My visualization project

Quantifying the Impact of Late-Night Screen Time on Sleep Quality & Mental Wellbeing

Final Term Project Report
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Course: DGM 6108 – Programming Foundations for Digital Media

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1. Introduction

This project explores the relationship between screen time before bed and sleep duration and how it influences ones sleep quality and overall mental wellbeing.

The final visualization focuses on the measurable relationship between **screen time before bed**, **sleep hours**, **sleep quality**, and **mental wellbeing**, providing a clear picture of how digital habits shape restorative rest. My report documents the full process: from the data collection to rationale, to visualization design, to the unused alternative sketches, conclusions, and then the future considerations.

2. Research Question & Hypothesis

Research Question

How does late-night screen exposure affect sleep quality and morning restfulness?

Hypothesis

Increased duration of screen time before bed correlates with lower reported sleep quality (same as what is in my visualization webpage).

This hypothesis aligns with recent sleep research, which consistently shows that exposure to screens late at night can suppress melatonin production, delay circadian rhythms, and reduce sleep quality (Harvard Medical School, 2020; Cleveland Clinic, 2023).

3. Data Collection Rationale & Process

My dataset includes both **objective** and **self-reported** metrics collected daily. The purpose was to capture relationships between behavior (screen usage) and outcomes (sleep quality and wellbeing).

3.1 Data Collected

The following variables were recorded:

- Date
- Data Source (manual entry, Samsung health)
- Recommended Adult Sleep Start Time (9:00 PM reference)
- Screen Time Start (PM)
- Screen Time End (PM)
- Screen Time Duration Before Bed
- Screen Time Activity (e.g., family call, social media, school work)
- Restfulness Rating (0–5)
- Sleep Time Start
- Sleep Time Finish
- Duration of Sleep (hours)
- Standard Sleep Time (7–9 hours recommended)
- Comparison to 8-hour Standard

- Sleep Quality Rating (0–5)
- Mental Wellbeing Score (0–5)

* The U.S. National Sleep Foundation and American Academy of Sleep Medicine recommend **7–9 hours of sleep nightly for adults**, confirming the benchmark used here.

3.2 Why These Data?

This project required understanding **how a personal habit leads to measurable physiological and psychological outcomes**.
Screen time and sleep duration directly support evaluating:

- Stress level
- Mental wellbeing

3.3 Frequency of Collection

Data was recorded daily, usually at night (screen habit) and in the morning (sleep outcome). Missing values were rare and were handled through direct entry.

3.4 Data Cleaning

Dataset cleaning included:

- Converting times to decimal hour format
- Calculating sleep duration automatically done with my phone (this starts immediately I put my phone away to sleep)
- Filtering unused descriptive columns for the final javascript file
- Normalizing scales to 0–5 for meaningful comparison

4. Visualization Development

4.1 Final Visualization(scatterplot) I chose below

The chosen visualization (Scatterplot) displays:

