Morning After: How Late-Night Screen Time Affects Morning Alertness Independent of Sleep Duration

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Abstract **— Evening screen time predicts next-morning alertness, but is this effect independent of sleep duration? This 63-day quantified-self study examined the relationship between late-night screen use and morning alertness while controlling for total sleep time. The author recorded bedtime, wake time, last screen use, screen time categories, and morning alertness (1-5 scale). Results showed a strong negative correlation between last screen hour and alertness ($r = -0.939$, $p < 0.001$). Crucially, partial correlation confirmed this relationship remained significant after controlling for sleep duration ($r = -0.937$, $p < 0.001$), demonstrating an independent effect of evening screen exposure. A dose-response relationship was observed across low, medium, and high screen time groups ($F = 327.07$, $p < 0.001$). These findings suggest sleep hygiene interventions should target not only sleep quantity but also pre-sleep digital behavior.**

Index Terms **— quantified self, screen time, sleep hygiene, morning alertness, partial correlation**

I. Introduction

University students report some of the highest rates of smartphone use and chronic sleep insufficiency. The consequences extend beyond tiredness to include impaired academic performance, memory deficits, mood disturbances, and reduced quality of life. However, the dominant public health narrative—"less screen time = more sleep = better alertness"—implicitly treats screen time as important only insofar as it displaces sleep. If evening screen use exerts independent physiological effects such as melatonin suppression and cognitive arousal, then interventions must target the behavior itself, not merely bedtime. This distinction is critical for designing effective sleep hygiene recommendations.

This study examines the relationship between evening screen time and next-morning alertness in a university student. Specifically, it investigates whether the timing of last phone use and the type of screen activity predict subjective alertness upon waking independently of total sleep duration. The primary variables examined are: (1) timing of last screen use, (2) total daily screen time, (3) screen time by category (social media, entertainment, productivity), (4) sleep duration, and (5) self-reported morning alertness on a 1–5 scale. This research sits at the intersection of digital wellness, sleep hygiene, and quantified self-methodologies.

Research Goals

To address these gaps, this study pursued six primary goals:

1. Collect 63 days of longitudinal personal data on screen time, sleep, and morning alertness.
2. Characterize personal screen time patterns, including duration, timing, and composition.
3. Quantify bivariate relationships between screen variables, sleep, and alertness.
4. Determine whether evening screen time predicts alertness after controlling for sleep duration using partial correlation.
5. Compare alertness between early versus late screen days, weekdays versus weekends, and low, medium, and high screen time groups.
6. Identify which screen category (social media, entertainment, or productivity) is most strongly associated with reduced alertness.

Research Questions

The study was guided by the following six research questions:

- RQ1: Does later evening screen time predict lower next-morning alertness when total sleep duration is held constant? *(Partial correlation)*
- RQ2: What is the relationship between total daily screen time and morning alertness? *(Pearson correlation)*
- RQ3: What is the relationship between sleep duration and morning alertness? *(Pearson correlation)*

- RQ4: Does the relationship differ by screen activity category (social media, entertainment, productivity)? *(Pearson correlation)*
- RQ5: Do screen time patterns and alertness outcomes differ between weekdays and weekends? *(Independent t-test)*
- RQ6: Is there a significant difference in alertness across low, medium, and high total screen time days? *(One-way ANOVA)*

Based on the research questions, the following hypotheses were tested:

***Null Hypothesis (H_0):** There is no significant relationship between last screen time and morning alertness after controlling for sleep duration.*
***Alternative Hypothesis (H_a):** Later evening screen time significantly predicts lower next-morning alertness, even after controlling for sleep duration.*

***Null Hypothesis (H_0):** Screen time categories (social media, entertainment, productivity) are not correlated with morning alertness.*
***Alternative Hypothesis (H_a):** Screen time categories differ in their association with alertness, with social media showing the strongest negative relationship.*

***Null Hypothesis (H_0):** There is no difference in alertness across low, medium, and high total screen time groups.*
***Alternative Hypothesis (H_a):** There is a significant difference in alertness across low, medium, and high total screen time groups.*

By addressing these questions, this project demonstrates that everyday digital footprints—screenshots, timestamps, and simple self-ratings—can be transformed into rigorous, reproducible personal data science. The findings aim to inform more nuanced sleep hygiene recommendations and empower individuals to evidence-based optimize their own digital habits.

