digital activities but also the mechanisms behind sleep disturbances, poor cognitive functioning, and physiological issues cannot be overstated.

III. Problem Statement

A study to assess the impact of night-time digital engagement on sleeping habits, cognitive function, and physiological well-being among young adults in selected semi-urban areas of Bhubaneswar, Odisha.

Objectives

- To assess the relationship between night-time digital engagement and sleeping habits among young adults.
- To assess the relationship between night-time digital engagement and Cognitive function among young adults.
- To assess the relationship between night-time digital engagement and Physiological Well Being among young adults.

Research Gap

Most available studies focus on isolated components such as screen time, sleep quality, or mental health separately. There is limited integrated research examining the combined influence of digital nocturnality on sleeping habits, cognitive function, and physiological well-being among young adults in community settings.

IV. Methodology

- **Research Approach:** Quantitative research approach.
- **Research Design:** Analytical cross-sectional study with correlational and comparative components.

Study Setting:

The study was conducted in selected semi-urban community areas of Bhubaneswar, Odisha. Data collection was carried out in community settings to reflect real-life digital engagement patterns and sleeping behaviors.

Study Population:

Young adults aged who routinely engage in academic or work-related digital activities during night-time hours.

Inclusion Criteria:

i. Young adults aged 18–39 years.
ii. Individuals engaging in night-time digital activities.
iii. Users of smartphones, tablets, or laptops during late-night hours.
iv. Individuals willing to participate and provide informed consent.

Exclusion Criteria:

- Individuals diagnosed with sleep disorders such as insomnia or sleep apnea.
- Individuals undergoing treatment for major psychiatric illness.
- Individuals using sedatives, stimulants, or sleep medications.
- Shift workers.

Sample Size:

- The sample size for the study was 180 participants.

Sampling Technique:

- Simple random sampling technique.

Data Collection Tools

A. Sociodemographic Questionnaire

- A self-structured questionnaire was used to collect baseline information regarding age, gender, educational status, residence, and digital device ownership.
- The questionnaire also included items related to patterns of night-time digital use, such as duration of screen time and device usage habits.
- Responses were coded numerically for statistical analysis and summarized using descriptive statistics.

B. Sleep Hygiene Index (SHI)

- The Sleep Hygiene Index (SHI) was used to assess sleep hygiene practices among participants.
- The tool consists of 13 items scored on a 5-point Likert scale ranging from **0 (Never) to 4 (Always)**.
- Total scores range from **0 to 52**, with higher scores indicating poorer sleep hygiene practices;

SHI INDEX SCORES	INTERPRETATION
<=26	Good
27-34	Average
>=35	Poor

C. Karolinska Sleepiness Scale (KSS)

- The Karolinska Sleepiness Scale (KSS) was used to assess subjective physiological sleepiness and alertness.
- The scale consists of a single item rated from **1 to 9**, where **1 = Extremely Alert** and **9 = Very Sleepy, Fighting Sleep**.
- Higher scores indicate greater physiological sleepiness and reduced alertness.

Score	Description
1	Extremely alert
2	Very alert
3	Alert
4	Rather alert
5	Neither alert nor sleepy
6	Some signs of sleepiness
7	Sleepy but no effort needed to remain awake
8	Sleepy, some effort to stay awake
9	Very sleepy, fighting sleep

D. Stroop Test

- The Stroop Test was used to assess cognitive functioning, including attention, cognitive flexibility, processing speed, and inhibitory control.
- Participants were instructed to **identify the ink colour of colour words while ignoring the written text.**
- Performance was scored based on response accuracy and completion time, with higher interference effects indicating poorer cognitive functioning.

TRIAL No.	COLOUR CODE	CORRECT ANSWER (YES/NO)
1	RED	
2	BLUE	
3	GREEN	
4	YELLOW	
5	BLACK	

E. Digital Wellbeing and App Tracker

- Digital Wellbeing and App Tracker were used to objectively monitor participants' smartphone usage patterns.

- Data regarding daily screen time, application usage, and night-time digital activity were obtained directly from the smartphone dashboard.
- Night-time digital activity was recorded in hours and categorized for analysis as **<1 hour, 1–2 hours, 2–3 hours, 3–4 hours, and >4 hours**.

