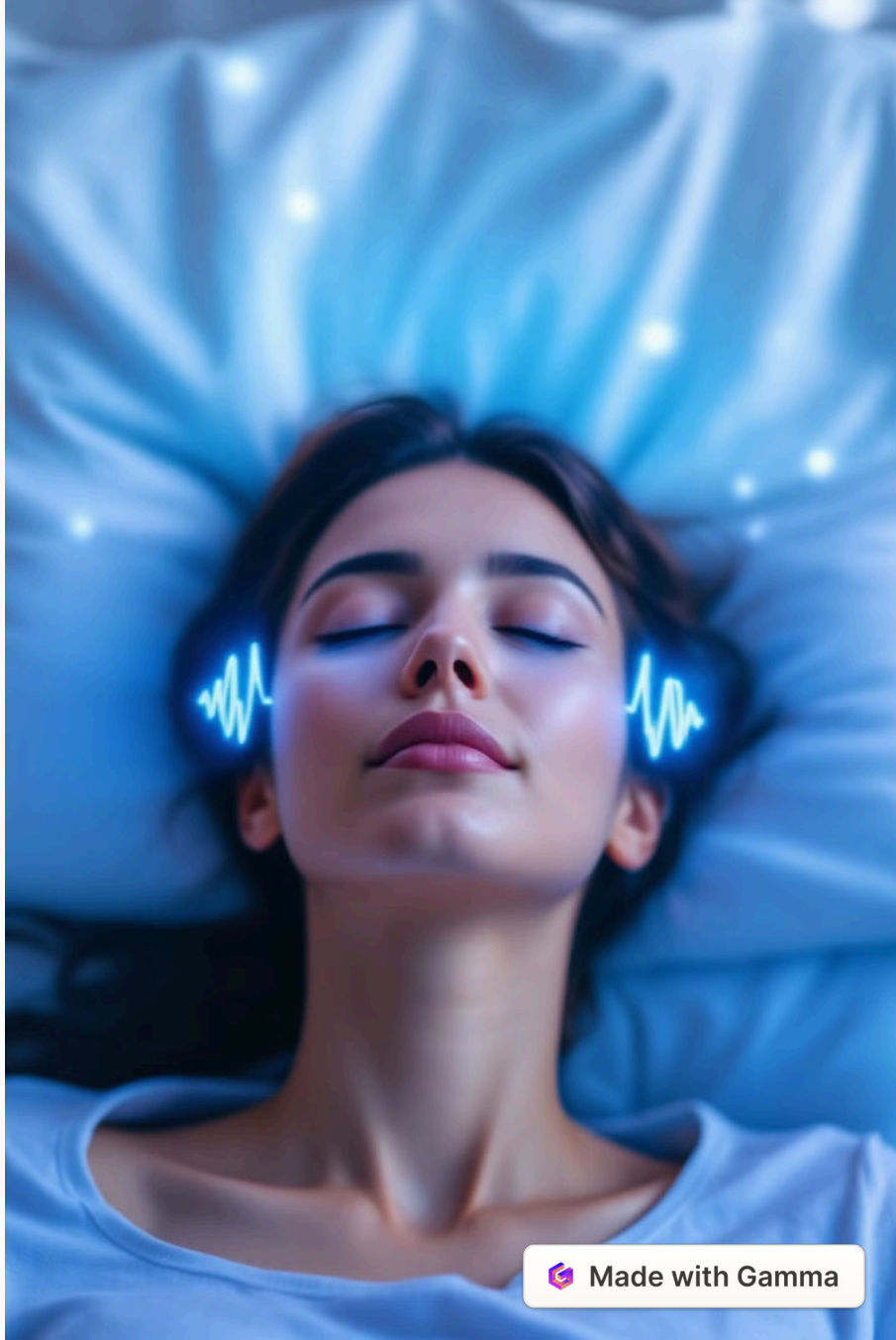
Analysis of Sleep Stages and Factors Affecting Sleep Quality

Our team explores sleep's impact on health using the Sleep-EDF dataset. We analyze physiological metrics across sleep stages and examine lifestyle factors influencing sleep patterns.



