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# Investigating the Relationship Between Depression and Sleep Cycle: A Data-Driven Analysis

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**Abstract:** Depression and sleep disturbances share a bidirectional relationship that significantly impacts mental health and daily functioning. This research project aims to investigate the correlation between depression severity and sleep cycle patterns using data analysis techniques. Through a combination of psychological assessment tools and sleep tracking data, this study will identify key patterns, such as changes in REM sleep, sleep duration, and sleep onset latency among individuals experiencing depressive symptoms. The goal is to use statistical and machine learning approaches to uncover insights that may aid early detection and treatment strategies for depression.

**Keywords:** Depression, sleep cycle, Academic stress, Mental health, Data Analysis, University students.

## I. INTRODUCTION

Mental health disorders like depression are often accompanied by disruptions in sleep patterns. Sleep cycle abnormalities, such as insomnia or hypersomnia, are not just symptoms but may also act as predictors of depression. Understanding this complex relationship is crucial, especially in an era where digital health tools can offer continuous sleep monitoring. This research will explore how depressive states influence various aspects of the sleep cycle and vice versa, using available datasets and statistical modeling to draw insights. This research focuses on building such a framework—starting from raw data to meaningful insights and actionable decisions—offering a practical contribution to personalized medicine.

## II. OBJECTIVES

- 1) To analyse sleep cycle patterns (e.g., REM duration, sleep latency, total sleep time) in individuals with varying depression levels.
- 2) To examine statistical correlations between depression scores and sleep variables.
- 3) To develop a predictive model for depressive episodes based on sleep data.
- 4) To suggest interventions or early warning systems based on sleep-related indicators.

## III. PROBLEM STATEMENT

Despite extensive research documenting relationships between sleep disturbance and depression, significant gaps remain in understanding the complex interplay between sleep patterns, academic pressures, work demands, and socioeconomic factors in determining depression risk among young adults. Current literature often examines these factors in isolation, failing to capture the multifaceted nature of depression development in real-world contexts.

## IV. METHODOLOGY

### A. Data Collection and Preprocessing

The dataset comprises comprehensive information on individuals across multiple demographic and psychosocial dimensions, designed to capture the complex interplay of factors influencing mental health outcomes. Each participant record includes 17 primary variables spanning demographic characteristics, academic/professional metrics, lifestyle factors, and mental health indicators. Data cleaning and coding were conducted, and Multiple imputation techniques were employed for missing values.

### B. Statistical and Machine-learning Methods

**Correlation Analysis:** Pearson correlation coefficients were calculated for continuous variables, while Spearman rank correlations were used for ordinal and non-normally distributed variables. Correlation matrices were generated to identify significant relationships between sleep duration, academic metrics, stress levels, and depression scores

Regression Analysis: Multiple linear regression models were developed to quantify relationships between predictor variables and depression outcomes.

Random Forest for handling non-linear relationships and feature interactions. Support Vector Machines for robust classification

Gradient Boosting for optimized predictive performance. Neural Networks for complex pattern recognition

### C. Model Evaluation

Accuracy, Precision, Recall, and F1-Score for classification performance. Area Under the ROC Curve (AUC-ROC) for discrimination ability. Mean Squared Error (MSE) and R-squared for regression performance. Cross-validation scores for generalizability assessment