Scoring Interpretation

- **SHI:** Higher score = Poorer sleep hygiene.
- **KSS:** Higher score = Greater physiological sleepiness.
- **Stroop Test:** Higher interference/longer response time = Poorer cognitive functioning.
- **Digital Wellbeing:** Higher night-time screen time = Greater digital engagement during nocturnal hours.

$$SHI_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \epsilon_i$$

Where:

- SHI_i = Sleep Hygiene Index score for participant i.
- X_1 = night-time digital usage.
- X_2 = age.
- X_3 = gender, appropriately coded.
- X_4 = average daily screen time.
- $\beta_0, \beta_1, \ldots\ldots, \beta_4$ = regression coefficients.
- ϵ_i = residual error.

V. Data Collection Procedure

Before conducting the research, ethical approval was taken from the Institutional Ethics Committee (IEC). Participants were recruited through a community-based approach in selected semi-urban areas of Bhubaneswar. Door-to-door visits were conducted to identify eligible participants. Individuals who met the inclusion criteria were informed about the purpose of the study, and written informed consent was obtained.

Data was collected using a structured interview schedule which, included the Sleep Hygiene Index (SHI), Karolinska Sleepiness Scale (KSS), Stroop Test, and Digital Wellbeing/App Tracker. The questions were asked by the interviewer in language which was understood by the participants.

Section 1 included sociodemographic data, for which the interviewer directly asked questions like respondent's age, gender, level of education, average digital engagement daily and specifically during night time. Some of these questions were multiple choice type questions. Responses were recorded on the schedule at the same time.

Section 2 consisted the Sleep Hygiene Index (SHI), for this section interviewer cited 13 statements related to sleeping habits and participants were asked to indicate the frequency of each behaviour on a 5-point Likert scale ranging from Never (0) to Always (4). The total score was calculated by summing all item scores.

For Section 3, Stroop test was conducted in the following steps:

Step 1: Participants were seated comfortably and provided with standardized instructions regarding the Stroop Colour Test.
Step 2: A series of colour words printed in incongruent font colours were displayed individually on a tablet screen.
Step 3: Participants were instructed to identify and verbally state the font colour of each word rather than reading the written word itself.
Step 4: Each stimulus was presented for approximately 3 seconds, and responses were recorded as correct (Yes) or incorrect (No).

In Section 4, Karolinska Sleepiness Scale (KSS) was used for data collection through the following steps

Step 1: Participants were informed about the purpose of the Karolinska Sleepiness Scale (KSS) and instructed on how to rate their current level of sleepiness.
Step 2: The KSS question, "How sleepy do you feel right now?", along with the 9-point rating scale, was displayed to participants.
Step 3: Participants selected the score that best represented their level of alertness or sleepiness during the past 5 minutes.
Step 4: Responses were recorded on a scale ranging from 1 (Extremely alert) to 9 (Very sleepy, fighting sleep).
Step 5: The selected score was used to assess the participant's subjective physiological sleepiness, with higher scores indicating greater levels of sleepiness.
Section 5: Data regarding screen time and digital engagement patterns were obtained in Section 5 through Digital Wellbeing/App Tracker applications from their mobile.

Steps for Accessing Digital Wellbeing and App Tracker

A. Access Device Settings
- Open the **Settings** application on the smartphone.
- Navigate to **Digital Wellbeing & Parental Controls**.

B. Open Screen Time Dashboard
- Select **Dashboard** to view screen-time statistics.
- Review daily and weekly device usage reports.

C. Record Night-Time Digital Activity
- Identify screen usage during night-time hours.
- Record total duration of night-time digital activity.

D. Monitor Application Usage
- Review the time spent on different applications.
- Record frequently used applications and usage duration.

E. Verify and Document Data

I. Cross-check usage statistics with Digital Wellbeing records.
II. Document the findings in the data collection proforma for analysis.

Data Analysis Plan

- Data analysis was performed using descriptive and inferential statistical methods.

Descriptive Statistics

- Frequency and percentage.
- Mean and standard deviation.