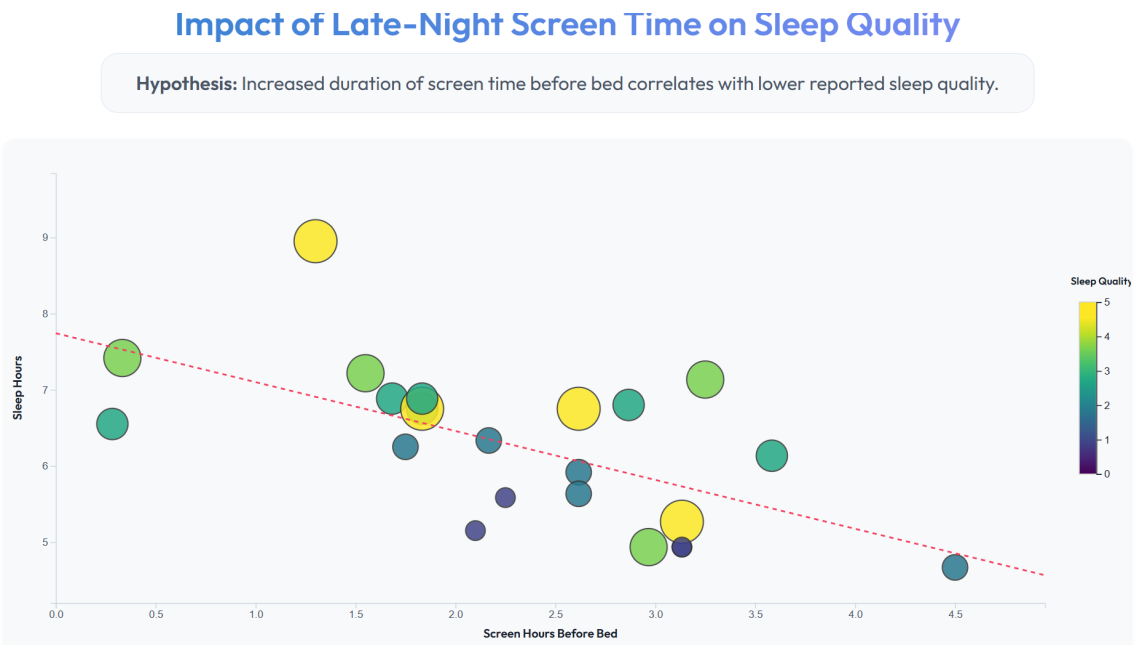
- **X-axis:** Screen Hours Before Bed
- **Y-axis:** Sleep Hours
- **Color:** Sleep Quality (0–5 scale)
- **Bubble Size:** Mental Wellbeing score

A downward trendline illustrates the negative relationship between screen time and sleep duration.

I decided to go with scatterplot because,

- scatterplot makes interpretation of my data easy to understand
- scatterplots is best for revealing correlations between numerical variables
- users can visually track multivariate relationships

- the use of color gradient to enhances interpretability
- it fits within the 1600×1000px requirement



Rationale

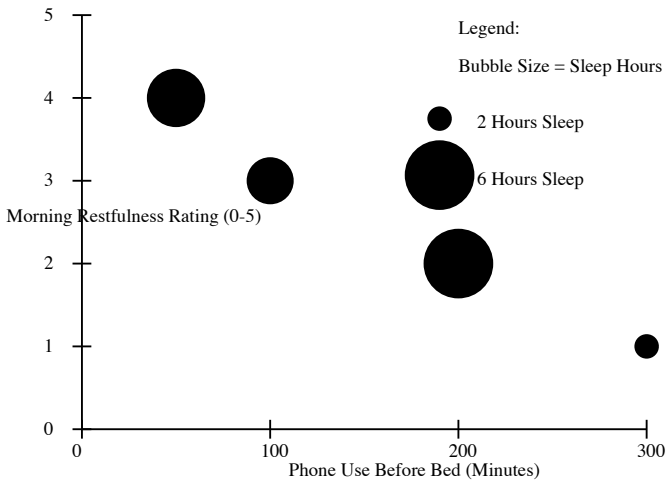
Scatterplots are the most effective for showing how independent variables (screen time) influence dependent outcomes (sleep hours, wellbeing).

Research also supports this choice:

- Sleep studies show that screen time negatively affects sleep quality through blue-light-induced circadian disruptions (Harvard Health, 2020).
- Behavioral visualization theory recommends scatterplots when exploring interaction patterns among continuous variables (data-to-viz.com).

4.2 Alternate Visualization Idea

Alternate Idea Chosen: Bubble Plot



Originally, I was working with a different research question but kind of similar to the one I eventually went with, the only difference was, I was trying to see the relationship between sleep duration and my morning restfulness, I considered a bubble plot that placed:

- screen time on X

- sleep quality on Y
- bubble size = sleep duration

Why It Was a Good Idea

- I think I wouldn't be able to create another plot even if I tried
- I found it visually compelling
- engaging for dashboard-style interpretation

Why I decided not to go with It

- one of the major reasons I didn't go with this was because it didn't pass testing phase when I submitted it for my assignment
- secondly, I was still experimenting other ways to visualize my data and I wasn't able to successfully do it with bubble plots. I felt it was harder
- I also noticed that sleep duration and quality appeared redundant
- the bubble plot did not communicate the *causal direction* clearly
- scatterplot offered clearer trend interpretation

This comparison strengthened confidence in my final selection.