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Our team:

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Course Name/Date: Emerging Technologies for Public Health Class at UC Berkeley/ Fall 2024

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Problem Statement

Understanding Sleep and Its Impact on Health

- Challenge:
  Sleep is a critical component of health, yet many factors—such as stress, occupation, and physiological variations—impact its quality and duration.
- Key Questions:
  - How do physiological metrics (e.g., heart rate, blood oxygen levels) vary across different sleep stages?
  - What is the relationship between lifestyle factors (e.g., occupation, stress) and sleep patterns?
- Motivation:
  Analyzing these relationships helps identify actionable insights to improve sleep quality and, ultimately, overall health and well-being.
- Objective:
  Leverage the Sleep-EDF dataset to explore and visualize sleep-related patterns, identify correlations, and highlight factors influencing sleep quality.

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Introduction

Exploring Sleep for Better Health

- Sleep affects physical and mental well-being, yet many people struggle to get quality rest.
- The Sleep-EDF dataset provides detailed recordings of sleep stages, heart rate, respiratory rates, and more, offering a rich resource for analysis.
- This project uses visualizations and analysis to explore:
  - How physiological metrics vary across sleep stages.
  - The impact of stress, and occupation on sleep patterns.
- Purpose: Gain insights into factors that influence sleep quality and identify opportunities for better health interventions.

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Literature Review

Our Question: How do lifestyle choices affect sleep stages?

Why Sleep Matters:

- Sleep is critical for overall health; poor sleep contributes to chronic conditions like obesity, diabetes, and heart disease.(CDC, 2022).

Physiological Patterns in Sleep:

- Heart rate, respiratory rate, and oxygen levels vary across different sleep stages, as shown in polysomnographic data (Sleep-EDF Database, 2023)

Wearable Technology's Role:

- Devices like the Apple Watch provide accessible and continuous monitoring of sleep duration, heart rate, and blood oxygen, complementing clinical studies

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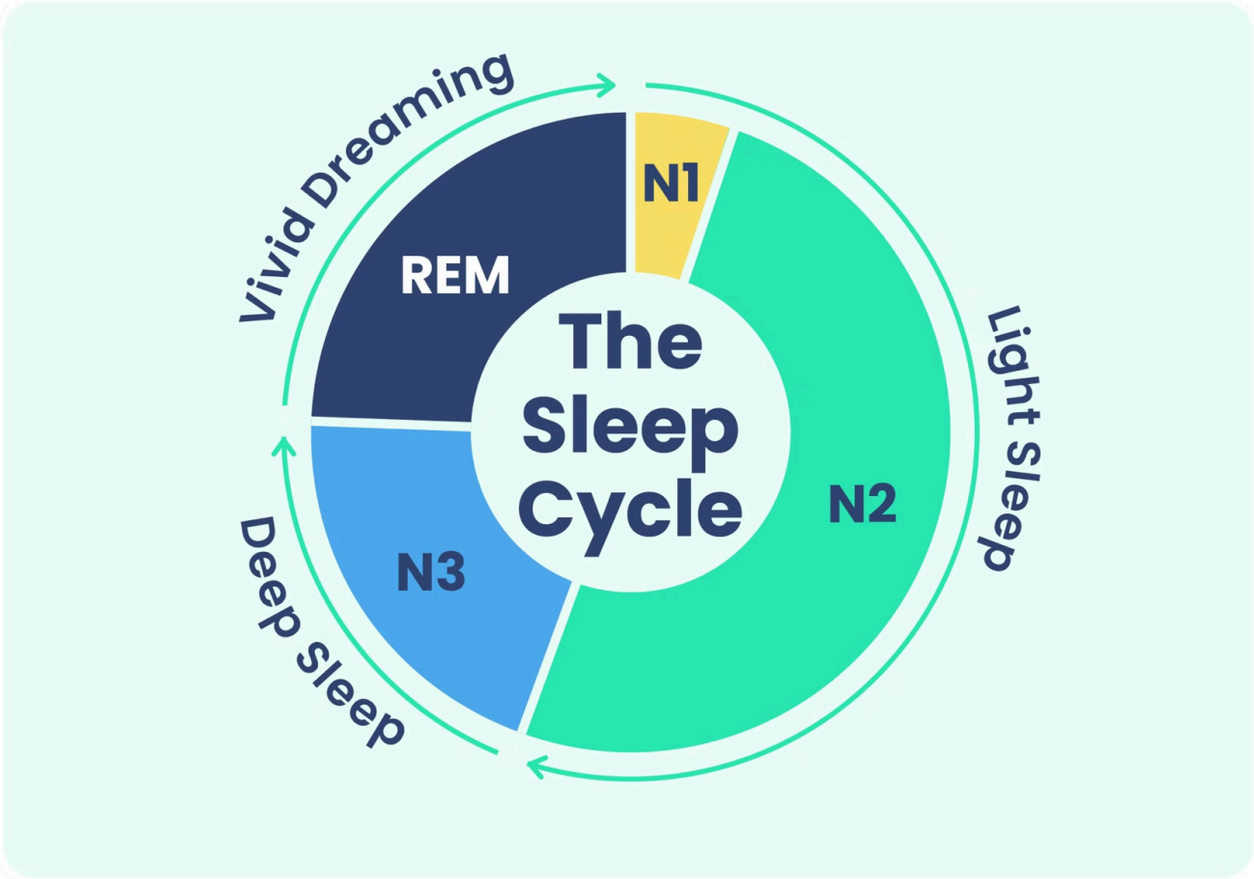
What Is the Sleep Cycle?