Inferential Statistics

- Spearman correlation.
- Multiple regression analysis.
- Comparative analysis between high and low digital nocturnality groups.

VI. Statistical Calculations and Mathematical Model

A. Percentage of night-time digital users

$$Percentage = \frac{89}{180} \times 100$$

$$= 49.44\%$$

B. Mean and standard deviation for KSS

Using the KSS frequency table, the weighted mean is

$$\bar{x} = \frac{\sum f_i x_i}{N} = \frac{508}{180}$$

$$= 2.82$$

The level of significance was set at $p < 0.05$.

Ethical Considerations

- Ethical clearance was obtained from the Institutional Ethics Committee.
- Written informed consent was obtained from all participants.
- Participation in the study was voluntary.
- Participants had the right to withdraw at any stage without penalty.
- Confidentiality and anonymity of participant data were strictly maintained.
- No invasive procedures were involved in the study.
- Data was used only for academic and research purposes.
- Participants received health education regarding sleep hygiene after completion of data collection.

Expected Outcomes

The study is expected to reveal that excessive night-time digital engagement affects sleep quality, cognitive functioning, and physiological well-being among young adults. Increased screen exposure before bedtime may be associated with delayed sleep onset, poor sleep efficiency, increased daytime sleepiness, reduced attention span, and higher fatigue levels.

The findings may help healthcare professionals, educators, and policymakers develop awareness programs and interventions promoting healthy digital behavior and sleep hygiene practices.

VI. Results

Demographic Data

Table 1:

Among the 180 participants, more than half (**52.22%**) were aged **20–25 years**, followed by those aged **25–30 years (24.44%)**. The study population comprised **45.00% males**, **42.78% females**, and **12.22% participants of other genders**. Most participants were pursuing **undergraduate education (63.33%)** and resided in **urban areas (80.00%)**. Regarding digital usage patterns, the highest proportion of participants reported an average daily digital use of **7 hours (18.89%)**, followed by **6 hours (15.56%)**. Nearly half of the participants (**49.44%**) engaged in **1–2 hours of night-time digital use**, while **25.00%** reported **2–3 hours** of night-time digital engagement.

Figure 1:

The figure illustrates the distribution of night-time digital use among the participants. Nearly half of the participants (**49%**) reported engaging in **1–2 hours** of night-time digital activity, representing the largest proportion. This was followed by **25%** of participants who used digital devices for **2–3 hours** during the night. A smaller proportion reported using digital devices for **less than 1 hour (15%)**, while only **11%** of participants engaged in **more than 3 hours** of night-time digital use. These findings indicate that moderate night-time digital engagement (1–2 hours) was the most common pattern among the study participants.

Table 1: Socio demographic Data of Participants

OCIO DEMOGRAPHIC VARIABLES			
	Category	**Frequency**	**Percentages**
Age (in years)	18-20	5	2.78
	20-25	94	52.22
	25-30	44	24.44
	30-35	23	12.78
	35-39	14	7.78
Gender			
	Male	81	45.00
	Female	77	42.78
	Others	22	12.22
Education			
	UG	114	63.33
	PG	55	30.56
	Others	11	6.11
Residence Type			
	Urban	144	80.00
	Semi Urban	26	14.44
	Rural	10	5.56
Average Digital Use			
	0	2	1.11
	1	3	1.67
	2	6	3.33
	3	14	7.78
	4	19	10.56
	5	19	10.56
	6	28	15.56
	7	34	18.89
	8	23	12.78
	9	12	6.67
	10	8	4.44
	11	4	2.22
	12	4	2.22
	13	2	1.11
	14	0	0.00
	15	0	0.00
	16	0	0.00