5. Code Architecture and Implementation

The visualization uses:

- D3.main.js is the main source of the whole visualization. It helped me to create almost everything in the scatter plot. Its helped with the visual story.
- Index.html is used to load my visualization on the web page
- CSS is used to help my visualization to be readable, polished, organised and professional.
- Java script to load my Your script loads your dataset: like date, duration (screen time and sleep), activity, sleep quality, wellbeing. It transforms the raw `"HH:MM"` format into numbers
- Color scales, size scales, axes, tooltips, and trendline calculation

All code was written following course standards:

- no arrow functions used (I realized this was forbidden after speaking to some of my classmates)
- 'const' used except where 'let' were required
- multi-line comments for loops and core structures

6. Results & Conclusions

6.1 Observed Patterns

The scatterplot reveals:

- A **clear negative trend**: more screen time equals fewer sleep hours.
- Lower sleep hours frequently coincide with **lower sleep quality colors** (greens → yellow → blue).
- Mental wellbeing (bubble size) also decreases as screen time increases.

6.2 Reflection on Hypothesis

The hypothesis is supported.
Greater screen exposure before bed correlates with:

- shorter sleep duration
- poorer sleep quality
- lower morning wellbeing
- reduced mental and psychological wellness

6.3 Surprising Findings

The things I found quiet surprising;

1. **What I did during screen time mattered more than expected**
    - Id I have too much screen time automatically equals poor restfulness
    - Social media surfing till late in the night equals low sleep quality
2. **Emotional overstimulation carried into the next morning**, producing lower energy and emotional fatigue.

These insights align with research showing that emotional screen content can overstimulate the nervous system before bed.

7. Past/Future Data Considerations

Although I am not continuing formal dataset collection, I plan to self-monitor screen habits using my google phone.

Future project extensions could add:

- caffeine consumption
- exercise intensity
- stress levels
- time spent outdoors
- ambient noise/light exposure

These variables could enrich future correlation analysis.

8. Personal Reflection

This project changed my behavior significantly.

I have become more aware of the connection between **nighttime screen choices and morning energy**.
Instead of blaming breakfast, stress, or mood, I learned I could predict my emotional state based on how I slept the previous night, which was directly related to screen time patterns.

This project taught me to be more intentional about winding down and protecting my rest.

For the aspect of the code, for me was the most challenging. I did a lot of things that didn't work, I changed a lot with the help of my friends back in my home country and AI. I also tried to debug the question asked in class and see if I will be able to successfully do it but I couldn't, I tried to debug why my bubbles were vanishing after mouse hover and still couldn't.

This is very challenging for me however, I am confident that I am not where I used to be before taking up the code programming class. The knowledge I have gained from the whole process is not in waste.

9. Works Cited

American Academy of Sleep Medicine. *Sleep Duration Recommendations*. 2015.

Cleveland Clinic. "Why Screens Before Bed Affect Your Sleep." *Cleveland Clinic Health Essentials*, 2023.

Harvard Medical School. "Blue Light Has a Dark Side." *Harvard Health Publishing*, 2020.

National Sleep Foundation. "How Much Sleep Do We Really Need?" *sleepfoundation.org*, 2021.

Data-to-Viz. "Choosing the Right Visualization." *www.data-to-viz.com*.

Taylor-Laird, Jay. DGM 6108 Lectures & Lab Materials. Northeastern University, 2025.

10. Appendices

- Full raw dataset (copied from Excel sheet as text)
- Alternative sketch screenshots
- Final scatterplot visualization

Links to my data, both used and unused below

https://docs.google.com/document/d/1MJvQAD4T9UW5byShwXIqfuYTBwDX-DH-/edit?usp=drive_link&ouid=113259777991353177997&rtpof=true&sd=true

https://docs.google.com/spreadsheets/d/1-4e7NzEeL0n9KD2Q5We5XNsViEmocTKw/edit?usp=drive_link&ouid=113259777991353177997&rtpof=true&sd=true