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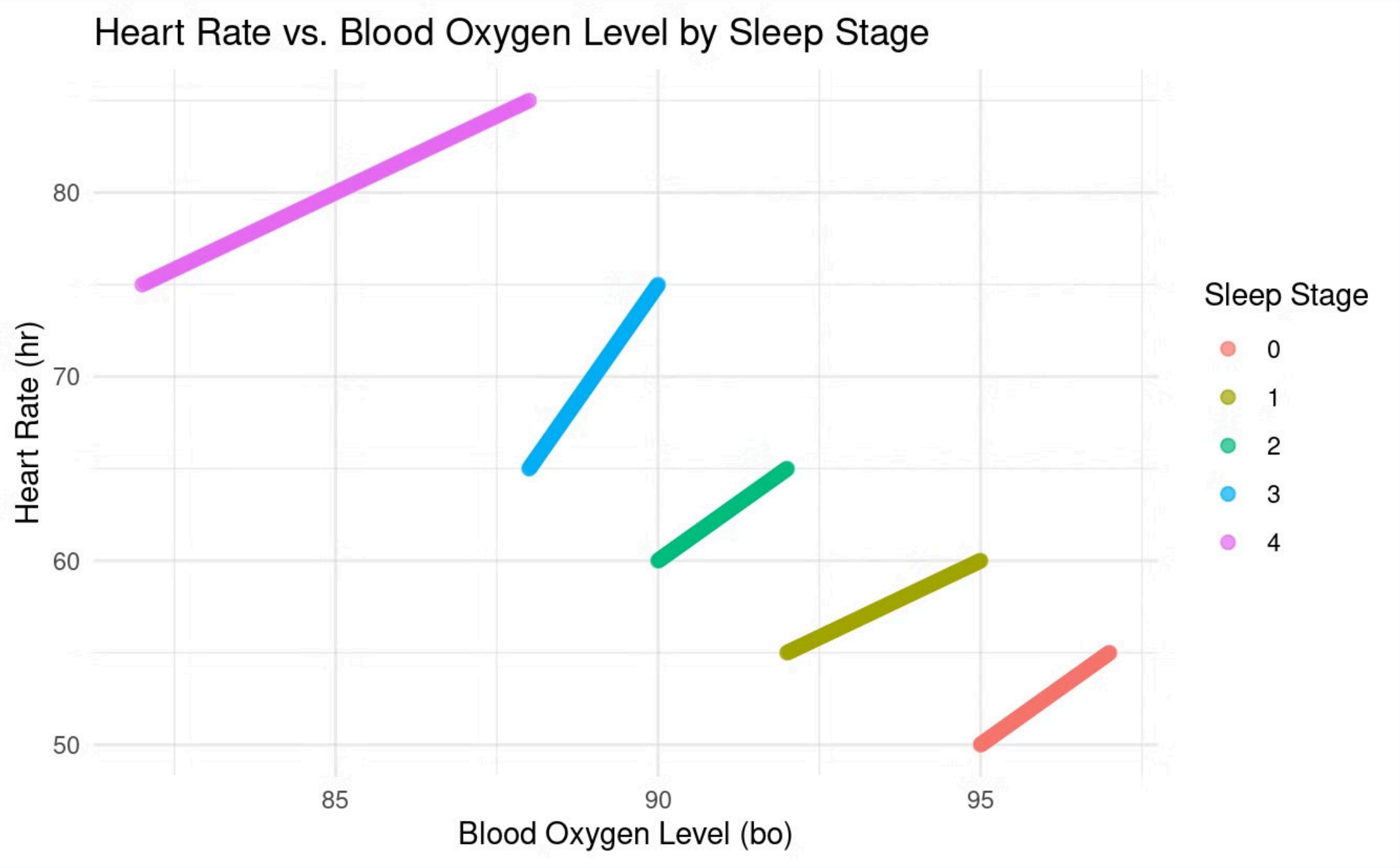

