Sleep Analysis

An Overview of Sleep Metrics and Insights

WHATEVER YOU DO, OWN IT

What Is the Stress Level Feature on My Garmin Device?

The stress level feature allows a user to determine their current level of stress based on their underlined heart-rate variability. When using the feature, the watch uses heart rate data to determine the interval between each heartbeat. The variable length of time in between each heartbeat is regulated by the body's autonomic nervous system. The less variability between beats equals higher stress levels, whereas the increase in variability indicates less stress. Some watches will prompt you when it detects a high level of stress offering you the option to reduce it through a breathing exercise. Some watches also provide all-day stress tracking so you can see your trends throughout the day and over time.

PULSE OX

All the various cells in your body need oxygen to function properly. Your circulatory system, which includes your heart, lungs and blood, all work together to import oxygen from the environment into your cells.

Oxygen is extracted from the air that fills your lungs when you inhale. It is mixed into your blood supply and pushed throughout your body with each heartbeat. A pulse oximeter measures how much oxygen (compared to maximum capacity) is in your bloodstream as it travels around your body.

If you think about your blood as a train and oxygen as the passengers on that train, a pulse oximeter is telling you how crowded the train is compared to maximum capacity. When every seat in the train has a passenger sitting in it, then the train is operating at 100% capacity.

Key Sleep Metrics

- Sleep Duration (hrs)
- Sleep Score
- Deep Sleep Duration (hrs)
- Light Sleep Duration (hrs)
- REM Duration (hrs)
- Awake Time (hrs)
- Stress Avg
- Steps
- Resting Heart Rate (bpm)
- High Heart Rate (bpm)

- Avg SpO$_2$
- Lowest SpO2
- Avg Respiration (bprm)
- Lowest Respiration (bprm)

Motivation behind the problem

Pseudo Code for Sleep Analysis Script

1. Import Required Libraries
2. Load and Prepare Data
3. Calculate Correlations
4. Analyse Strong Correlations
5. Compute Summary Statistics
6. Model Sleep Duration and Sleep Score
7. Calculate Sleep Efficiency
8. Detect Anomalies and Outliers
9. Visualize Low Sleep Score and Stress
10. Visualize Sleep Types and Trends
11. Additional Visualizations
12. Weekday vs Weekend Comparison

```python
cols_to_keep = [
    'Sleep Duration_hrs', 'Sleep Score', 'Stress Avg',
    'Deep Sleep Duration_hrs', 'Light Sleep Duration_hrs',
    'REM Duration_hrs', 'Awake Time_hrs',  'Avg SpO?',  'Lowest SpO2',  'Avg Respiration (bprm)',  'Lowest Respiration (bprm)','Steps',
    'Resting Heart Rate (bpm)', 'High Heart Rate (bpm)'

]

# Select those columns from the DataFrame
new_data = df[cols_to_keep]
numeric_df = new_data.select_dtypes(include=[np.number])

# Calculate the correlation matrix
correlation_matrix = numeric_df.corr()

new_data_corr=new_data.corr()
plt.figure(figsize=(6,6))
sns.heatmap(data=new_data_corr)
filtered_corr = correlation_matrix.where((correlation_matrix > 0.4) | (correlation_matrix < -0.4))

# Create a heatmap for the filtered correlation matrix
plt.figure(figsize=(10, 8))
plt.title("Filtered Correlation Matrix")
sns.heatmap(filtered_corr, annot=True, cmap="coolwarm", fmt=".2f", cbar=True, square=True)
plt.show()
```
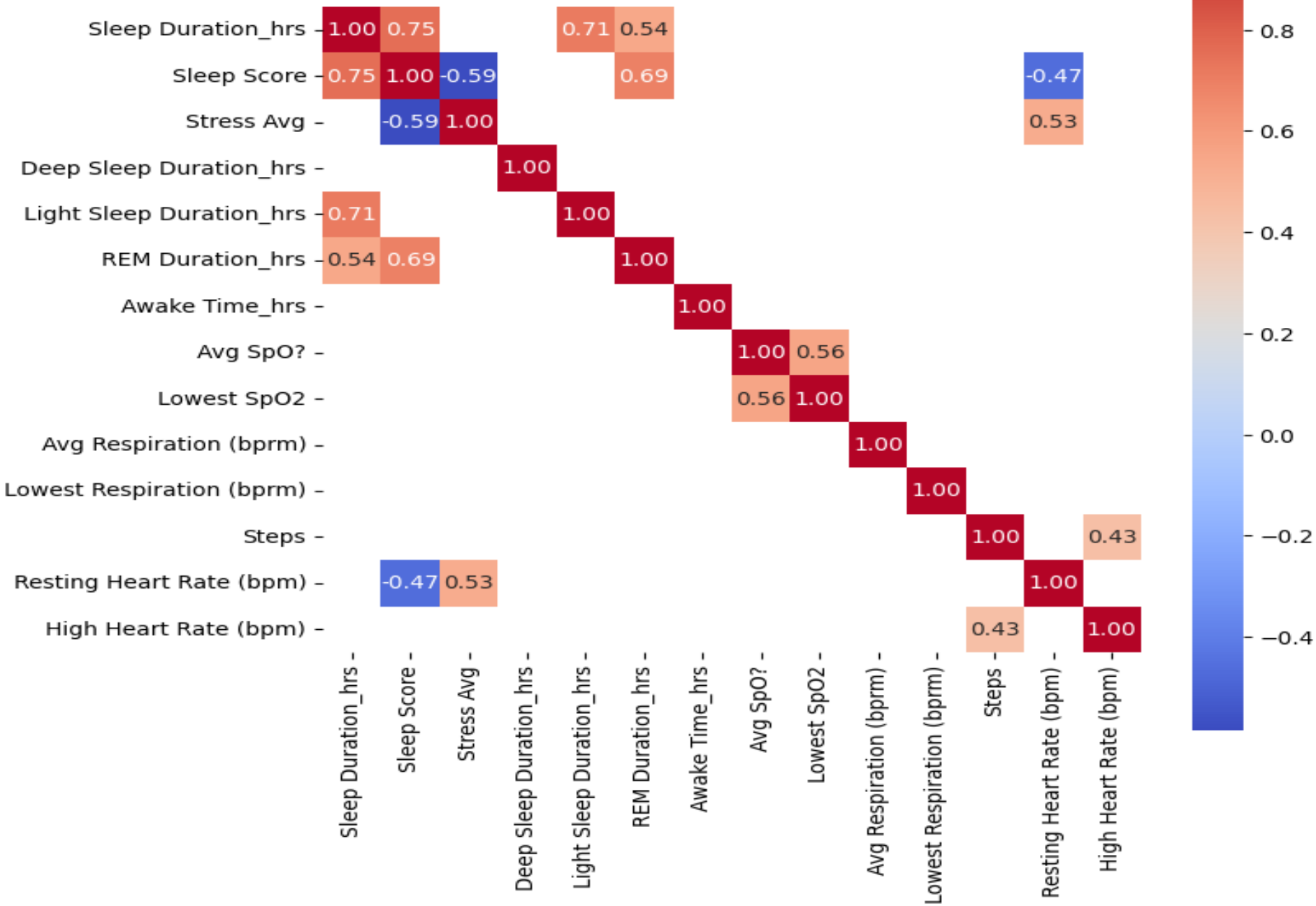
✓ 2.3s