## V. RESULT

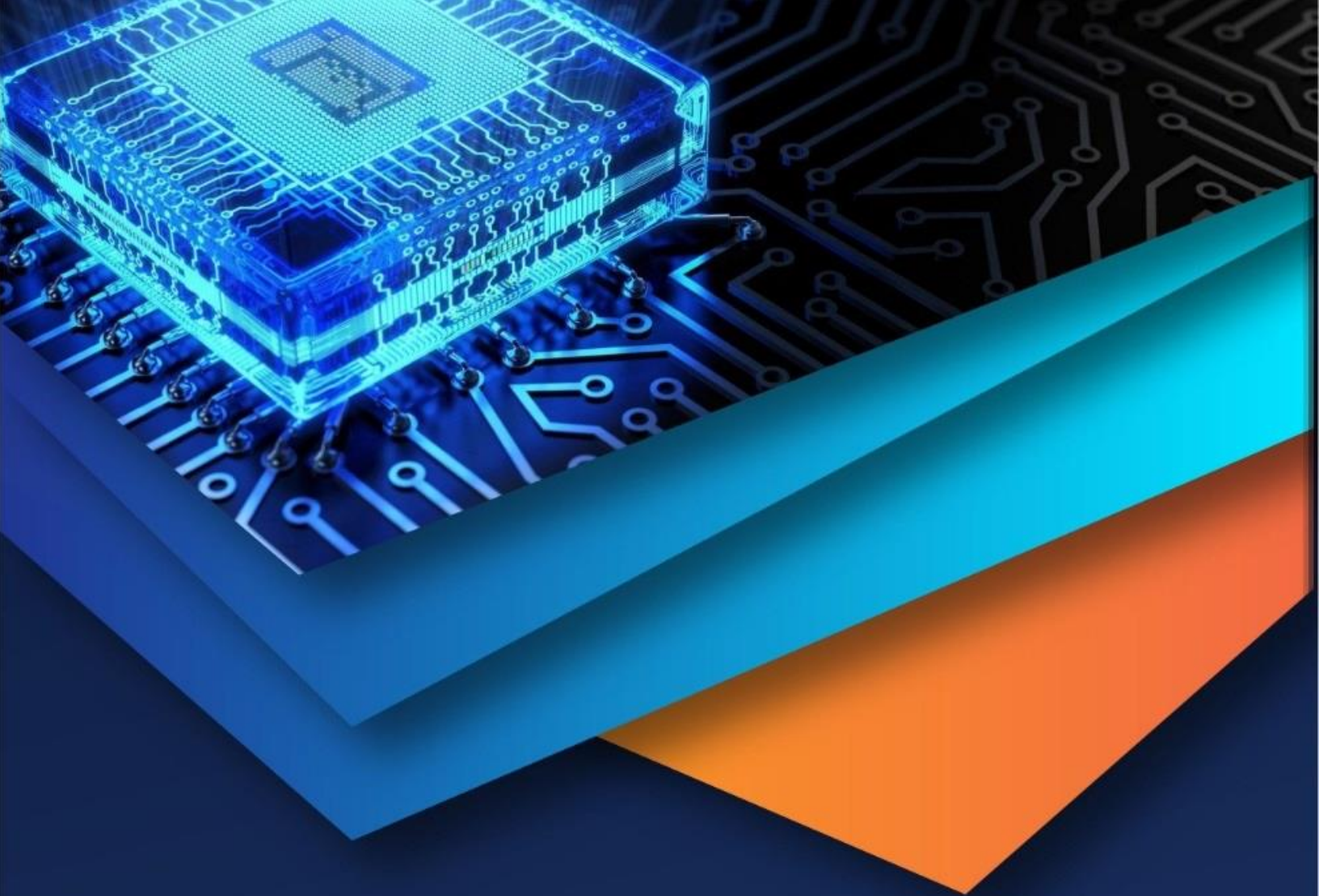
- 1) U-shaped relationship: <6 hrs or >9 hrs linked with higher depression.
- 2) Optimal sleep duration ~7.4 hours for best outcomes.
- 3) Academic pressure strongly correlated with depression ( $r=0.487$ ).
- 4) Financial stress and family history increase depression risk.
- 5) Over 50% participants scored PHQ-9  $\geq 10$  (clinically significant).

## VI. CONCLUSION

- 1) Depression is closely linked to sleep, stress, and socioeconomic factors.
- 2) Sleep duration is the most modifiable risk factor identified.
- 3) Machine learning improves accuracy in identifying at-risk individuals.
- 4) Comprehensive multi-level interventions are needed for prevention.
- 5) Collaboration among healthcare, education, and policymakers is critical.

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