The Impact of Exercise Habits on Physical and Mental Health Among Students

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*Abstract*— Exercise is a critical factor in maintaining physical and mental well-being, particularly among college students who often face stress, irregular sleep patterns, and demanding schedules. This study analyzes the relationship between exercise habits, mood, sleep quality, and overall well-being using the Fitness Trends Dataset. Linear regression and clustering methods were applied to explore correlations between step count, mood, and sleep hours. Results show that higher exercise intensity correlates with improved mood and better sleep quality. These findings highlight the value of regular exercise in promoting healthier lifestyles among students.

Keywords— Exercise frequency, sleep quality, mood analysis, college students, physical health, clustering, linear regression

# Introduction

Regular physical activity has long been associated with numerous health benefits, including stress management, improved sleep, and enhanced mood. For college students, these benefits are especially important in light of their demanding schedules and frequent mental health challenges. This study seeks to answer key questions related to exercise and its effects on mood, sleep, and well-being. The research questions are:

1. How does the frequency of exercise affect students' stress levels?
2. Are students who exercise regularly less likely to fall sick?
3. Is there a link between the type of exercise (e.g., cardio vs. strength) and physical health markers?
4. Does time spent exercising correlate with better sleep quality?
5. How does group exercise versus solo exercise impact motivation and consistency?

# Datasets

The dataset used for this research, titled **Fitness Trends Dataset**, contains 96 records collected over several days. It provides insights into various aspects of fitness and health, including daily step counts, mood scores, sleep quality, calories burned, and weight. Below are the dataset's key attributes:

## Features

1. **Step Count**: The number of steps taken daily, representing physical activity levels.
2. **mood**: A self-reported mood score, ranging from 100 to 300, where higher scores indicate better mood.
3. **Calories Burned**: Total calories burned daily, reflecting exercise intensity and effort.
4. **Hours of Sleep**: Total hours of sleep each day, used to assess sleep quality.
5. **Bool of Active**: A binary indicator (active or not) that provides additional context for daily activity.
6. **Weight kg**: The individual's weight in kilograms, which could influence exercise intensity and health markers.

## Data Cleaning

1. **Missing Values**: Zero values in the calories\_burned column were replaced with NaN, and rows with NaN were dropped.
2. **Outliers:** Extreme outliers in step\_count and hours\_of\_sleep were examined and removed to ensure data accuracy.
3. **Data Consistency**: Units and ranges for each attribute were checked to confirm consistency.

## Feature Engineering

1. **Exercise Intensity**: A new feature created by dividing step\_count by calories\_burned to measure physical effort during exercise.
2. **Sleep Category**: Sleep hours were categorized into three bins:
   * **Poor** (0–4 hours)
   * **Average** (5–7 hours)
   * **Good** (8+ hours)

The processed dataset was used for regression and clustering to uncover relationships between exercise habits and health outcomes.

# Methodology

This study applied a combination of statistical analysis, machine learning models, and data visualization techniques to explore the relationships between exercise, sleep, and mood. Below are the steps followed in the analysis

## Statistical Methods

1. **Correlation Analysis**:
   * Explored the relationships between variables such as step\_count, mood, and hours\_of\_sleep.
   * Provided insights into whether higher activity levels and longer sleep hours were associated with better mood.
2. **Descriptive Statistics**:
   * Calculated summary statistics such as means, medians, and standard deviations for all variables to understand data distribution.

## Machine Learning Models

1. **Linear Regression**:
   * Used to model the relationship between step\_count, hours\_of\_sleep, and mood.
   * Assessed the predictive power of step count and sleep hours on mood, with an RMSE of 15.37.
2. **K-Means Clustering**:
   * Applied to group individuals based on exercise intensity (Exercise\_Intensity) and sleep quality (hours\_of\_sleep).
   * Identified three clusters representing different activity and sleep patterns:
     1. Cluster 0: High activity, good sleep.
     2. Cluster 1: Moderate activity, average sleep.
     3. Cluster 2: Low activity, poor sleep.

## Data Visualization

1. **Scatter Plots:** Used to visualize relationships between step\_count and mood, as well as actual vs. predicted mood scores.
2. **Heatmaps**: Generated to show correlations between variables such as step\_count, calories\_burned, and hours\_of\_sleep.
3. **Clustering Visualizations**: Plotted clusters to highlight distinct groupings based on exercise and sleep patterns.

## Tools Used

1. **Python Libraries**:
   * Pandas and NumPy: For data cleaning and preprocessing.
   * Matplotlib and Seaborn: For creating visualizations.
   * Scikit-learn: For implementing linear regression and clustering algorithms.
2. **Hardware**:
   * Analysis was conducted on a laptop with 64RAM, ensuring sufficient computational power for clustering and regression.

# Results

The analysis reveals multiple insights into the relationships between exercise, mood, and sleep quality among students. Three key results are discussed: the impact of exercise frequency on mood, clustering by exercise intensity and sleep, and the relationship between exercise and predicted mood scores.

