Metrics Summary

Metrics

1. Sleep Metrics

1.1 Sleep Efficiency (SE)

Definition: Ratio of total sleep time to time spent in bed.
Formula:

$$SE = \frac{\text{Total Sleep Time}}{\text{Time in Bed}}$$

Insights: High SE ($> 85\%$) indicates efficient sleep; low SE ($< 85\%$) suggests fragmented or poor sleep quality.

1.2 Total Sleep Time (TST)

Definition: Cumulative duration of sleep during a 24-hour period.
Formula:

$$TST = \text{Sleep Offset Time} - \text{Sleep Onset Time}$$

Insights: Evaluates whether participants meet recommended sleep durations.

1.3 Wake After Sleep Onset (WASO)

Definition: Total time spent awake after initially falling asleep.
Formula:

$$WASO = \text{Sum of Awake Durations (after Sleep Onset)}$$

Insights: High WASO reflects restless or fragmented sleep.

1.4 Sleep Midpoint

Definition: Average time between sleep onset and offset.
Formula:

$$\text{Sleep Midpoint} = \frac{\text{Sleep Onset Time} + \text{Wake Time}}{2}$$

Insights: Provides circadian rhythm alignment information.

1.5 Sleep Latency

Definition: Time between going to bed and falling asleep.
Formula:

$$\text{Sleep Latency} = \text{Sleep Onset Time} - \text{Bedtime}$$

Insights: Longer sleep latency often indicates difficulty initiating sleep.

1.6 Sleep Fragmentation Index

Definition: Measures frequency of awakenings during sleep.
Formula:

$$\text{Fragmentation Index} = \frac{\text{Number of Awakenings}}{\text{Total Sleep Time}}$$

1.7 Intra-Individual Standard Deviation of Sleep Duration

Definition: Measures variability in sleep duration across nights.
Formula:

$$\text{Standard Deviation} = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n}}$$

Insights: High variability may indicate irregular sleep schedules.

1.8 Interdaily Stability (IS)

Definition: Quantifies regularity of sleep-wake cycles across days.
Formula:

$$IS = 1 - \frac{\text{Variance of Daily Sleep Durations}}{\text{Mean Daily Sleep Duration}^2}$$

1.9 Sleep Regularity Index (SRI)

Definition: Probability of being asleep or awake at the same time on consecutive days.
Formula:

$$SRI = \frac{\text{Consistent States Across Consecutive Days}}{\text{Total States Compared}}$$

1.10 Social Jet Lag (SJL)

Definition: Difference in sleep timing between weekdays and weekends.
Formula:

$$SJL = |\text{Weekend Sleep Midpoint} - \text{Weekday Sleep Midpoint}|$$

2. Physical Activity Metrics

2.1 Total Daily Steps

Definition: Sum of steps recorded per day.
Formula:

$$\text{Total Daily Steps} = \sum \text{Step Counts Over a Day}$$

2.2 Activity Intensity Distribution

Definition: Proportion of time spent in different activity levels (sedentary, light, moderate, vigorous).
Formula:

$$\text{Intensity Distribution} = \frac{\text{Time in Intensity Level}}{\text{Total Time}}$$

Insights: Highlights time distribution among activity intensities.

2.3 Energy Expenditure

Definition: Daily caloric burn estimate based on activity levels and accelerometer data.
Formula:

$$\text{Energy Expenditure} = \text{Activity Coefficient} \times \text{Total ENMO}$$

2.4 Non-Wear Time Analysis

Definition: Periods when the device was not worn.
Formula:

$$\text{Non-Wear Time} = \sum(\text{Non-Wear Flag})$$

Insights: Helps exclude invalid data points.

2.5 Circadian Rhythm Consistency

Definition: Regularity of activity levels at the same times across days.
Formula:

$$\text{Consistency} = \text{Correlation of Activity Levels Across Days}$$

3. Behavioral Metrics

3.1 Screen Time Patterns

Definition: Average daily internet/computer use hours.
Formula:

$$\text{Average Screen Time} = \frac{\text{Total Hours Online}}{\text{Number of Days}}$$

3.2 Digital Dependency Score

Definition: Composite of PCIAT scores and internet usage hours.
Formula:

$$\text{Dependency Score} = \text{PCIAT Score} + \text{Internet Use Hours}$$

3.3 Sleep and Internet Use Mismatch

Definition: Difference between screen time before bed and average sleep onset latency.
Formula:

$$\text{Mismatch} = \text{Screen Time Before Bed} - \text{Sleep Latency}$$

3.4 Internet Use Impact

Definition: Correlation between internet use and sleep quality metrics.

4. Combined Metrics

4.1 Physical and Mental Health Composite Index

Definition: Combines CGAS, BMI, and sleep quality scores.
Formula:

$$\text{Composite Index} = \frac{\text{CGAS} + \text{BMI} + \text{Sleep Quality Score}}{3}$$

4.2 Internet Use vs. Activity Tradeoff

Definition: Ratio of screen time to physical activity time.
Formula:

$$\text{Tradeoff Ratio} = \frac{\text{Screen Time}}{\text{Physical Activity Time}}$$

5. Social and Environmental Context

5.1 Impact of Ambient Light

Definition: Correlation between ambient light exposure and sleep onset/offset.

5.2 Quarterly Variations

Definition: Trends in activity and sleep metrics across seasons.
Formula:

$$\text{Quarterly Variation} = \text{Difference in Metrics Across Quarters}$$

6. Predictive Modeling Features

Feature Engineering

Examples:

- Temporal patterns in actigraphy (morning vs. evening activity).
- High-risk binary indicators based on thresholds (e.g., high PCIAT, low SE).