- **Higher heart rates are linked with lower blood oxygen levels:** Sleep Stages 3 (deep sleep) and 4 (REM sleep) show elevated heart rates (70-80 bpm) and lower oxygen levels (85-90%), indicating physiological changes in these stages.
- **Lighter sleep stages (0, 1, 2) show better oxygenation:** Blood oxygen levels remain higher (~90-95%) in these stages, with relatively lower heart rates compared to deeper sleep stages.
- **Sleep Stage 4 (REM sleep) has the highest heart rate:** REM sleep exhibits a distinct increase in heart rate (~80 bpm) despite low blood oxygen levels (~85-88%), potentially indicating intense physiological activity during this phase.

Blood oxygen level decreases progressively across stages: Blood oxygen levels tend to decline as sleep transitions from lighter stages (0, 1, 2) to deeper stages (3, 4), reflecting variations in respiratory and cardiovascular activity.

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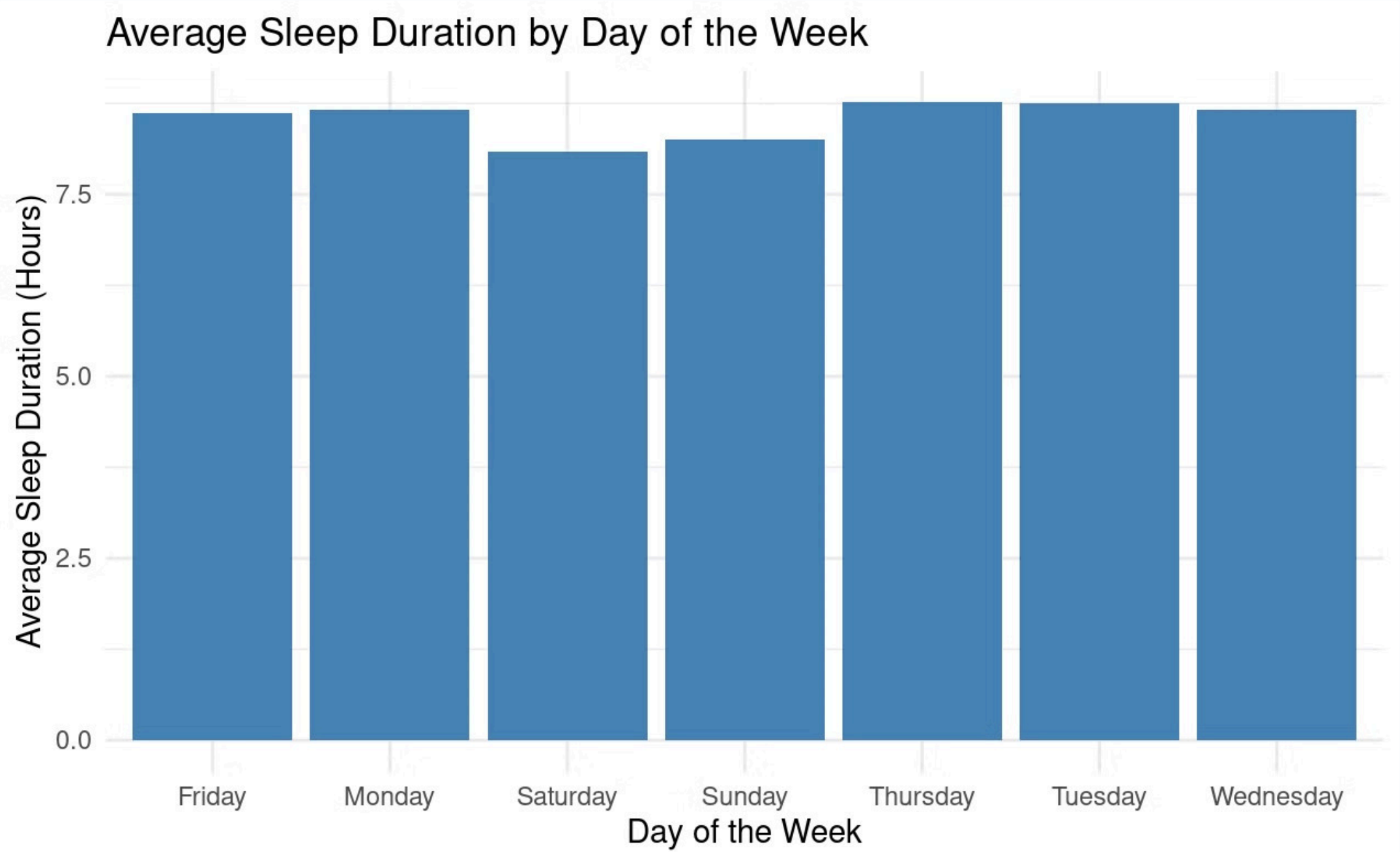