## Exercise Frequency and Mood

A graph with blue dots

Description automatically generated

1. Step Count vs. Mood

The scatter plot (Figure 1) shows a positive trend between the number of steps taken daily and mood scores. Students with higher step counts tend to report better mood scores, suggesting a clear relationship between physical activity and emotional well-being.

* **Observation**: There are clusters of mood scores, with most values concentrated around scores of 100, 200, and 300. These groupings suggest that some students may be reporting mood on a fixed scale, but the overall trend still shows higher mood with increased step counts.
* **Regression Analysis**:
  + A linear regression model was fitted using step\_count and hours\_of\_sleep as predictors for mood. The model had a Root Mean Square Error (RMSE) of **15.37**, indicating a reasonably good fit considering the small dataset size.
  + **Interpretation**: Each additional 1,000 steps taken is associated with an approximate increase in mood score by 10 points, controlling for sleep duration.

This analysis highlights the importance of maintaining regular physical activity for better emotional health.

## Clustering by Exercise Intensity and Sleep

A graph of a clustering chart

Description automatically generated with medium confidence

1. Clustering by Step Count and Sleep

Using K-Means clustering, the dataset was divided into three distinct groups based on exercise intensity (Exercise\_Intensity) and hours of sleep. The clustering results are visualized in Figure 2, showing clear separations between the three clusters.

* Cluster 0:
  + Represents individuals with high step counts and good sleep quality (7–9 hours).
  + These students are likely the most active and benefit from balanced physical activity and rest.
* Cluster 1:
  + Represents individuals with moderate step counts and average sleep quality (5–7 hours).
  + This group reflects students maintaining some activity levels but with less consistent sleep.
* Cluster 2:
  + Represents individuals with low step counts and poor sleep quality (<5 hours).
  + These students may lack physical activity and have disrupted sleep patterns.

**Interpretation**: The clustering analysis underscores the strong relationship between higher exercise intensity and better sleep quality. Students who exercised more regularly not only performed better physically but also enjoyed more restorative sleep.

## Predicting Mood from Exercise and Sleep

A diagram of a mood prediction

Description automatically generated

1. Mood Prediction

#### The relationship between mood, step count, and sleep quality was further explored using linear regression. The model’s predictions are visualized in Figure 3, where red dots represent predicted mood scores and blue dots represent actual scores.

* Key Findings:
  + Step Count: Positively associated with mood, where higher steps are linked to better mood scores.
  + Sleep Hours: Also positively associated with mood, where longer sleep durations result in higher mood scores.
* Model Fit:
  + The predicted mood scores closely follow the actual mood scores, with some deviations, particularly in the middle range of mood scores. These deviations may stem from unmeasured factors like stress, diet, or social interactions.

**Interpretation**: The model confirms that both exercise and sleep contribute significantly to mood. Students who maintain higher activity levels and longer sleep durations tend to report the highest mood scores.

## Relationship Between Exercise and Sleep Quality

The clustering results in Section B also highlight how exercise impacts sleep patterns:

* Students with higher exercise intensity (Cluster 0) are more likely to fall into the "Good Sleep" category.
* Low exercise intensity is strongly associated with poor sleep quality, emphasizing the role of regular physical activity in improving rest and recovery.

**Key Takeaway**: Exercise not only improves mood but also contributes to better sleep hygiene. This dual benefit makes physical activity an essential component of a healthy lifestyle.

## Limitations and Further Analysis

The dataset lacks direct indicators of stress or illness, which could provide deeper insights into the mental and physical benefits of exercise.

The mood scores appear to have been reported on a limited scale (e.g., 100, 200, 300), which may limit the granularity of the analysis.

Future work could incorporate more robust metrics, such as heart rate variability or detailed breakdowns of exercise type (e.g., cardio vs. strength training).

# Discussion

**Findings and Implications**

1. **Exercise and Stress**: Regular exercise correlates with reduced stress, reflected in improved mood scores.
2. **Exercise and Health**: While direct illness metrics were unavailable, improved sleep and mood suggest better overall health in active individuals.
3. **Sleep Quality**: Higher exercise intensity is linked to better sleep quality, reinforcing existing research.
4. **Motivation and Consistency**: Though not explicitly measured, group clustering indicates potential areas for further exploration of group vs. solo exercise.

**Importance**

These findings suggest that encouraging college students to adopt regular exercise routines can significantly enhance their well-being. Universities could promote exercise programs or provide resources for group activities to increase consistency and motivation.

# Conclusion

This study provides evidence that exercise habits positively affect mood and sleep quality among college students. Higher exercise intensity correlates with improved mood and better sleep, highlighting the importance of physical activity for mental and physical well-being. Clustering analysis further supports the link between exercise and healthier sleep patterns. While this research answers key questions about exercise and health, it opens avenues for future studies on exercise type, illness metrics, and group versus solo exercise dynamics. Encouraging regular exercise can play a vital role in fostering healthier lifestyles among students.

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