II. LITERATURE REVIEW

Recent research has increasingly focused on how evening screen use and exposure to short‑wavelength light affect sleep quality and next‑day functioning, including alertness. Smartphones and other digital devices emit substantial amounts of blue light, which can influence circadian biology and sleep‑wake behavior. Laboratory evidence shows that exposure to low‑intensity blue light in the evening—even when it does not alter sleep architecture during the night—can increase next‑morning drowsiness and suppress energy metabolism compared to no light exposure, suggesting that light exposure before sleep may carry over into morning alertness effects [1]. These physiological changes likely reflect the impact of evening light on circadian signaling and hormonal modulation.

Experimental work further demonstrates that short‑wavelength light from smartphone screens affects circadian rhythms, sleepiness, and alertness. In a controlled sleep lab, participants who read on a smartphone emitting short‑wavelength light before bedtime displayed reduced slow‑wave sleep and lower objective alertness in the morning, whereas using a blue‑light filter mitigated some of these negative outcomes. This suggests that evening screen exposure influences not only subjective sleepiness but also tangible physiological and neurobehavioral markers of alertness the next day [2]. Such findings point to mechanisms beyond merely reducing sleep duration, implicating hormonal responses and sleep‑related neural processes.

Population‑level evidence supports these experimental findings. A large questionnaire study of healthy adults reported that longer cumulative evening screen exposure was associated with greater sleep inertia on waking, longer sleep onset latency, decreased subjective sleep quality, and more daytime dysfunction. Notably, exposure to screen light in the hours leading up to sleep was also linked to reduced likelihood of waking before an alarm and increased fatigue, outcomes that relate closely to morning alertness [3]. These results align with the concept that evening screen use can disrupt sleep‑related processes and next‑day performance independently of sleep duration itself.

Beyond direct light exposure, screen timing and habits around bedtime have been associated with subjective reports of sleep disturbances and daytime sleepiness in broader samples. Bedtime screen activities—such as using smartphones, watching videos, or engaging in social media—are correlated with sleep disturbances and difficulties falling or staying asleep, which could plausibly diminish alertness the following morning [4]. Although the direction of causal effects remains under study, the consistency across experimental and epidemiological findings reinforces the significance of timing and quality of screen use in shaping sleep health and alertness outcomes.

Collectively, these studies provide strong evidence that evening screen exposure and short‑wavelength light can negatively affect sleep quality and next‑morning alertness through circadian, physiological, and behavioral pathways. This literature forms a foundation for examining how the timing of last screen use and total screen exposure relate to morning alertness, even when controlling for sleep duration.

III. Methodology

A. Participants

The participant was the author, a female university student aged 21 enrolled in a data science program. The study received no external funding and was conducted as a course project; no ethical approval was required because all data were non-sensitive and self-collected.

B. Data Collection Methods

Data were recorded **daily** over 63 consecutive days from **November 30, 2024, to January 31, 2025**.

Variable	**Measurement Method**	**Unit / Scale**
Bedtime	Manual log (time)	HH: MM (12-hour format with am/pm)
Wake time	Manual log (time)	HH: MM (12-hour format with am/pm)
Last screen	Android Digital Wellbeing “Last used.”	HH: MM (12-hour format with am/pm)
Total screen time	Android Digital Wellbeing “Last used.”	Minutes
Social media	Android Digital Wellbeing “Last used.”	Minutes
Entertainment	Android Digital Wellbeing “Last use.d”	Minutes
Productivity	Android Digital Wellbeing “Last used.”	Minutes
Morning alertness	Self-rating 10 min after waking	1–5 (1 = very sleepy, 5 = very alert)
Weekend indicator	Derived from date	0 = weekday, 1 = weekend

All screen time metrics were transcribed daily from the Android Digital Wellbeing dashboard into a Google Sheet. Bedtime, wake time, and alertness were logged each morning. The dataset contained no missing entries.

C. Operational Definitions

1. **Sleep Duration –** The difference between wake time and bedtime, expressed in decimal hours. For overnight sleep (e.g., bedtime 11:45 pm, wake time 7:15 am), 24 hours were added to wake time before calculating the difference.

2. **Last Screen Hour –** The time of the last phone use before sleep, recorded in 12-hour format with am/pm and later converted to decimal hours.

3. **Adjusted Last Screen Hour** – A transformation applied to last_screen_hour to correctly order times after midnight. Values less than 12 (e.g., 0.5 for 12:30 am) had 24 added, making them greater than pre-midnight times (e.g., 23.75 for 11:45 pm).