Python

Filtered Correlation Matrix

Parameter	Correlation with Sleep Score	Interpretation
Sleep Duration (hrs)	0.75	Longer sleep duration is associated with a better sleep score.
Stress Average	-0.59	Higher stress levels are associated with lower sleep scores.
Deep Sleep Duration (hrs)	Not shown	Generally contributes to sleep quality but not explicitly shown in this matrix.
Light Sleep Duration (hrs)	0.71	Adequate light sleep contributes to higher sleep scores.
REM Duration (hrs)	0.69	Longer REM sleep durations improve sleep scores.
Resting Heart Rate (bpm)	0.53	Slight tendency for lower resting heart rates to improve sleep quality.
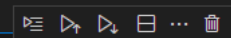
```python
# Extract relevant correlations
strong_correlations = filtered_corr.dropna(how='all', axis=1).dropna(how='all', axis=0)

# Extract column names with strong correlations
columns_to_extract = strong_correlations.columns

# Filter the original DataFrame for these columns
filtered_df = df[columns_to_extract]

# Display the extracted DataFrame
filtered_df.to_csv('filtered_df.csv')
```
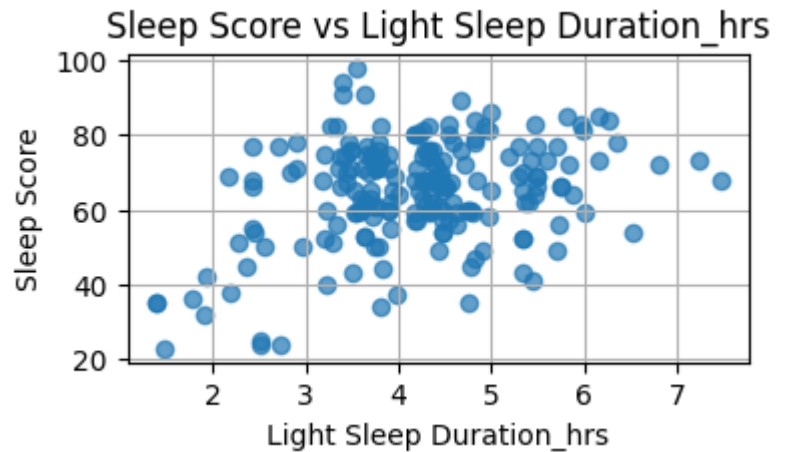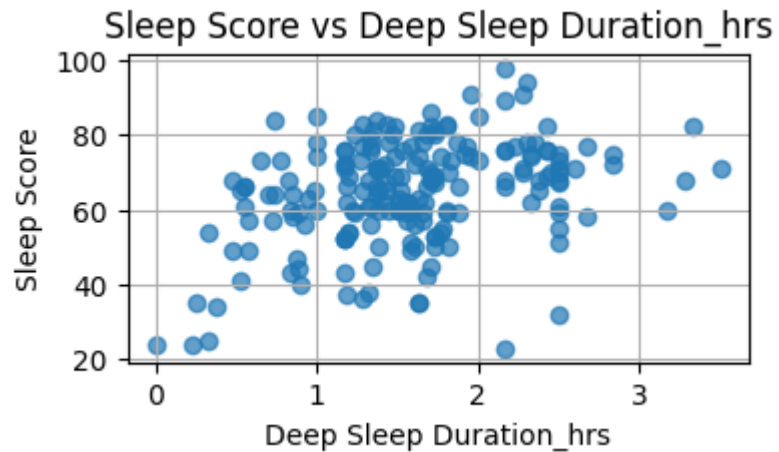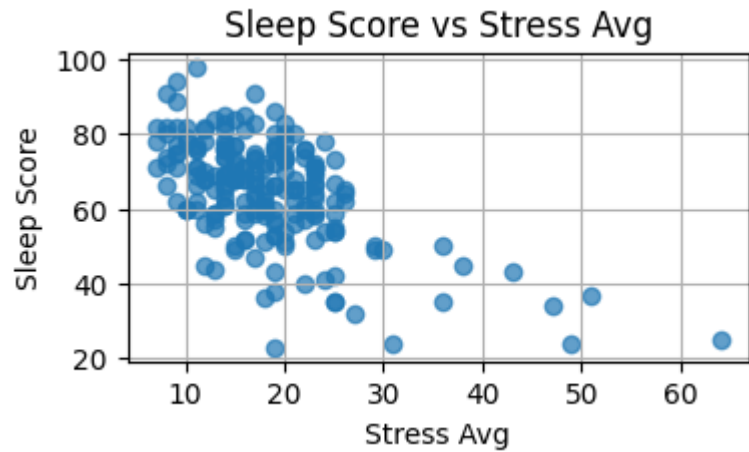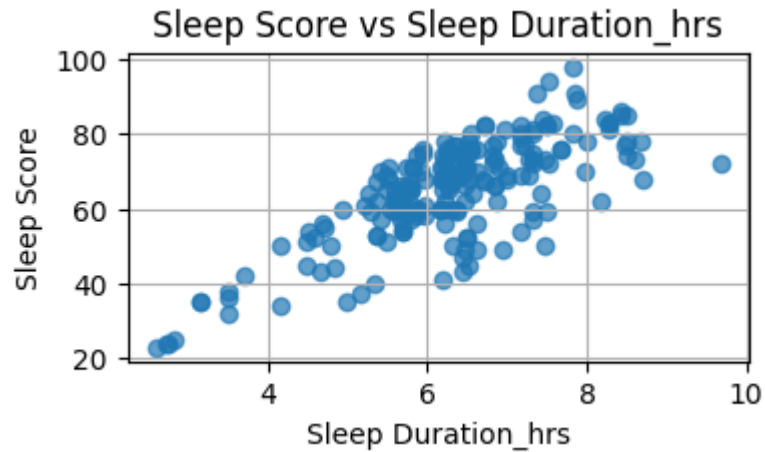
[23] ✓ 0.0s   Python

```python
# Iterate through each column in the filtered DataFrame
for column in filtered_df.columns:
    if column != "Sleep Score":  # Exclude the "Sleep Score" column itself
        plt.figure(figsize=(4, 2))
        plt.scatter(filtered_df[column], filtered_df["Sleep Score"], alpha=0.7)
        plt.title(f"Sleep Score vs {column}")
        plt.xlabel(column)
        plt.ylabel("Sleep Score")
        plt.grid(True)
        plt.show()
```
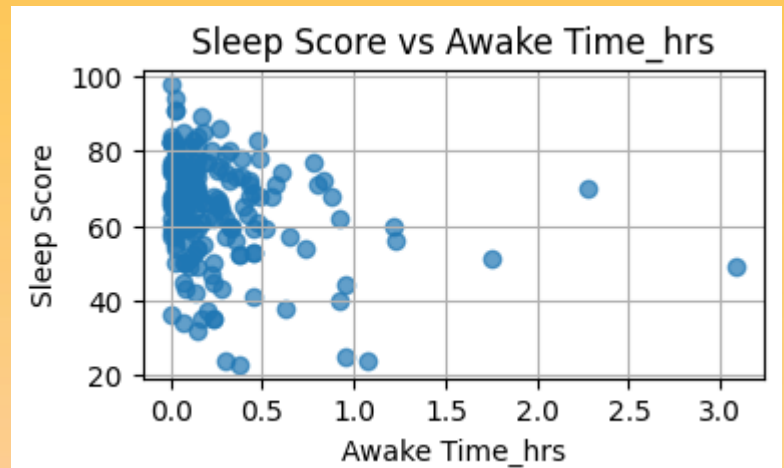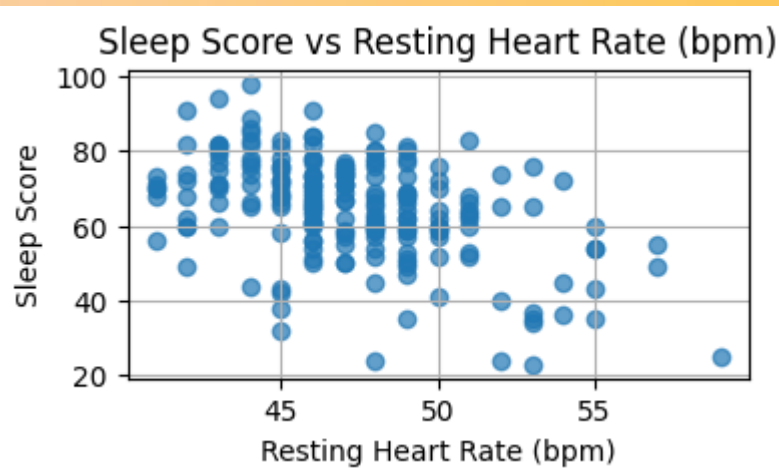
[24] ✓ 3.5s   Python

Sleep Score vs REM Duration_hrs

Sleep Score vs High Heart Rate (bpm)

Sleep Score vs Resting Heart Rate (bpm)