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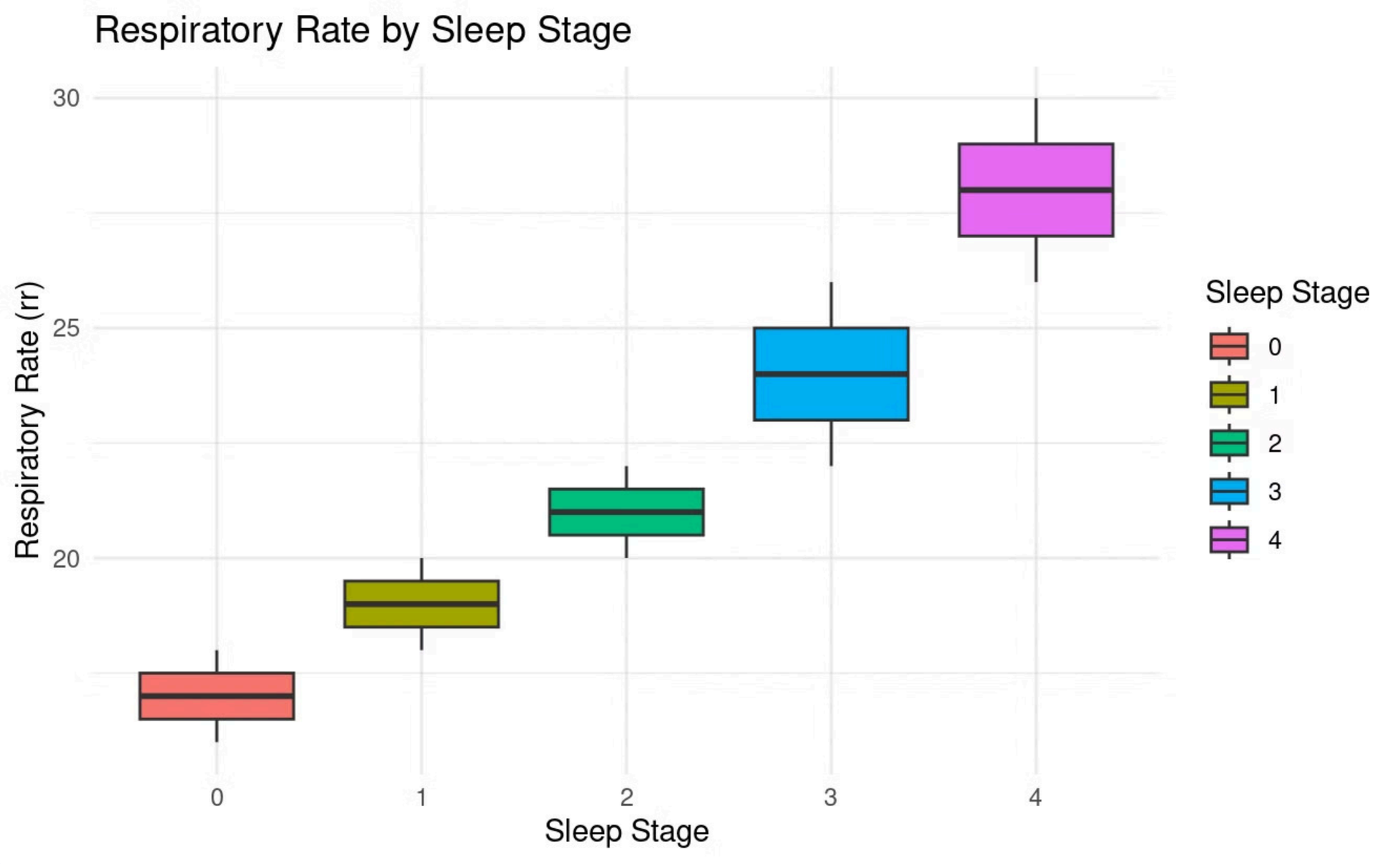