	17	0	0.00
	18	2	1.11

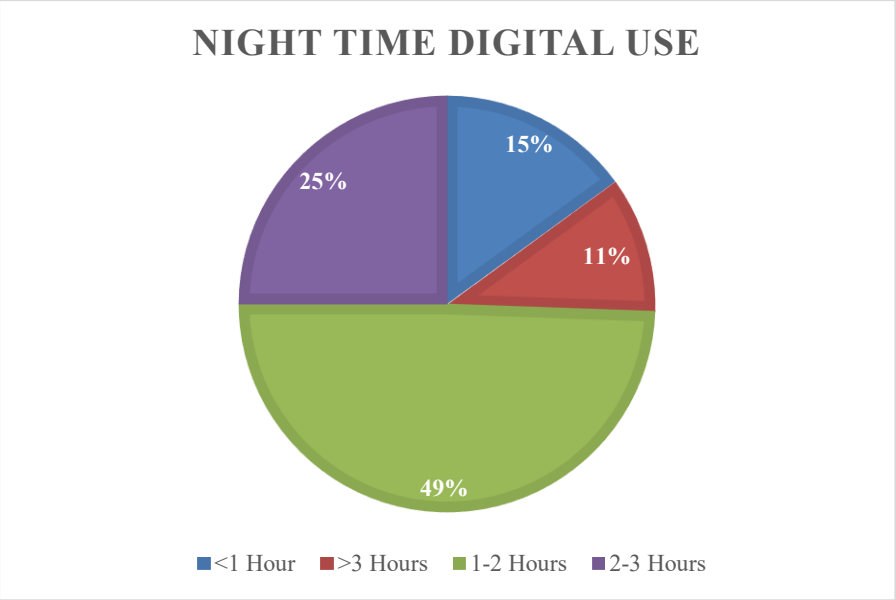


Fig. 1. On digital use during night time

Table 2:

The table depicts the distribution of participants according to their Sleep Hygiene Index (SHI) scores. The majority of participants (**84%**, *n* = 152) demonstrated **good sleep hygiene practices** with SHI scores of **≤26**. A smaller proportion (**14%**, *n* = 26) exhibited **average sleep hygiene** with scores ranging from **27 to 34**, while only **1%** (*n* = 2) had **poor sleep hygiene practices**, with SHI scores of **≥35**. These findings indicate that most participants maintained relatively good sleep hygiene behaviours, whereas poor sleep hygiene was observed in only a small fraction of the study population.

Table : 2 Distribution of participants according to Sleep Hygiene Index

SHI Index Scores	Interpretation	Frequency	Percentage
<=26	Good	152	84%
27-34	Average	26	14%
>=35	Poor	2	1%

Figure 2:

The figure depicts the distribution of participants according to their Stroop Test scores. Nearly half of the participants (**45.56%**) obtained a score of **3**, representing the largest proportion, followed closely by **42.78%** who scored **4**. A smaller percentage of participants scored **2 (10.56%)**, while only **1.11%** obtained a score of **1**. These findings indicate that the majority of participants demonstrated moderate to high levels of cognitive functioning, as reflected by their performance on the Stroop Test.

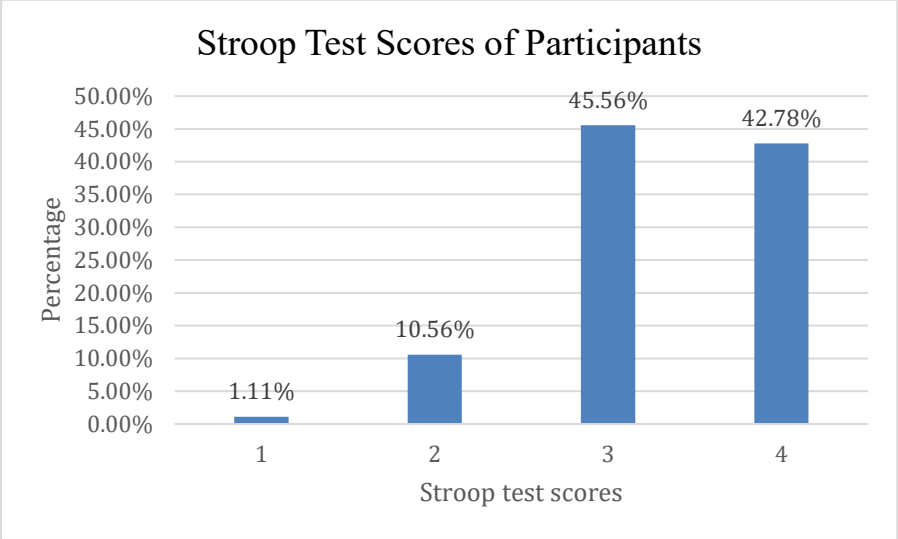


Fig. 2. Distribution of participants according to their Stroop Test scores

Table 3:

The table presents the distribution of participants according to their Karolinska Sleepiness Scale (KSS) scores. The majority of participants were categorized as **Alert (34.44%)**, followed by **Very Alert (25.56%)** and **Extremely Alert (17.22%)**. A smaller proportion of participants were classified as **Rather Alert (11.11%)** and **Neither Alert nor Sleepy (7.22%)**. Only a few participants exhibited signs of sleepiness, with **2.22%** reporting some signs of sleepiness and **1.11%** each reporting mild and moderate sleepiness. No participants were classified as **Very Sleepy, Fighting Sleep (0%)**. These findings indicate that most participants maintained a satisfactory level of physiological alertness.

Table 3: Distribution of participants according to Karolinska Sleepiness Scale

KSS Scores	Attributes	Count	Percentage
1	Extremely Alert	31	**17.22%**
2	Very Alert	46	**25.56%**
3	Alert	62	**34.44%**

4	Rather Alert	20	**11.11%**
5	Neither Alert nor Sleepy	13	**7.22%**
6	Some Signs of Sleepiness	4	**2.22%**
7	Sleepy but no effort needed to remain awake	2	**1.11%**
8	Sleepy, some effort to stay awake	2	**1.11%**
9	Very Sleepy, Fighting sleep	0	**0.00%**

The relationship between night-time digital use and sleep hygiene status. Were identified where Participants with **less than 30 minutes** of night-time digital use demonstrated **100% good sleep hygiene**. As the duration of night-time digital use increased, the proportion of participants with good sleep hygiene gradually declined from **86.21%** in the **30–60 minutes** group to **60%** among those using digital devices for **more than 2 hours**. Conversely, the proportion of participants with average sleep hygiene increased, reaching **40%** in the **>2 hours** category. Poor sleep hygiene was observed only among participants with **30–60 minutes** of night-time digital use (**3.45%**). Overall, increased night-time digital use was associated with poorer sleep hygiene outcomes.

The relationship between night-time digital use and Stroop Test scores among participants found that Lower Stroop scores (Scores 1 and 2) were observed in very few participants across all categories of night-time digital use. Participants with **less than 30 minutes** of night-time digital use demonstrated the highest proportion of **Stroop Test Score 4 (65.71%)**, whereas those with **more than 2 hours** of night-time digital use exhibited the highest proportion of **Stroop Test Score 5 (61.90%)**. The proportion of participants with **Stroop Test Score 3** remained relatively low across all categories. Overall, the distribution of Stroop Test scores varied across different levels of night-time digital use, suggesting a potential association between nocturnal digital engagement and cognitive functioning.

The relationship between night-time digital use and physiological alertness as measured by the Karolinska Sleepiness Scale (KSS) where Participants with **less than 30 minutes** of night-time digital use demonstrated the highest proportions of **extremely alert (34.29%)** and **very alert (25.71%)** states. In contrast, participants with **more than 2 hours** of night-time digital use were predominantly categorized as **alert (80.00%)** and **rather alert (20.00%)**. The proportion of participants classified as **very alert** decreased with increasing duration of night-time digital use, while the distribution shifted toward lower levels of physiological alertness. Overall, the findings suggest that prolonged night-time digital engagement may be associated with reduced physiological alertness among young adults.

Table 5. Descriptive Statistics of the Study Variables (N = 180)

Variable	Mean (M)	Standard Deviation (SD)
Sleep Hygiene Index (SHI)	18.55	7.90
Karolinska Sleepiness Scale (KSS)	2.82	1.41
Stroop Test Total Score	4.30	0.70

The descriptive statistics of the study variables as presented in **Table 5**. The participants had a mean Sleep Hygiene Index (SHI) score of **18.55 ± 7.90**, indicating that, on average, sleep hygiene was within the good range. The mean Karolinska Sleepiness Scale (KSS) score was **2.82 ± 1.41**, suggesting relatively low levels of daytime sleepiness among the participants. The mean Stroop Test total score was **4.30 ± 0.70**, reflecting generally good cognitive performance. These descriptive findings provide an overall summary of the participants' sleep hygiene, physiological sleepiness, and cognitive functioning prior to further inferential analyses.