Sleep Score vs Awake Time_hrs
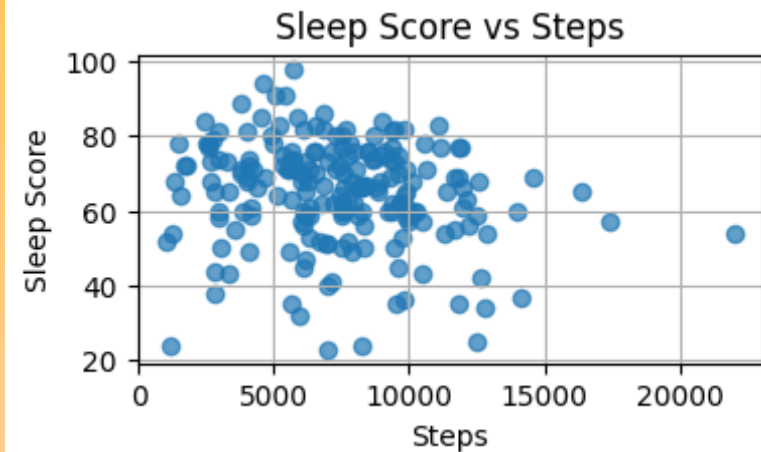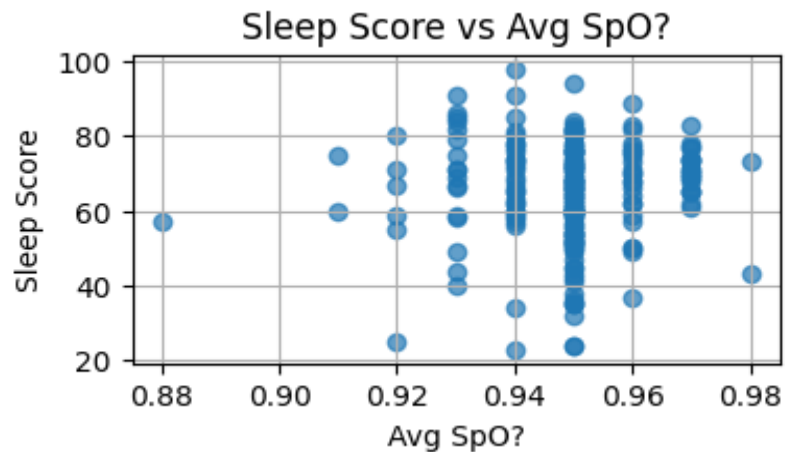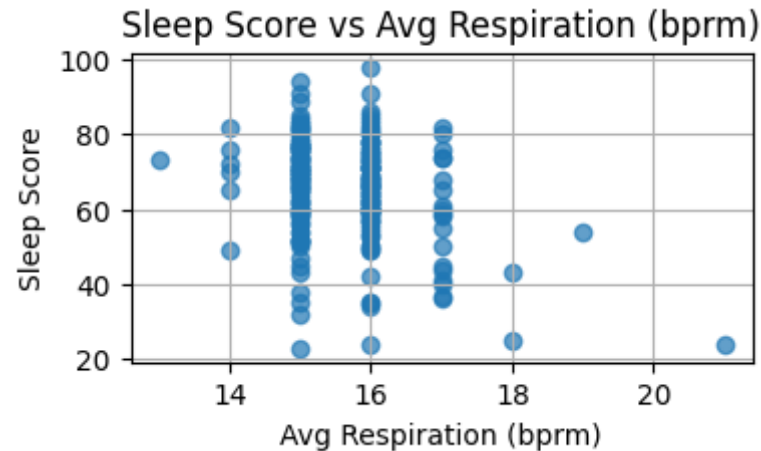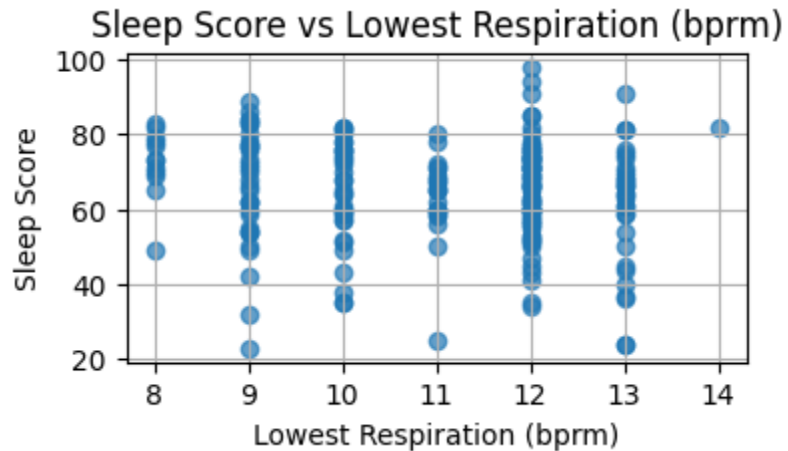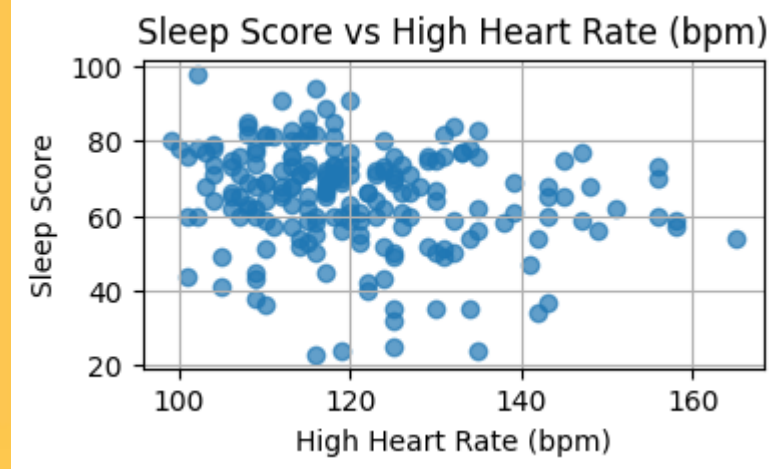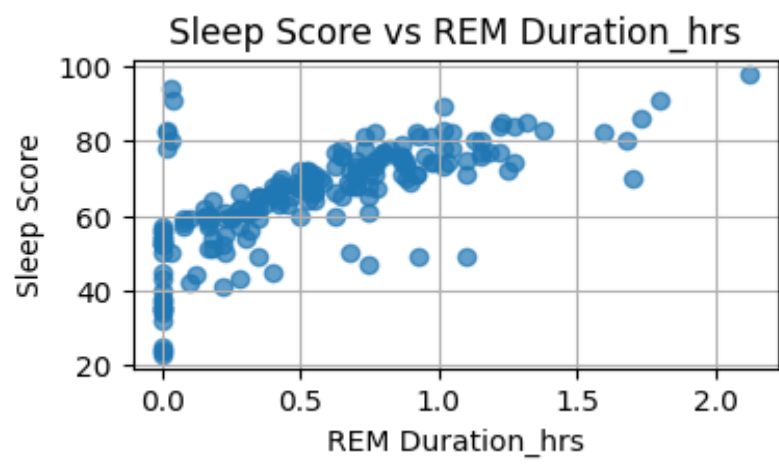
| Parameter	MeanValue	Global Average	Comparison
Sleep Duration (hrs)	6.2922	7-8 hrs	Below the global average; insufficient sleep may affect overall health.
Sleep Score	64.925	~75-85	Below the average, indicating moderate to poor sleep quality.
Stress Avg	18.23	~10-15	Higher than average stress levels, which could negatively impact sleep and overall well-being.
Deep Sleep Duration (hrs)	1.5787	~1.5-2 hrs	Near the lower end of the average range.
Light Sleep Duration (hrs)	4.1865	~4-5 hrs	Within the global average range.
REM Duration (hrs)	0.53805	~1.5-2 hrs	Below average REM sleep, potentially impacting memory and emotional regulation.
Awake Time (hrs)	0.23845	~0.5 hrs	Lower than average, indicating minimal wake time during sleep cycles, which is good.

Avg SpO$_2$	0.94865 (~94.8%)	~95-98%	**Slightly below average, indicating mildly reduced oxygen saturation during sleep.**
Lowest SpO$_2$	0.93545 (~93.5%)	~90-95%	Within the expected range, though closer to the lower end.
Avg Respiration (bprm)	15.65	~12-20 bprm	Within the normal range of respiratory rates.
Lowest Respiration (bprm)	10.99	~10-12 bprm	Within the lower end of the range, indicating efficient breathing during sleep.
Steps	7388.71	~7000-10,000 steps/day	Within the recommended range but slightly below the upper average for active individuals.
Resting Heart Rate (bpm)	47.235	~60-100 bpm	Significantly below average, which is common for highly fit individuals or athletes.
High Heart Rate (bpm)	120.675	~120-140 bpm	Within the average range for peak heart rate.