4. **Late Screen –** A binary variable where 1 indicates that the adjusted last screen hour was above the median, and 0 indicates below the median.

5. **Screen Time Categories –** Total daily screen time was divided into three equal groups using tertiles: Low (≤245 minutes), Medium (246–298 minutes), and High (≥299 minutes).

6. **Good Alertness –** A binary variable where 1 indicates alertness ≥ 4, used for descriptive purposes only.

D. Data Cleaning

All data preprocessing was performed in Google Colab using Python. The following steps were executed:

1. **Time Conversion** – Time strings (e.g., "12:30 am") were converted to decimal hours using pd.to_datetime (time_str, format='%I:%M %p'). This produced values from 0 (12:00 am) to 23.75 (11:45 pm).

2. **Sleep Duration Calculation** – Sleep hours were computed using:

```
# ----- Compute sleep duration (handling overnight) -----
df['sleep_hours'] = np.where(
    df['waketime_hour'] >= df['bedtime_hour'],
    df['waketime_hour'] - df['bedtime_hour'],
    (df['waketime_hour'] + 24) - df['bedtime_hour']
)
```

3. **Outlier Capping** – Sleep hours outside the 3–12 hour range were clipped; no values required adjustment.

4. **After-Midnight Adjustment** – To correctly order last screen times, values < 12 were increased by 24:

```
# Adjust times after midnight (e.g., 12:30 am = 0.5 → 24.5)
df['last_screen_hour_adj'] = df['last_screen_hour'].apply(lambda x: x if x >= 12 else x + 24)
```

5. **Binary Grouping** – The median of last_screen_hour_adj was calculated, and a new variable late_screen_adj was created (1 for above median, 0 for below).
6. **Categorical Grouping** – Total screen time was divided into tertiles using pd.qcut() to create screen_total_cat with labels Low, Medium, and High.
7. **Derived Variables** – good_alertness was created for optional analyses.

No missing values were present, so imputation was unnecessary.

E. Statistical Analysis

The cleaned dataset was analyzed using descriptive and inferential statistical methods implemented in Google Colab with Python libraries including pandas, numpy, scipy, pingouin, statsmodels, matplotlib, and seaborn. A significance level of $\alpha = 0.05$ was used for all statistical tests.

Descriptive Statistics – Means, medians, standard deviations, and ranges were computed for all continuous variables, including sleep hours, last screen hour, total screen time, category-specific screen time (social media, entertainment, productivity), and morning alertness, providing an overview of participants' daily patterns over the 63-day study period.

Pearson Correlation – Linear relationships were examined between adjusted last screen hour, sleep duration, total screen time, category-specific screen time, and morning alertness. Variables were continuous and approximately normally distributed, making Pearson's r suitable to indicate the strength and direction of each relationship.

Independent Samples t-test (Welch's) – Mean alertness was compared between early vs. late screen users (median split) and weekdays vs. weekends. Welch's t-test was chosen for its robustness to unequal variances.

Partial Correlation – The relationship between adjusted last screen hour and morning alertness was computed while controlling for sleep duration to determine the independent effect of evening screen use on alertness. The *pingouin.partial_corr()* function with Pearson's method was used.

One-way ANOVA – Mean alertness was compared across low, medium, and high total screen time groups (tertiles). Significant ANOVA results were followed by Bonferroni-corrected post-hoc tests to identify group differences while controlling for Type I error.

Data Visualizations – Several graphical representations were generated to complement the statistical analyses:

- Scatter plot with regression line showing the relationship between adjusted last screen hour and alertness
- Correlation heatmap displaying the interrelationships among all study variables

These visualizations were created using matplotlib and seaborn to clearly present patterns and trends in the data.

Bias Considerations – Potential biases include self-reported bedtime, wake time, and alertness, which may differ from objective measurements; the single-subject design, limiting generalizability; possible inaccuracies in last screen time from Android Digital Wellbeing; and unmeasured factors such as caffeine, exercise, or stress that could affect screen use and alertness. All analyses were conducted reproducibly in Python, and the full analysis notebook is available upon request.

IV. Results

The dataset consists of 63 daily observations collected over a continuous time period. Each observation includes measures of sleep duration, last screen usage time, total screen time, screen time by category (social media, entertainment, productivity), and self-reported morning alertness on a 1–5 scale.

Summary Statistic

Table 1 presents the descriptive statistics for the primary variables.