Table 6. Spearman's rank correlation analysis

Variables	Spearman's rho (ρ)	p-value	Interpretation
Night-time digital use vs Sleep Hygiene Index (SHI)	0.504	<0.001	Moderate positive, statistically significant
Night-time digital use vs Stroop Test score	-0.051	0.494	Very weak negative, not statistically significant
Night-time digital use vs Karolinska Sleepiness Scale (KSS)	0.215	0.0037	Weak positive, statistically significant

Spearman's rank correlation analysis as illustrated in Table .6 demonstrated a **moderate positive and statistically significant correlation** between night-time digital use (10 PM–3 AM) and Sleep Hygiene Index (SHI) scores ($\rho = 0.504$, $p < 0.001$), indicating that greater night-time digital engagement was associated with poorer sleep hygiene. In contrast, the correlation between night-time digital use and Stroop Test scores was **very weak and not statistically significant** ($\rho = -0.051$, $p = 0.494$), suggesting no meaningful association with cognitive performance. Furthermore, a **weak but statistically significant positive correlation** was observed between night-time screen use and Karolinska Sleepiness Scale (KSS) scores ($\rho = 0.215$, $p = 0.0037$), indicating that increased night-time screen use was associated with greater daytime sleepiness.

VII. Discussion

The present study examined the association between night-time digital engagement, sleep hygiene, physiological sleepiness, and cognitive functioning among young adults. Nearly half of the participants (49.44%) reported engaging in digital activities for 1–2 hours during the night, with the majority demonstrating good sleep hygiene (84%). However, Spearman's correlation analysis revealed a **moderate positive and statistically significant correlation between night-time digital use and Sleep Hygiene Index (SHI) scores ($\rho = 0.504$, $p < 0.001$)**, indicating that increased night-time digital engagement was associated with poorer sleep hygiene. These findings are consistent with those of (2)(14)(15) (16) (18), who reported that prolonged bedtime smartphone use contributes to delayed sleep onset, reduced sleep duration, and poorer sleep quality. The adverse effects are likely mediated through blue-light-induced melatonin suppression and increased cognitive arousal before sleep (1) (9).

The study also demonstrated a **weak but statistically significant positive correlation between night-time digital use and Karolinska Sleepiness Scale (KSS) scores ($\rho = 0.215$, $p = 0.0037$)**, suggesting that greater night-time screen exposure was associated with increased daytime sleepiness. This finding agrees with (2) and (6), who reported

that nocturnal smartphone use is associated with reduced daytime alertness and increased fatigue.

Conversely, **no significant association was found between night-time digital use and cognitive functioning**, as indicated by the very weak correlation with Stroop Test scores **($\rho = -0.051$, $p = 0.494$)**. Although previous studies have reported impaired executive functioning following excessive screen exposure (10)(17),the present findings suggest that cognitive performance may be influenced more by sleep delay and overall sleep quality than by digital engagement alone. Overall, the findings emphasize that reducing night-time digital use and promoting healthy sleep practices may improve sleep hygiene and daytime alertness among young adults.

VIII. Recommendations

- Longitudinal research should be carried out in the future to determine the effects of digital nocturnality.
- Experimental interventions such as sleep hygiene interventions would provide positive results.
- Comparisons between urban and rural settings might be more revealing.
- Wearable sleep trackers should be considered in order to make objective assessments.

IX. Conclusion

Night time digital engagement has been raised as a serious concern in relation to younger adults' health and wellbeing, due to increasing dependence on digital technologies at night time. Such a trend could interfere with sleep quality, cognitive functioning and physiological health in a negative manner. It can thus be appreciated that health improvements in young adults require maintenance of good sleep and digital hygiene.

Conflict of Interest:

There was no relevant conflict of interest regarding this paper.

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