Linear Regression Model to predict Sleep Duration
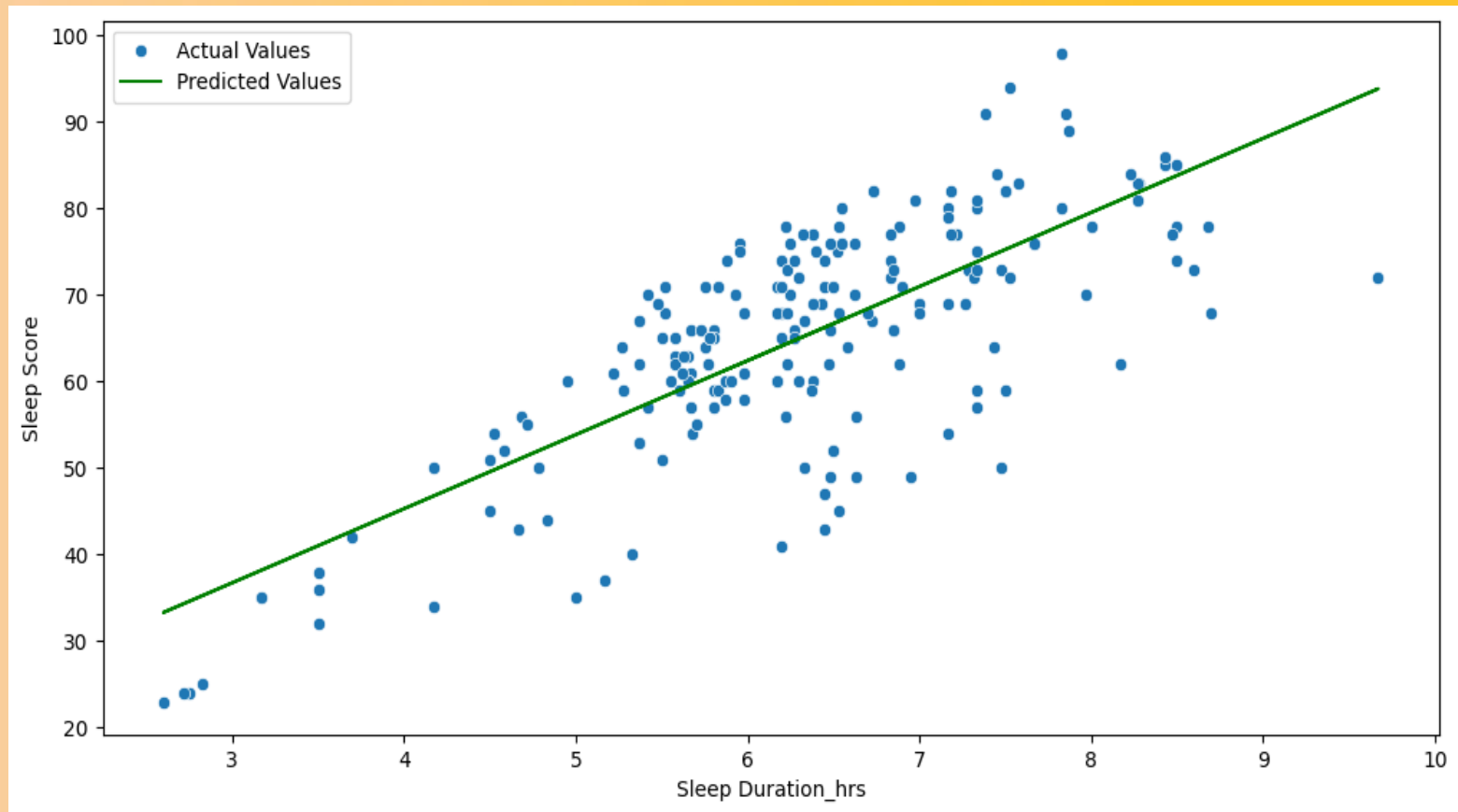
```python
# Detect anomalies in Sleep Duration
anomalies = df[(df['Sleep Duration_hrs'] < 4) | (df['Sleep Duration_hrs'] > 10)]

print("Anomalies in Sleep Duration vs. Sleep Score:")
print(anomalies)
```

```python
# Identify outliers using the IQR method
def detect_outliers(column):
    Q1 = df[column].quantile(0.25)
    Q3 = df[column].quantile(0.75)
    IQR = Q3 - Q1
    lower_bound = Q1 - 1.5 * IQR
    upper_bound = Q3 + 1.5 * IQR
    return df[(df[column] < lower_bound) | (df[column] > upper_bound)]

# Detect outliers for each sleep stage
outliers_deep_sleep = detect_outliers('Deep Sleep Duration_hrs')
outliers_rem_sleep = detect_outliers('REM Duration_hrs')
outliers_light_sleep = detect_outliers('Light Sleep Duration_hrs')

# Print results
print("Outliers in Deep Sleep Duration:")
print(outliers_deep_sleep)
print("Outliers in REM Duration:")
print(outliers_rem_sleep)
print("Outliers in Light Sleep Duration:")
print(outliers_light_sleep)

outliers_deep_sleep.to_csv('outliers_deep_sleep.csv')
outliers_rem_sleep.to_csv('outliers_rem_sleep.csv')
outliers_light_sleep.to_csv('outliers_light_sleep.csv')
```
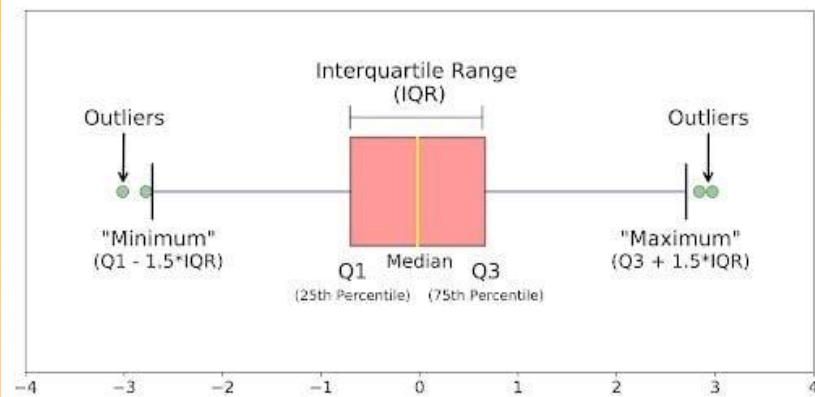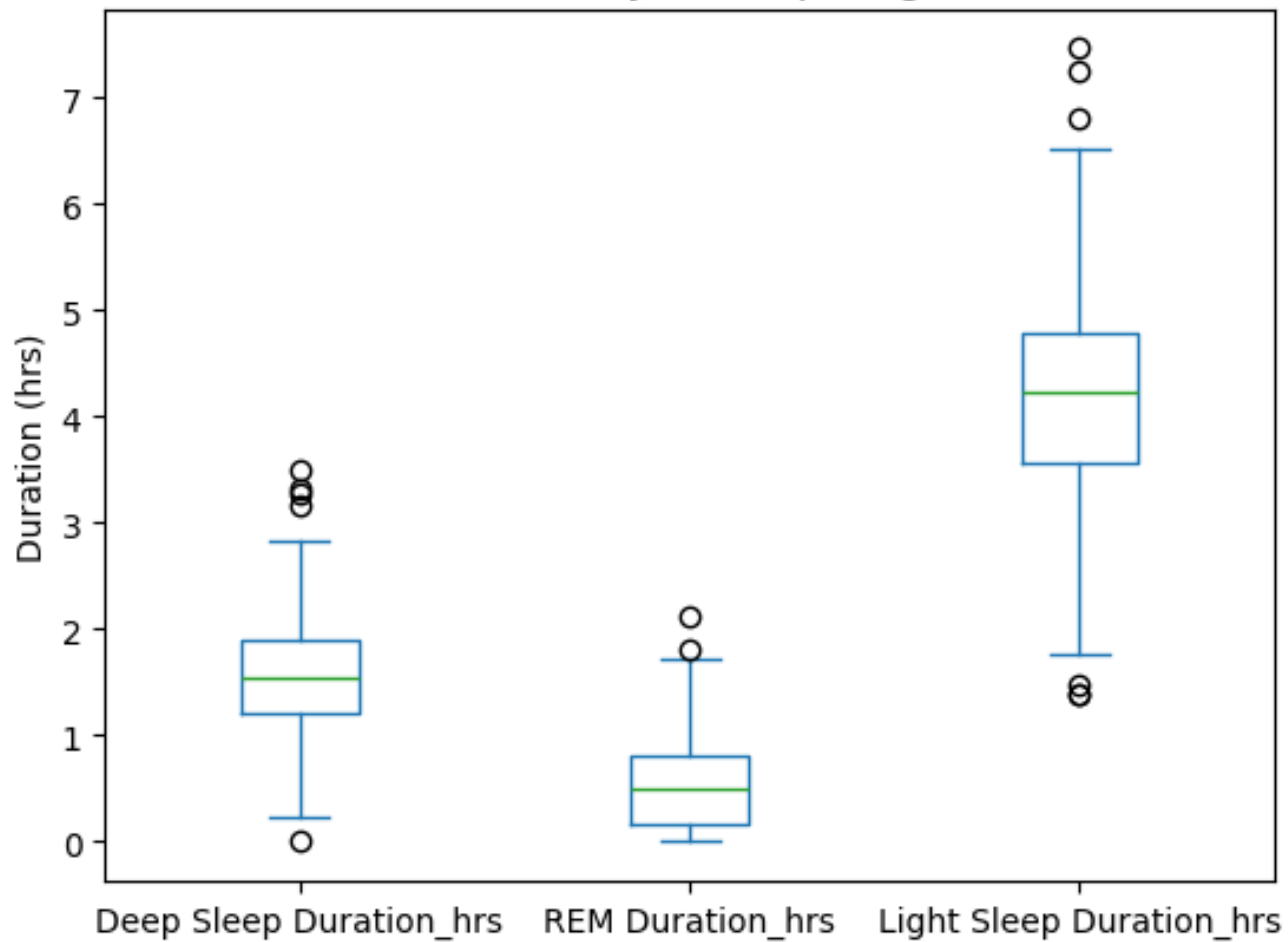
Consistency of Sleep Stages

Deep Sleep Duration

➤ **The median for deep sleep duration is around 1.5–2 hours.**

➤ **IQR (Interquartile Range): The IQR is relatively small, indicating that most data points for deep sleep duration are consistent across individuals.**

➤ **Outliers: Several outliers are visible above the upper whisker (more than 3 hours). These may represent individuals with abnormally long periods of deep sleep or recording errors.**

Actionable Insight:

➤ **If deep sleep duration is below 1.5 hours for most individuals, focus on improving deep sleep through:**

➤ **A cooler, darker sleep environment.**

➤ **Avoiding caffeine or alcohol close to bedtime.**

➤ **Maintaining a consistent sleep schedule.**

REM Sleep Duration

➤ **Median: Approximately 0.5 hours, suggesting that most individuals spend relatively little time in this sleep stage.**

➤ **IQR: REM durations mostly range between 0.3 and 0.7 hours, showing less variability compared to other stages.**

➤ **Outliers: Some outliers exist below 0.3 hours and above 0.8 hours, indicating abnormal durations of REM sleep for a few individuals.**

Actionable Insight:

REM sleep is crucial for cognitive functions like memory and mood regulation. The goal should be 1.5–2 hours of REM sleep per night.

To improve REM sleep, focus on stress management, maintaining a dark, quiet sleep environment, and avoiding late-night alcohol consumption.