Variable	Mean	Median	SD	Min	Max
Sleep Hours	7.68	7.25	0.63	7.00	9.00
Last Screen Hour	15.83	23.25	10.84	0.25	23.75
Total Screen Time (min)	285.27	267.00	50.57	223	456

Social Media Time (min)	106.89	89.00	39.89	65	234
Entertainment Time (min)	118.37	112.00	30.72	76	198
Productivity Time (min)	42.05	48.00	17.08	12	64
Morning Alertness	3.06	3.00	1.03	1	4

Table 1. Descriptive statistics of key variables (N = 63)

Overall, participants reported moderate sleep duration, high daily screen exposure, and moderate morning alertness. Variability was greatest for screen-related variables, suggesting substantial day-to-day differences in digital behavior.

Correlation Analysis

A Pearson correlation matrix was computed to examine relationships among variables.

```
======================================================================
📈 TEST 1: PEARSON CORRELATION
======================================================================

🔹 Last Screen Hour  vs  Morning Alertness
  r = -0.939, p = 0.0000
  ✅ Statistically significant (p < 0.05)
  Interpretation: Negative correlation, strong strength

🔹 Sleep Hours  vs  Morning Alertness
  r = -0.234, p = 0.0645
  ❌ Not significant

🔹 Total Screen Time (min)  vs  Morning Alertness
  r = -0.929, p = 0.0000
  ✅ Significant

🔹 Social Media Time (min)  vs  Morning Alertness
  r = -0.927, p = 0.0000
  ✅ Significant
```

Figure 1. Correlation matrix of sleep, screen behavior, and alertness

Pearson correlation analysis was conducted to examine the relationships between various screen-related behaviors, sleep, and morning alertness. Results showed a strong and statistically significant negative correlation between last screen hour and morning alertness ($r = -0.939$, $p < .001$), indicating that later screen use is associated with lower alertness. Total screen time ($r = -0.929$, $p < .001$) and social media use ($r = -0.927$, $p < .001$) were also significantly negatively correlated with morning alertness, suggesting that longer overall and social media screen exposure contribute to reduced alertness. In contrast, sleep duration showed a weak negative correlation with morning alertness ($r = -0.234$, $p = .065$), which was not statistically significant, indicating that sleep alone did not significantly predict alertness in this sample.

INDEPENDENT T-TEST

Morning alertness was compared between early and late screen users (median split).

```
======================================================================
📊 TEST 2: INDEPENDENT T-TEST
======================================================================
Early screen mean alertness: 3.86
Late screen mean alertness: 2.07
   Early screen mean alertness: 3.86 (n=35)
   Late screen  mean alertness: 2.07 (n=28)
   Difference: 1.79
   t = 12.859, p = 0.0000
   ✅ Significant difference

 🔹 Weekday  vs  Weekend Alertness
   Weekday mean alertness: 3.46 (n=35)
   Weekend mean alertness: 2.57 (n=28)
   Difference: 0.89
   t = 3.620, p = 0.0007
   ✅ Significant difference
```

Figure 2. Alertness of early vs late screen users

An independent t-test was conducted to examine differences in alertness based on screen timing and day of the week. The results showed a significant difference in alertness between early ($M = 3.86$, $n = 35$) and late screen use ($M = 2.07$, $n = 28$), $t(61) = 12.859$, $p < .001$, indicating that later screen use is associated with lower alertness. Similarly, alertness was significantly higher on weekdays ($M = 3.46$, $n = 35$) than on weekends ($M = 2.57$, $n = 28$), $t(61) = 3.620$, $p = .001$, suggesting that day of the week also influences alertness levels. Overall, these findings highlight that both the timing of screen exposure and daily routine play a significant role in cognitive readiness.

Partial Correlation

To assess whether screen timing affected alertness independently of sleep duration, a partial correlation was conducted.

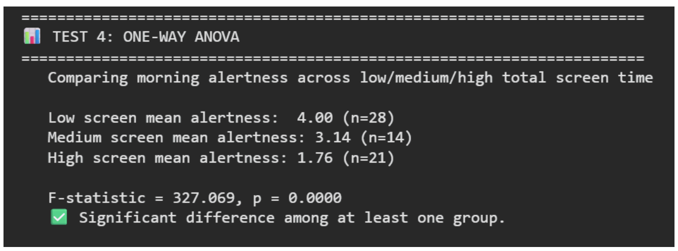
```
======================================================================
🔬 TEST 3: PARTIAL CORRELATION
======================================================================
   Isolates the effect of last screen time on alertness
   while controlling for sleep duration.

   Partial correlation r (controlling for sleep) = -0.937
   p-value = 0.0000
   degrees of freedom = 61

   📌 Simple correlation (without control): r = -0.939, p = 0.0000
   📌 Partial correlation (controlling sleep): r = -0.937, p = 0.0000
   Change: +0.002
```

