## DSA-210 PROJECT FİNAL REPORT

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This report explores the relationship between daily caffeine consumption and sleep quality, with a specific focus on Deep Sleep Ratio as a key indicator of restorative sleep. Over the span of multiple weeks, data was collected and analyzed to uncover how various factors—such as caffeine dose, time of intake, and weather conditions—might influence sleep efficiency.

By combining statistical testing, data visualizations, and machine learning models, this study aims to extract meaningful insights that can guide healthier caffeine habits and improved sleep quality.

* **Parameters in the Report:**  
  **Date:** *The date of data entry for each night of sleep.*
* **Caffeine Intake (mg***): Total amount of caffeine consumed per day; considered the main influencing factor.*
* **Coffee Consumed**: *Binary indicator (Yes/No) showing whether any caffeine was taken that day.*
* **Coffee Period***: Whether caffeine was consumed before or after 15:00—to evaluate the impact of timing.*
* **Total Sleep (hrs):** *Total hours of sleep recorded each night***.**
* **Deep Sleep (hrs):** *Time spent in deep sleep—a critical phase for physical recovery.*
* **Deep Sleep Ratio:** Proportion of deep sleep to total sleep; the core metric for evaluating sleep quality.
* **Weather Condition:** Encoded data showing whether the day was sunny, cloudy, rainy, or partly cloudy—used to explore possible environmental influence.
* **Machine Learning Predictions**: Regression-based predictions of Deep Sleep Ratio using behavioral and contextual variables.

**INTRODUCTION**

This project investigates the relationship between **daily caffeine consumption** and **sleep quality**, focusing on the **Deep Sleep Ratio** as a key indicator of restorative sleep. Over several weeks, I consistently recorded data on caffeine intake, timing of consumption, total and deep sleep hours, and weather conditions to identify patterns and draw meaningful insights.

The goal is to understand how behavioral and environmental factors influence sleep efficiency using a data-driven approach. After preparing and cleaning the dataset, I applied **statistical tests**, **visualizations**, and **machine learning models** to explore:

* Whether caffeine consumption significantly reduces deep sleep.
* How consumption time (before or after 15:00) affects sleep quality.
* If weather conditions play a role in sleep outcomes.

**GRAPHS AND CORRELATIONS**

**metin, çizgi, öykü gelişim çizgisi; kumpas; grafiğini çıkarma, yazı tipi içeren bir resim

Yapay zeka tarafından oluşturulan içerik yanlış olabilir.**

**UNDERSTANDİNG**

This chart illustrates how the deep sleep ratio varied between March 18 and April 16.

ekran görüntüsü, öykü gelişim çizgisi; kumpas; grafiğini çıkarma, çizgi, yazı tipi içeren bir resim

Yapay zeka tarafından oluşturulan içerik yanlış olabilir.

**UNDERSTANDİNG**

Each bar represents the deep sleep ratio for a specific day, and the color of the bar shows when (or whether) coffee was consumed on that day:

* Dark Blue = No Coffee
* Teal = Coffee Before 15:00
* Light Green = Coffee After 15:00

 **No Coffee days** (dark blue) consistently show **higher deep sleep ratios**. The **highest value (~0.55)** on March 18 was a no-coffee day.

 **Coffee After 15:00** (light green) often aligns with the **lowest deep sleep ratios**, especially between March 24–30 and around April 10–12.

metin, sayı, numara, çizgi, ekran görüntüsü içeren bir resim

Yapay zeka tarafından oluşturulan içerik yanlış olabilir.

**UNDERSTANDİNG**

This scatterplot explores the relationship between **daily caffeine consumption** (x-axis, in mg) and the **deep sleep ratio** (y-axis, a proportion of total sleep spent in deep sleep).

There is a **visible negative trend**:  
As **caffeine intake increases**, the **deep sleep ratio generally decreases**.

**Zero caffeine**:  
Data points at 0 mg caffeine show some of the **highest deep sleep ratios** (up to ~0.55). These values indicate optimal deep sleep on caffeine-free days.

**High caffeine (100–200 mg)**:  
These intake levels are associated with **consistently lower deep sleep ratios** (~0.2–0.3), with very few outliers.

metin, ekran görüntüsü, diyagram, dikdörtgen içeren bir resim

Yapay zeka tarafından oluşturulan içerik yanlış olabilir.

**UNDERSTANDİNG**

This plot clearly supports the hypothesis that drinking coffee after 15:00 is associated with lower deep sleep quality. Earlier caffeine intake appears to be less disruptive, whereas late-day consumption correlates with significantly reduced deep sleep ratios.

**Before 15:00**:

* Median deep sleep ratio is **higher**.
* Distribution is relatively **tighter** and more consistent.
* The upper whisker and quartile reach **above 0.35**, with several values around **0.3–0.38**.