Light Sleep Duration

- ➤ **Median: Approximately 4 hours, suggesting light sleep constitutes the largest portion of sleep for most individuals.**

- ➤ **IQR: Light sleep durations span 3 to 5 hours, showing greater variability compared to deep and REM sleep.**

- ➤ **Outliers: A few individuals exceed 7 hours, indicating a disproportionate amount of time in light sleep, which may indicate fragmented or poor-quality sleep.**

Actionable Insight:

- ➤ **While light sleep is normal and makes up the majority of total sleep, excessive light sleep may suggest inefficient sleep cycles.**

- ➤ **Focus on improving sleep quality through consistent sleep schedules and reducing nighttime disturbances.**

Overall Observations

The consistency in Deep Sleep Duration and REM Duration is a positive sign, with fewer variations across days.

Variability in light sleep duration could be due to lifestyle habits, sleep disruptions, or other factors (e.g., late-night activity, stress, or underlying health issues).

| Sleep Stage	Proportion in Chart	Global Average	Comparison
Deep Sleep Duration	25.00%	15–20%	Above average; positive as deep sleep aids in physical restoration and immunity.
REM Sleep Duration	8.50%	20–25%	Significantly below average; may impact cognitive function and memory.
Light Sleep Duration	66.40%	50–60%	Above average; could indicate fragmented or less restorative sleep cycles.