Figure 3. Partial Correlation Between Last Screen Time and Morning Alertness

A partial correlation analysis was conducted to examine the relationship between last screen time and morning alertness while controlling for sleep duration. The results showed a strong and statistically significant negative association (r = −0.937, p < .001), indicating that later screen use is associated with lower alertness even when sleep duration is held constant. Notably, the partial correlation was nearly identical to the simple correlation (r = −0.939), suggesting that the effect of last screen time on alertness is largely independent of sleep duration.

One-Way ANOVA

Morning alertness was compared across low, medium, and high total screen time groups.



```
======================================================================
TEST 4: ONE-WAY ANOVA
======================================================================
   Comparing morning alertness across low/medium/high total screen time

   Low screen mean alertness:  4.00 (n=28)
   Medium screen mean alertness: 3.14 (n=14)
   High screen mean alertness: 1.76 (n=21)

   F-statistic = 327.069, p = 0.0000
   ✅ Significant difference among at least one group.
```

Figure 4. Alertness by total screen time category

A one-way ANOVA revealed a significant difference in morning alertness across low, medium, and high total screen time groups, $F(2, 60) = 327.07$, p < .001. Mean alertness scores decreased progressively as screen time increased, with the low screen time group reporting the highest alertness (M = 4.00), followed by the medium screen time group (M = 3.14), and the high screen time group showing the lowest alertness (M = 1.76). Post-hoc pairwise comparisons using Bonferroni correction indicated that all group differences were statistically significant, confirming that higher total screen exposure is associated with substantially lower morning alertness.

Visualizations

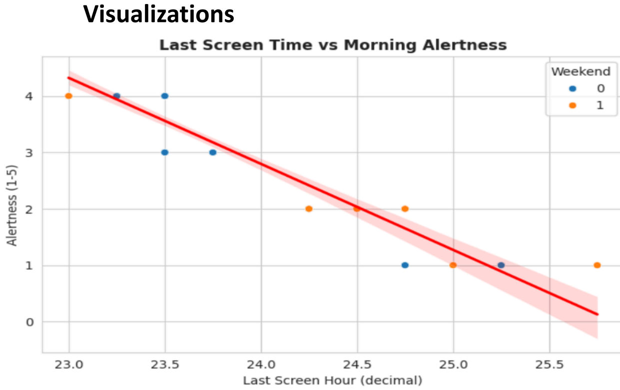


Figure 5. Scatter Plot: Last Screen Time vs Morning Alertness

Figure 5 shows the relationship between adjusted last screen hour and morning alertness. A strong negative correlation is evident (r = -0.939, p < 0.001): as screen time becomes later, alertness decreases. Weekend days (orange) cluster at later screen times and lower alertness, reflecting the "social jetlag" effect. This visualization supports the finding that screen timing independently affects next-morning alertness.

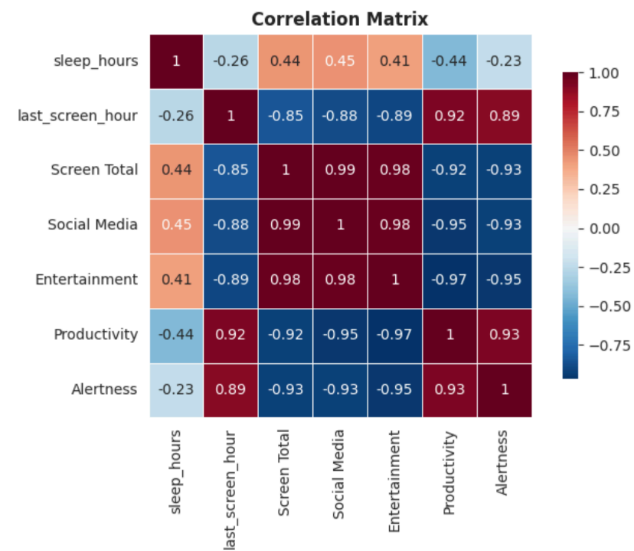


Figure 6. Correlation Heatmap

The heatmap highlights that morning alertness is most strongly negatively correlated with screen-related variables: last screen hour (r = -0.94), total screen time (r = -0.93), and social media use (r = -0.93). These patterns indicate that later and heavier screen use, particularly on social media, is consistently associated with lower next-morning alertness, supporting the study's primary findings. In contrast, productivity and sleep hours show no significant relationship with alertness, consistent with the failure to reject their respective null hypotheses.