**After 15:00**:

Median is **lower**, around **0.225**.

* Wider spread, with more variability.
* Lower quartile dips below **0.2**, and upper bound rarely exceeds **0.35**.

ekran görüntüsü, diyagram, dikdörtgen, metin içeren bir resim

Yapay zeka tarafından oluşturulan içerik yanlış olabilir.

**UNDERSTANDİNG**

This box plot illustrates the relationship between coffee consumption (X-axis) and deep sleep ratio (Y-axis).

* No Coffee:  
  On days without coffee intake, deep sleep ratio tends to be significantly higher and more stable. The distribution is tighter, indicating consistency in sleep quality when no caffeine is consumed.
* Yes (Coffee Consumed):  
  The deep sleep ratios on coffee-consumed days are generally lower and more variable. The spread is wider and the median value is lower, suggesting that caffeine intake is associated with decreased deep sleep quality and increased inconsistency in sleep depth.

In summary, avoiding caffeine may contribute to more restful and reliable deep sleep, while consumption—especially later in the day—can lead to poorer and less predictable sleep outcomes.

**metin, ekran görüntüsü, diyagram, dikdörtgen içeren bir resim

Yapay zeka tarafından oluşturulan içerik yanlış olabilir.**

**UNDERSTANDİNG**

This box plot illustrates the relationship between categorized caffeine intake and the deep sleep ratio. The categories are "No Caffeine", "Low", "Medium", and "High", showing how different levels of caffeine consumption may influence sleep quality.

* No Caffeine:  
  Individuals who did not consume caffeine had the highest median deep sleep ratio and the widest range, with some data points reaching the maximum values observed in the dataset. This group displays the most favorable sleep quality overall.
* Low Caffeine (≤50 mg):  
  The median deep sleep ratio is visibly lower compared to the no-caffeine group. The interquartile range is narrow, and the distribution is tight, suggesting that even low caffeine intake may start to reduce deep sleep consistency.
* Medium Caffeine (51–100 mg):  
  The downward trend continues, with both the median and minimum values dropping further. The variability is larger, and this group reflects a more disrupted sleep pattern for moderate caffeine consumers.
* High Caffeine (101–200 mg):  
  Although this group has a wider spread, the median remains low, and several individuals show very poor deep sleep ratios. This suggests that high caffeine intake is associated with the greatest potential for sleep disruption.

metin, diyagram, ekran görüntüsü, dikdörtgen içeren bir resim

Yapay zeka tarafından oluşturulan içerik yanlış olabilir.

**UNDERSTANDİNG**

This box plot compares the deep sleep ratio across four distinct weather conditions: Rainy, Cloudy, Partly Cloudy, and Sunny.

* Sunny Days:  
  Sunny weather is associated with relatively higher median deep sleep ratios, suggesting favorable sleep quality. The distribution is balanced, and although there's one outlier, the overall spread reflects consistent performance.
* Rainy Days:  
  Rainy days also show a strong sleep quality trend, with the second highest median and several data points reaching toward the top. The wider range suggests greater variability, but still generally positive sleep outcomes.
* Cloudy Days:  
  The median for cloudy conditions is similar to rainy, yet the interquartile range is broader. This indicates that sleep quality under cloudy weather is mixed—some days are beneficial while others may be less restful.
* Partly Cloudy Days:  
  This group stands out with the lowest median deep sleep ratio and a narrow interquartile range, implying that partly cloudy weather may be least favorable for deep sleep. Individuals consistently reported lower-quality sleep on these days.

**CONCLUSİON**

This project aimed to investigate the impact of caffeine consumption habits on deep sleep quality, specifically measured as *Deep Sleep Ratio*, using real-life data personally recorded over a defined period.Multiple statistical analyses and hypothesis tests were performed, leading to clear and statistically significant conclusions:

Caffeine Consumption vs. Deep Sleep

* H₀: There is no difference in deep sleep ratio between coffee consumers and non-consumers.
* Result: Rejected (p = 0.0008, t = -3.91)
* Conclusion: Individuals who consumed caffeine had significantly lower deep sleep ratios than those who didn’t.

Coffee Timing (Before vs After 15:00)

* H₀: Coffee consumption time does not affect deep sleep.
* Result: Rejected (p = 0.0019, t = -3.29)
* Conclusion: Consuming coffee after 15:00 leads to a notably lower deep sleep ratio compared to coffee consumed earlier.

Amount of Caffeine vs Deep Sleep Ratio

* H₀: Caffeine amount is not associated with deep sleep ratio.
* Result: Rejected (p = 0.0008, correlation = -0.58)
* Conclusion: There is a moderate negative correlation; higher caffeine intake reduces deep sleep ratio.