Cumulative Sleep Duration Trends
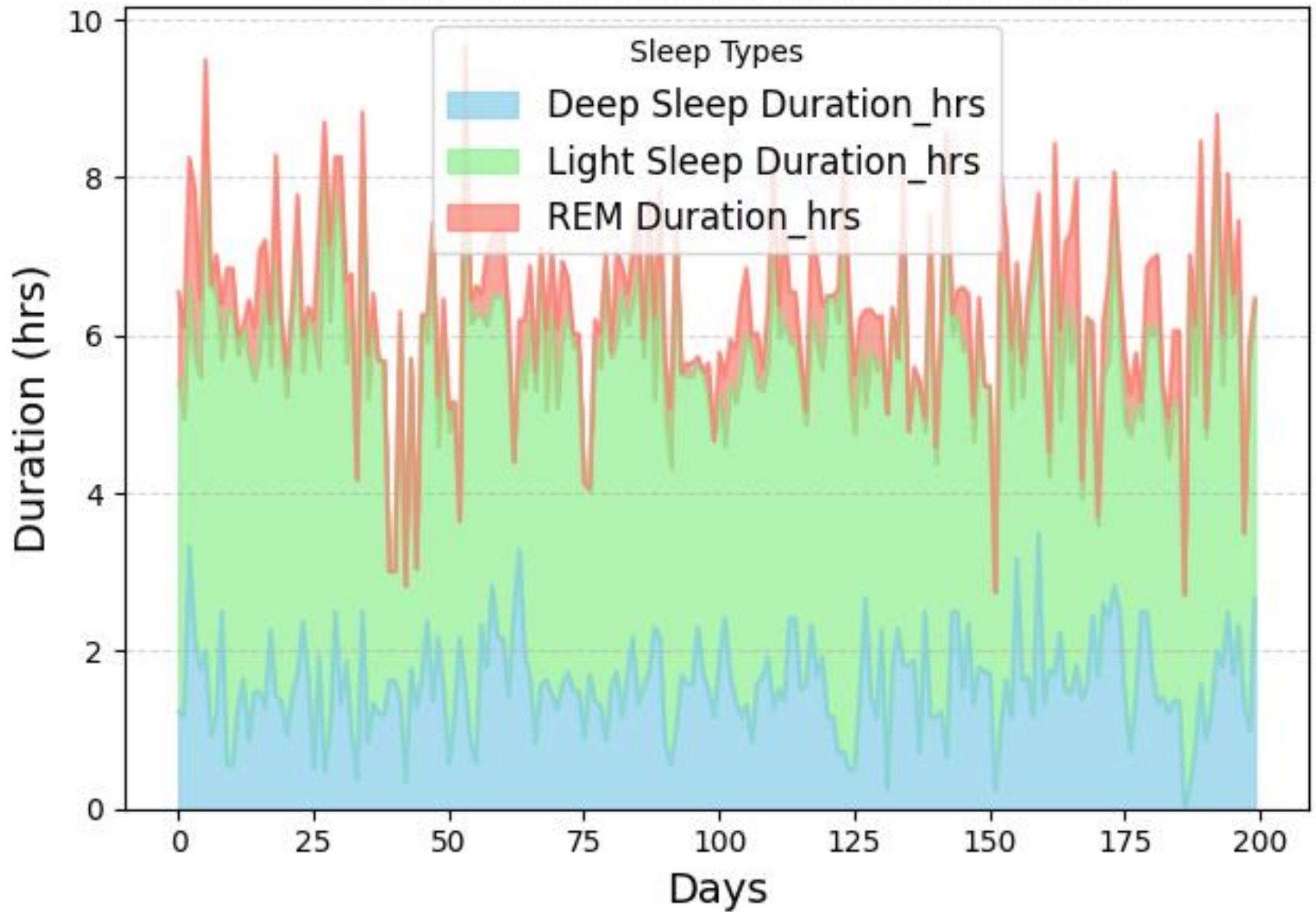
KDE Plot of Avg SpO₂ and Lowest SpO₂
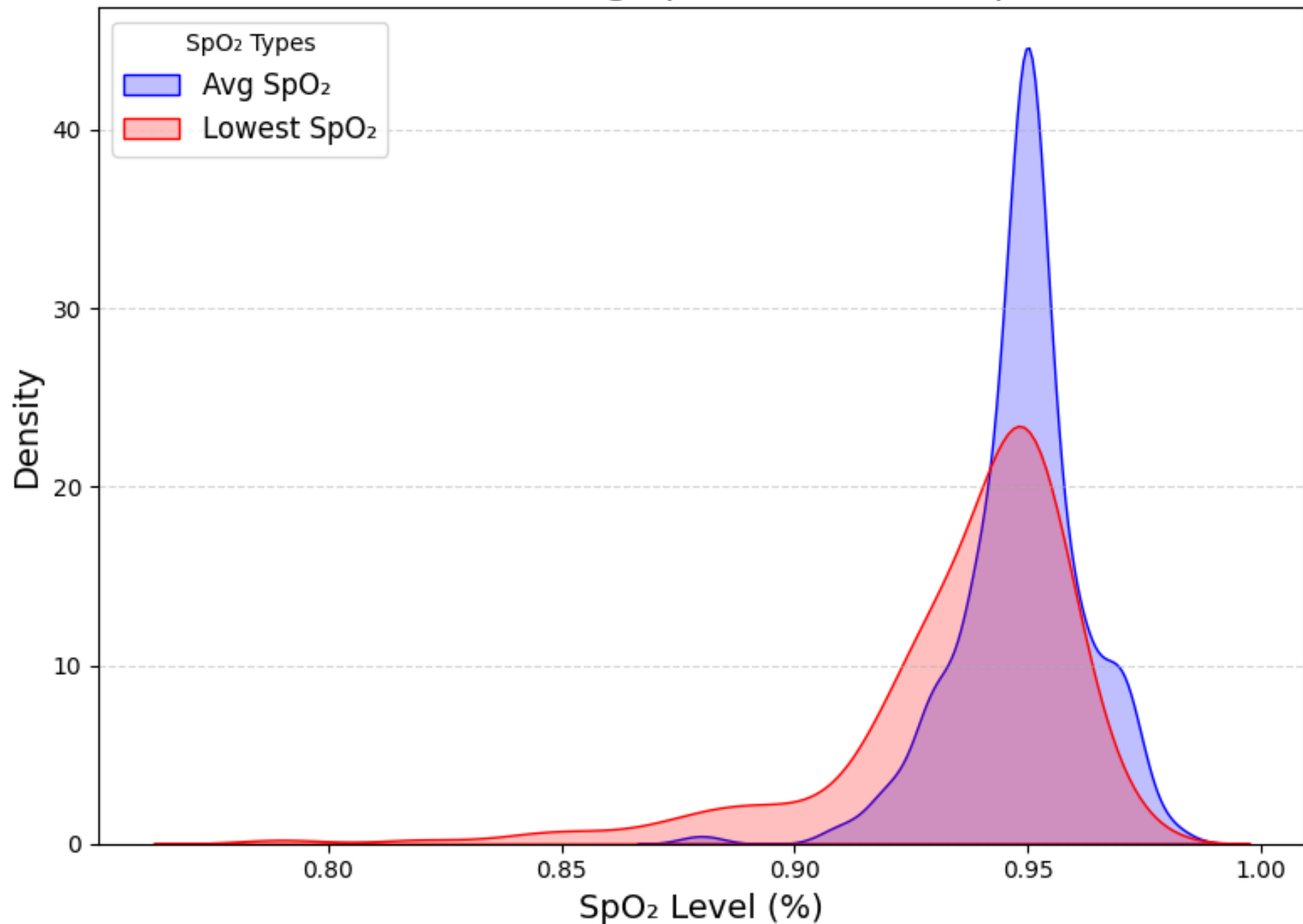
Heart Rate and Sleep Score Over Time
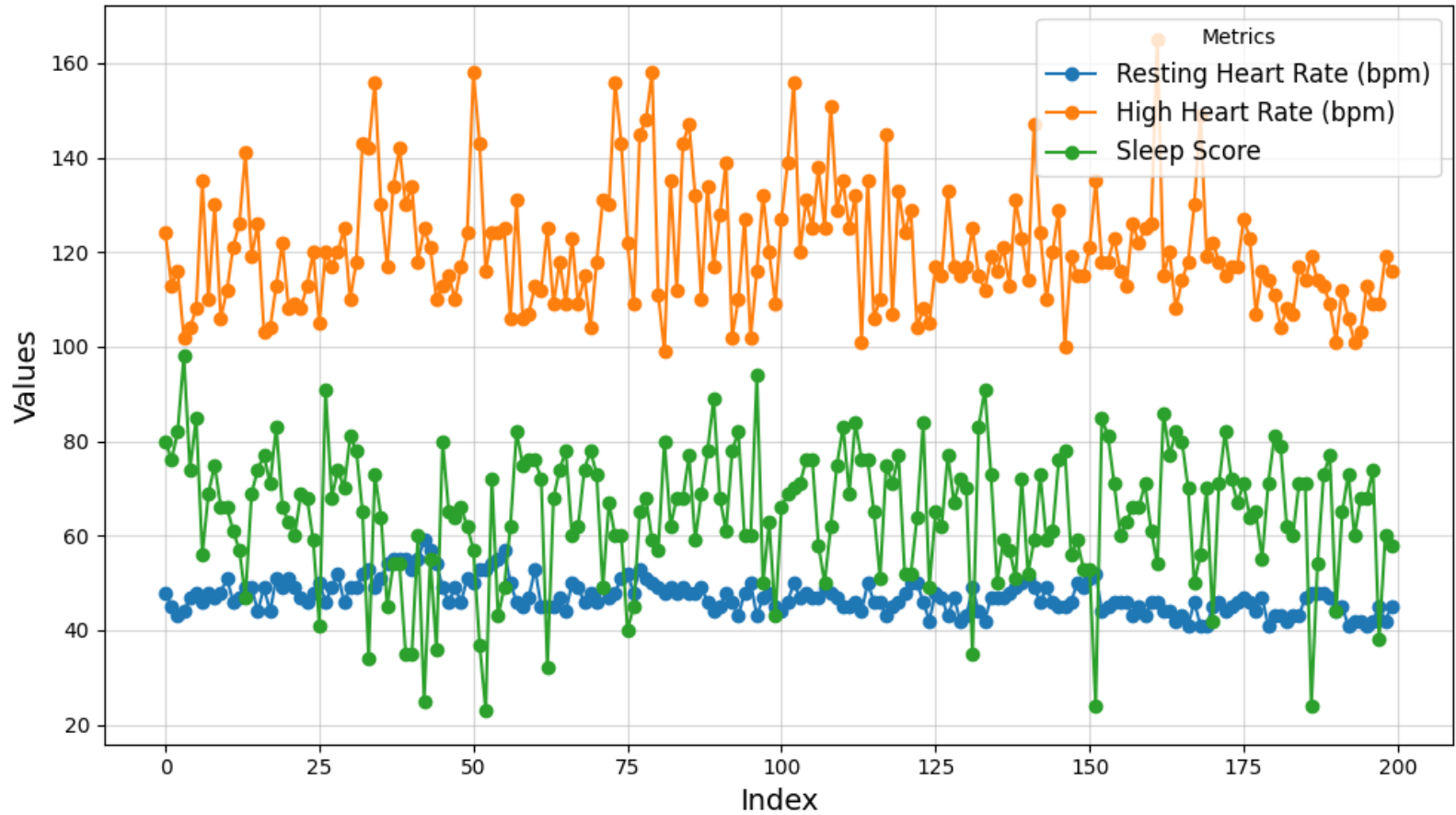
```python
# Convert the 'Date' column to datetime format
df['Date'] = pd.to_datetime(df['Date'], errors='coerce')

# Extract the day of the week from the 'Date' column
df['Day of Week'] = df['Date'].dt.day_name()

# List of columns to analyze
columns_to_analyze = [
    'Sleep Duration_hrs', 'Sleep Score', 'Stress Avg',
    'Deep Sleep Duration_hrs', 'Light Sleep Duration_hrs',
    'REM Duration_hrs',
]

# Generate a separate plot for each day of the week
ordered_days = ['Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday', 'Sunday']

for day in ordered_days:
    # Filter data for the specific day