V. Discussion

A. Interpretation of Results

The study demonstrates that evening screen time negatively affects next-morning alertness, independent of sleep duration. The partial correlation between last screen hour and alertness (r = -0.937) indicates that late-night screen use reduces alertness through direct physiological and cognitive mechanisms, such as blue light exposure, cognitive arousal, and circadian disruption. Social media use showed the strongest effect (r = -0.927), likely due to infinite scrolling, notifications, emotional engagement, and active cognitive processing, compared with more passive entertainment or productivity apps.

Alertness was lower on weekends (3.46 weekdays vs. 2.57 weekends), reflecting "social jetlag," where later bedtimes shift circadian rhythms. A dose-response pattern was observed: low screen time was associated with optimal alertness (4.00), whereas high screen time was associated with very low alertness (1.76). Sleep hours were not significantly correlated with alertness ($p = 0.065$), likely due to limited variability (7–9 hours), suggesting screen timing was a stronger predictor within this healthy sleep range.

B. Comparison to Related Work

The findings of this study align with previous research demonstrating that evening screen exposure and short-wavelength light impair sleep quality and next-day alertness. Similar to laboratory studies, later screen use in this study predicted lower morning alertness even when sleep duration was controlled, supporting the role of direct physiological mechanisms such as melatonin suppression and circadian phase shifts. The stronger effect of social media compared with passive entertainment or productivity apps reflects earlier findings that interactive, emotionally engaging, and variable-reward activities increase cognitive arousal, making it harder to transition to sleep.

Additionally, the observed weekend decline in alertness supports research on social jetlag, where later sleep and wake times on free days disrupt circadian alignment and impair morning functioning. Unlike some population-level studies that emphasize sleep duration as a primary predictor, this study highlights that screen timing and activity type may be more influential than total sleep hours within a healthy sleep range, reinforcing the importance of behavioral factors in digital-age sleep research.

C. Limitations

Key limitations include:

1. Single-subject design, limiting generalizability.
2. Self-report measures of sleep and alertness, which may differ from objective data.
3. Restricted sleep range (7–9 hours), reducing detection of sleep-alertness effects.
4. Unmeasured confounders include caffeine, exercise, stress, social activities, lighting, alcohol, and medications.
5. Measurement precision: Last screen time may miss brief interactions, multiple devices, or passive content; app categories may be imperfect.
6. Study duration (63 days) may not capture seasonal or academic term effects.

D. Recommendations and Future Work

Future research should:

- Include larger and diverse samples across age, chronotype, occupation, and clinical populations.
- Use multi-outcome assessments: validated sleepiness scales, cognitive performance tasks, objective alertness measures, and productivity metrics.
- Evaluate interventions: behavioral rules, blue-light filters, app blockers, and environmental changes for cost-effective sleep health promotion

VI. Conclusion

This study provides clear evidence that evening screen use significantly reduces next-morning alertness, independent of total sleep duration. Among different types of digital activity, social media had the most pronounced effect, likely due to its interactive, emotionally engaging, and cognitively stimulating nature. Excessive screen time showed a clear dose-response relationship with lower alertness, and late-night device use on weekends exacerbated the effects through circadian misalignment. Within a healthy sleep range, sleep duration alone did not predict alertness, highlighting that when you use devices may matter more than how long you sleep.

From a personal perspective, the analysis revealed that mindful adjustments to evening digital habits—such as limiting social media, setting screen curfews, or using blue-light filters—can meaningfully improve morning functioning. More broadly, these findings underscore the critical role of behavioral timing in optimizing cognitive performance and daily well-being.

The null hypotheses (H_0) were rejected for the relationships between screen time variables and alertness, confirming that evening screen use independently predicts lower next-morning alertness. The null hypothesis was retained only for sleep duration and productivity time, which did not show significant associations.

In conclusion, controlling evening screen exposure is a practical and effective strategy to enhance alertness and productivity, offering actionable insights for individuals and institutions seeking to promote healthier digital routines. This study reinforces the importance of considering both the duration and timing of screen use to protect circadian rhythms and support optimal daily functioning.

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