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A negative correlation was observed between stress levels and sleep quality. Higher stress levels were associated with lower sleep quality.

This supports the hypothesis that financial stress negatively impacts sleep, potentially mediated by physiological factors like cortisol elevation and heart rate variability reduction.

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Nurses have the widest variability in sleep duration: This indicates significant differences in sleep patterns within this occupation, possibly due to irregular work shifts or stress levels.

• Software Engineers and Salespersons exhibit consistently low sleep durations: These occupations show minimal variation, suggesting consistently lower sleep hours, potentially due to demanding work environments or sedentary lifestyles.

•Doctors have a higher median sleep duration compared to other professions: While their sleep shows some variation, doctors tend to sleep more on average than occupations like Scientists or Sales Representatives.

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Methodology

Data Collection

1. **Primary Datasets**:

- Sayopillow dataset from kaggle: Focuses on sleep quality and factors influencing it.
- Sleep-EDF dataset: Provides physiological data related to sleep stages.
- Apple Watch Data: Tracks personal sleep and health metrics like heart rate and oxygen levels.
- **Sleep Health and Lifestyle Dataset From kaggle Contains variables related to sleep patterns, lifestyle, and health factors.**

1. **Supplementary Information**:

- **Sleep Foundation Website**:
  - Used as a reference for understanding the science behind sleep stages and their physiological significance.
  - Helped in categorizing and interpreting sleep stages (0 to 4) in the dataset:
    - Stage 0: Awake.
    - Stages 1–2: Light sleep.
    - Stage 3: Deep sleep.
    - Stage 4: REM sleep.

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Methodology

Data Preprocessing:

- Imported and cleaned the data by:
  - Removing missing or invalid entries.
  - Standardizing variable names for consistency.
  - Filtering data for relevant variables like heart rate, oxygen level, and sleep stages.

Feature Engineering:

- Mapped sleep stages (0-4) to their corresponding physiological meanings.
- Calculated correlations between key variables, e.g., heart rate and sleep quality.

Visualization Tools:

- Used **R** (ggplot2, dplyr, etc.) to create interactive and static visualizations.

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Summary of Findings

- Lower heart rates and stable oxygen levels are critical indicators of better sleep quality, particularly during deep sleep (Stage 3).
- High stress levels negatively impact sleep quality, highlighting the importance of stress management for restful sleep.
- Personal sleep tracking (e.g., Apple Watch) provided insights consistent with dataset findings, validating the results.

Significance of Results:

- Understanding the relationships between physiological parameters (e.g., heart rate, oxygen levels) and sleep stages can inform strategies to improve sleep health.
- Insights from this analysis can be used to design personalized interventions to enhance sleep quality, such as stress reduction techniques and monitoring tools.

Implications for Future Research:

- Further studies can explore additional variables like diet, exercise, or mental health to create a more comprehensive understanding of sleep health.
- Larger datasets and longitudinal studies can help validate these findings across diverse populations.

Takeaway Message:

- Optimizing sleep involves managing physiological factors and external influences, such as stress, to achieve restorative and high-quality sleep.

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"Healthy sleep is the foundation of well-being, and understanding its physiological drivers empowers us to take control of our health."

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Questions?

We Thank You For Your Time!

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