    day_data = df[df['Day of Week'] == day]

    # Plot all metrics for this day
    plt.figure(figsize=(12, 6))
    for column in columns_to_analyze:
        plt.plot(day_data['Date'], day_data[column], marker='o', label=column)

    # Add labels, title, and legend
    plt.title(f"Metrics Trend on {day}", fontsize=16)
    plt.xlabel("Date", fontsize=14)
    plt.ylabel("Values", fontsize=14)
    plt.legend(title="Metrics", fontsize=12)
    plt.grid(alpha=0.5)
    plt.tight_layout()
    plt.show()
```
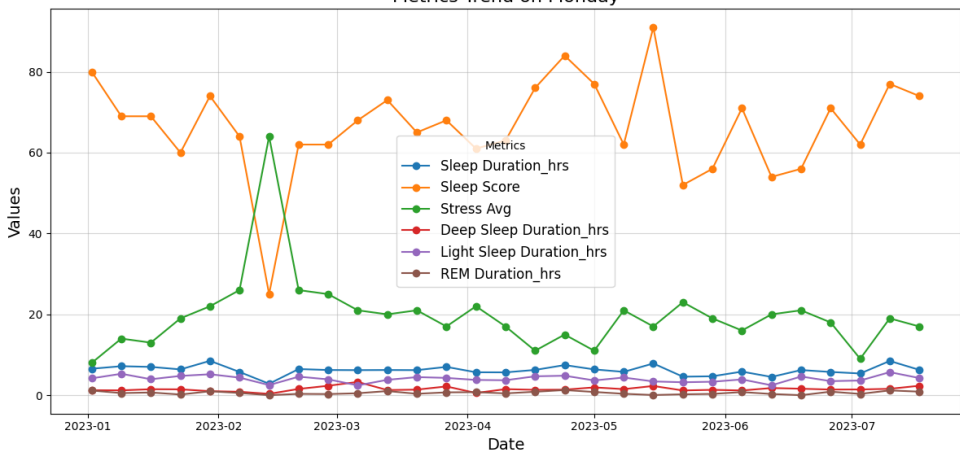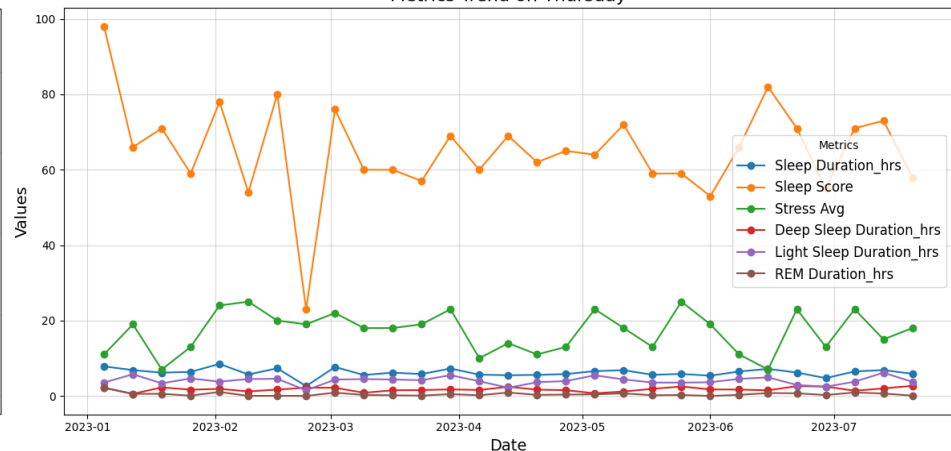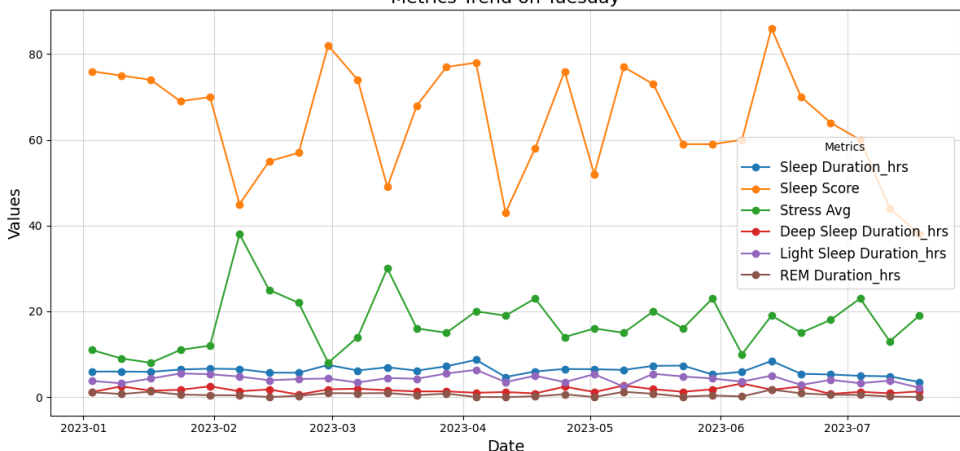
✓ 4.2s
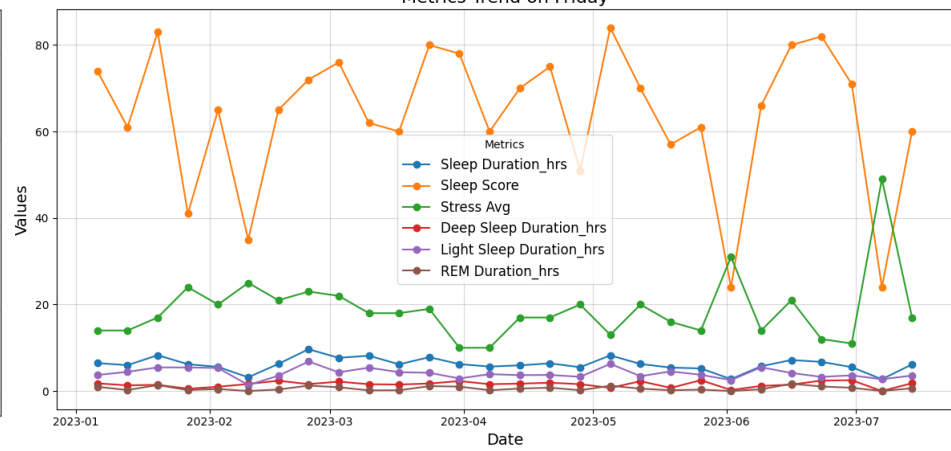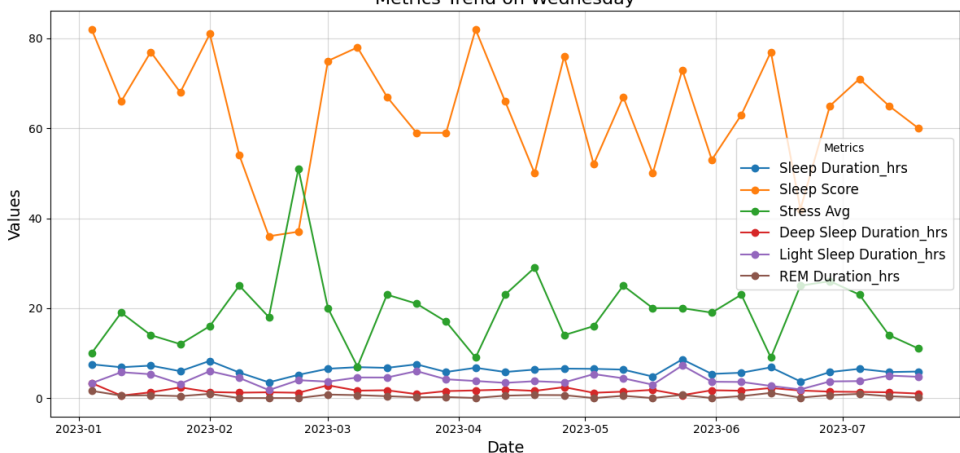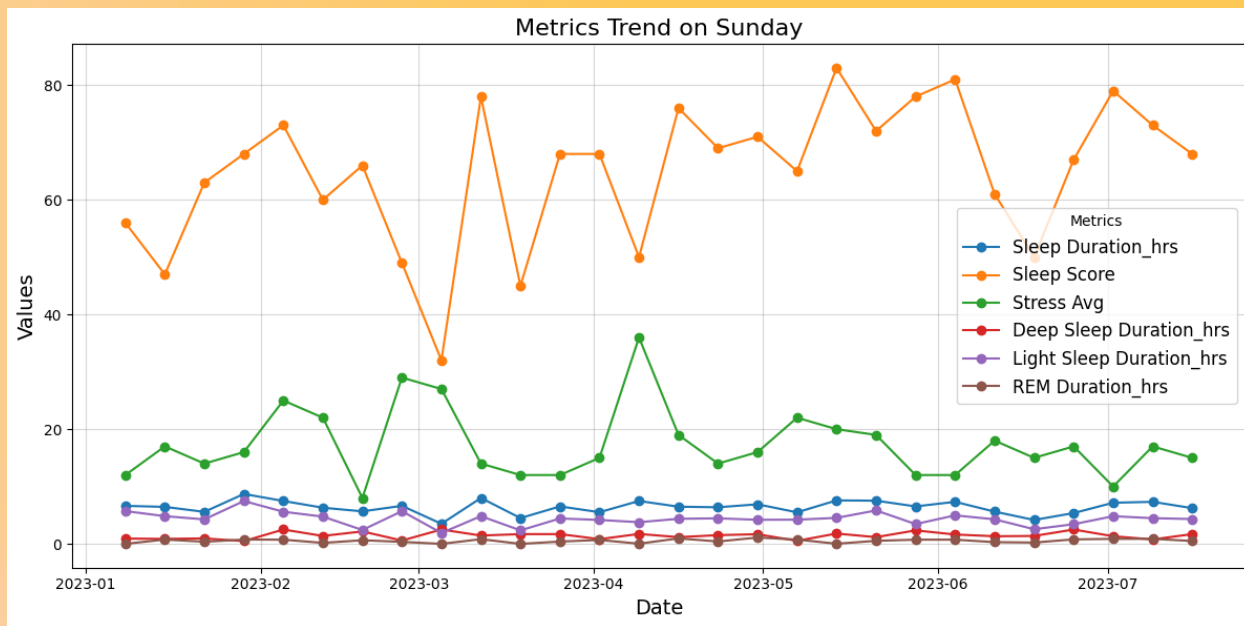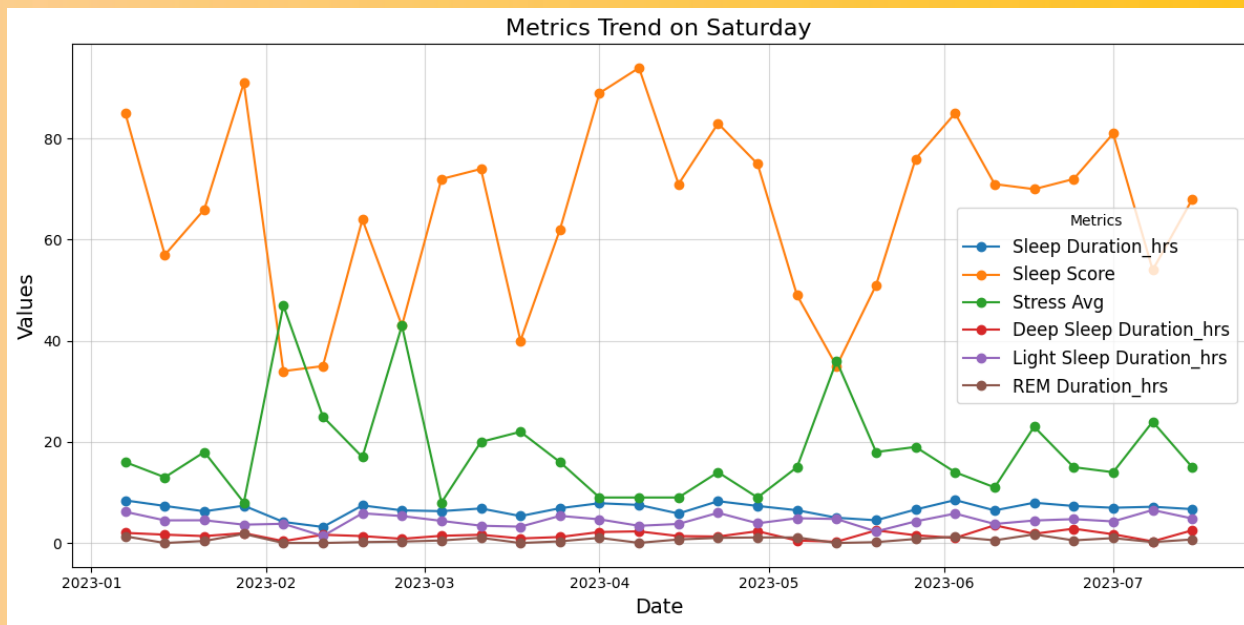
Python

Metrics Trend on Saturday

Metrics Trend on Sunday

Weekend VS Weekday

```python
df['Week Type'] = df['Day'].apply(
    lambda x: 'Weekend' if x in ['Saturday', 'Sunday'] else 'Weekday'
)
columns_to_analyze = [
    'Sleep Duration_hrs', 'Sleep Score', 'Stress Avg',
    'Deep Sleep Duration_hrs', 'Light Sleep Duration_hrs',
    'REM Duration_hrs', 'Resting Heart Rate (bpm)'
]
# Group by Week Type (Weekday or Weekend) and calculate mean values
week_comparison = df.groupby('Week Type')[columns_to_analyze].mean()
print("Comparison between Weekdays and Weekends:")
print(week_comparison)
plt.figure(figsize=(14, 8))
week_comparison.T.plot(kind='bar', figsize=(14, 8), rot=45, grid=True)
plt.title("Comparison of Metrics Between Weekdays and Weekends", fontsize=16)
plt.ylabel("Average Values", fontsize=14)
plt.xlabel("Metrics", fontsize=14)
plt.legend(title="Week Type", fontsize=12)
plt.tight_layout()

plt.show()
```
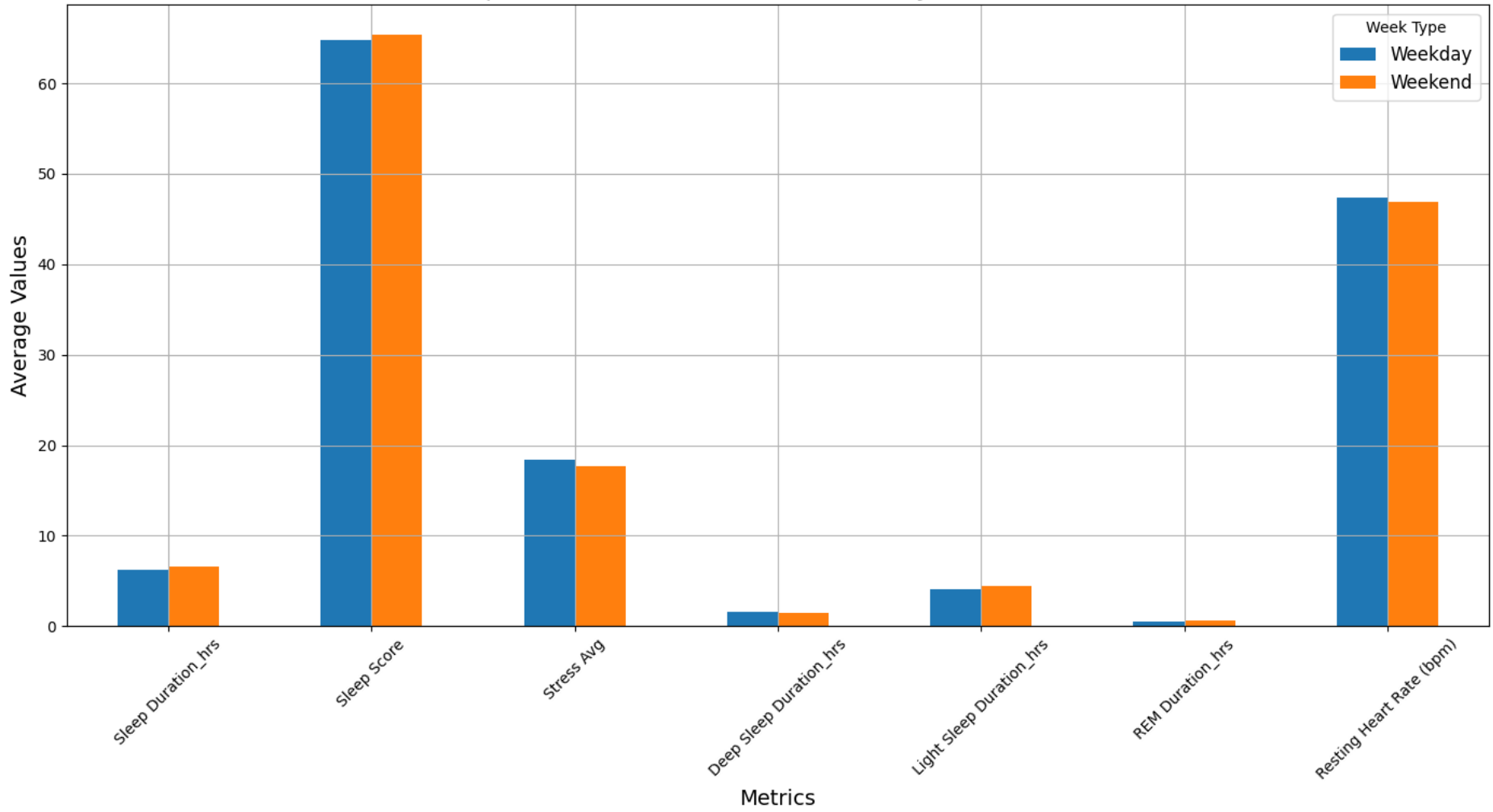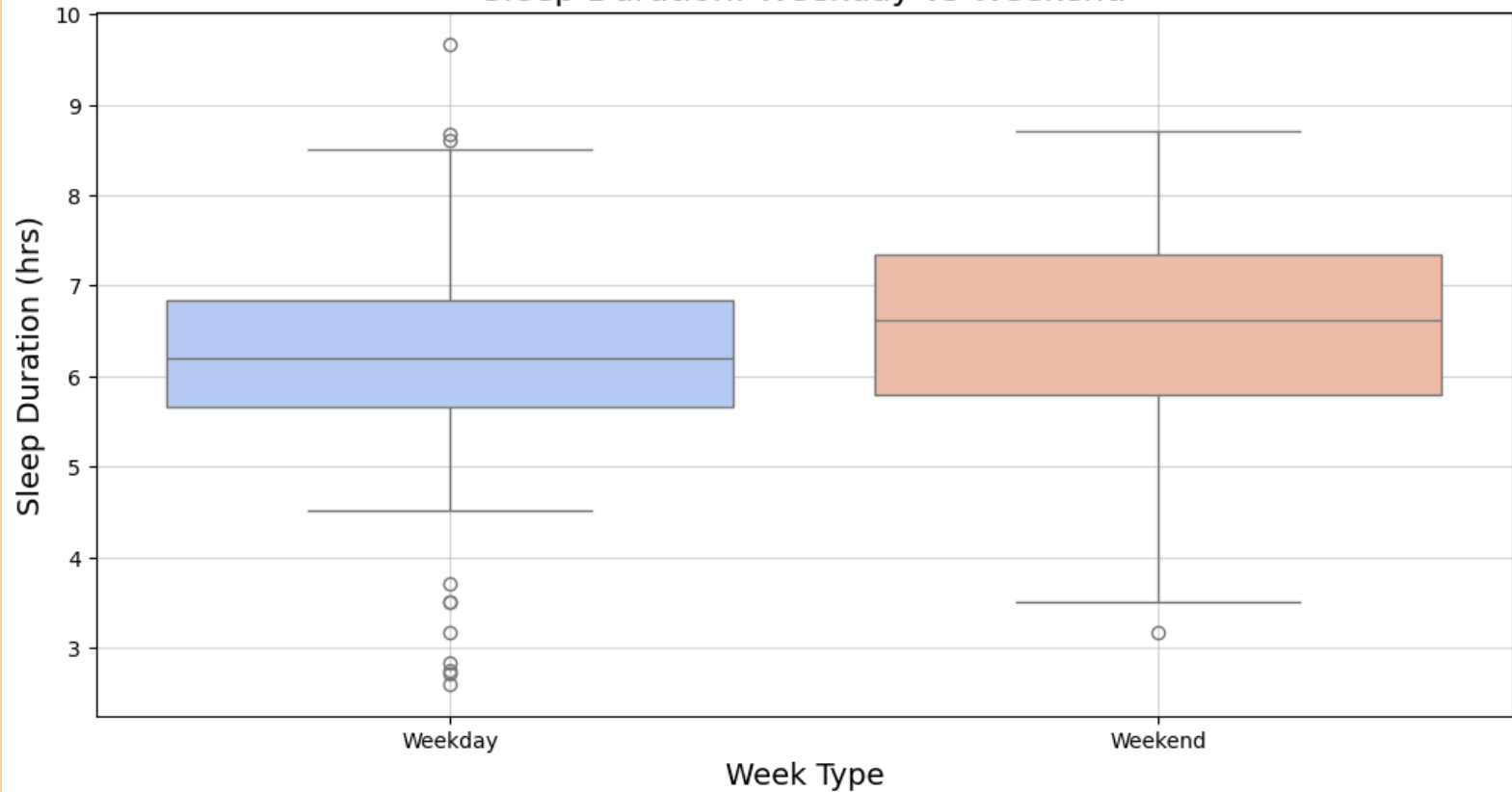
✓ 1.1s

Python

Comparison of Metrics Between Weekdays and Weekends

Sleep Duration: Weekday vs Weekend

Aspect	Weekday	Weekend	Insights
Median Sleep Duration	~6 hours	~7 hours	Sleep duration is higher on weekends, indicating compensatory sleeping.
Interquartile Range (IQR)	5–7 hours	6–8 hours	Weekends show less variability, suggesting more consistent sleep patterns.
Outliers (Low)	Below 4 hours	Below 5 hours	More individuals experience insufficient sleep on weekdays compared to weekends.
Outliers (High)	Above 9 hours	Above 9 hours	Some individuals oversleep on both weekdays and weekends, likely compensating for deficits.
Variability	Higher variability	Lower variability	Weekday sleep patterns are more inconsistent compared to weekends.
Key Comparison	Shorter sleep duration, more outliers	Longer sleep duration, fewer outliers	Weekends generally show healthier sleep patterns compared to weekdays.

Average Sleep Efficiency: 96.37%

Low Averages for Other Parameters

1. Short Total Sleep Duration	Inadequate total sleep reduces time available for REM and light sleep stages.
2. Disrupted Sleep Architecture	High efficiency doesn't reflect the quality or balance across sleep stages.
3. Weekday vs. Weekend Sleep	Short weekday sleep durations reduce averages across all stages, especially REM sleep.

Recommendations for Better Sleep

➢ Maintain a consistent sleep schedule.

➢ Create a comfortable sleep environment.

➢ Limit caffeine and screen time before bed.

➢ Engage in regular physical activity.

➢ Monitor and reduce stress levels.