A Machine Learning Based Approach to Detect the Impact of Sleeping Disorders on Mental Health in Youth.

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FINAL YEAR DESIGN PROJECT REPORT

This Report Presented in Partial Fulfillment of the Requirements for the **Degree of Bachelor of Science in Computer Science and Engineering**

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APPROVAL

This Project titled **"A Machine Learning Based Approach to Detect the Impact of Sleeping Disorders on Mental Health in Youth"**, submitted by **Sazal Das (213-15-4498) & Shah. Md. Mafidur Hasan (213-15-4350)** to the Department of Computer Science and Engineering, Daffodil International University has been accepted as satisfactory for the partial fulfillment of the requirements for the degree of B.Sc. in Computer Science and Engineering and approved as to its style and contents. The presentation has been held on **16 September, 2025.**

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We hereby declare that this project has been done by us under the supervision of **Dr. Naznin Sultana**, **Associate Professor**, Department of Computer Science and Engineering, Daffodil International University. We also declare that neither this project nor any part of this project has been submitted elsewhere for the award of any degree or diploma.

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ABSTRACT

Sleep is one of the basic needs of survival. Sleep helps to reactivate our bodies; it also helps to build and preserve memory and boost immunity. Our body feels relaxed because of sleep. It also relieves our extreme tiredness. Sleep helps in growth and development in children and adolescents. But nowadays sleeping disorders have become a great concern in our society mostly in the youth. Sleeping disorders are happening for so many ways, like-stress, anxiety, depression or an underlying health condition etc. In this paper we propose a machine learning solution to detecting the effect of sleeping disorders on mental health of young people. Adolescents commonly experience sleep difficulties, such as chronic insomnia and delayed sleep phase disorders, which have been demonstrated to adversely impact mental health symptoms such as anxiety, depression, and other psychiatric comorbidities. Using a mixture of youths' self-reports and clinical diagnoses, several machine learning models were developed to detect patterns associating sleep problems with mental health signs among the young population. The method allows for early identification of at-risk patients and timely intervention. The results show that the machine learning models have a high performance of predicting mental health effects due to types of sleep disorder. In addition, the study emphasizes certain sleep parameters that have the greatest impact on mental health of young people. For this problem, there are so many solutions. The research in the sleeping disorder area is really huge. There are a lot of machine learning algorithms which were proposed to detect sleeping disorders. Firstly, we apply the dataset preprocessing in our dataset. In this paper we are using some machine learning algorithm to detect the sleeping disorder problem in youth.

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Chapter 1

Introduction

People need sleep to live. We need sleep for memory, for learning, for mood balance and almost everything else in moderation even our immune response. Sleep disorders are being increasingly implicated as contributors to mental health problems in children and adolescents. Poor sleep quality has not only a direct impact on the physical body, but also influences mental health causing anxiety, depression and stress. The sooner we catch this and do an intervention, the better off we will be. Interesting insights into sleep data processing can be provided by machine learning algorithms, especially when considering the complicated patterns for sleep data and their role in predicting the risk for mental health disturbances related to sleep disorders. In this paper, we introduce millions of Pinterest and Community Health Center posting data collected from young users to help detect mental health problems of young individuals caused by sleeping disorders, raising awareness for early diagnosis and resulting in timely and optimized treatments and higher the overall health quality of younger population.

1.1 Introduction

Humans need sleep to survive. An adult needs 7 to 8 hours of sleep per day for a healthy body and mind. Sleep helps us maintain memory, learning ability, emotion regulation, and immunity. But due to busy lifestyles, dependence on technology, and stress, many people are not getting enough deep sleep. As a result, they suffer from various types of sleep problems. According to recent research, about 45% of the world's population suffers from some form of sleep disorder. Bangladesh is an emerging country where the rate of this problem is increasing day by day. Students, office workers, the elderly—almost all classes of people are affected by this problem! If sleep problems are neglected for a long time, it can have a serious impact on physical and mental health and destroy the quality of life. This paper will attempt to analyze various types of sleep problems, their symptoms, causes, remedies, and prevention methods. In addition, the importance of awareness and lifestyle changes to improve sleep quality will be highlighted.

1.2 Motivation

The issue of global mental health issues in young people is a growing concern and studies show that sleep disorders go hand in hand with mental health. Bangladesh has limited mental health resources; therefore, understanding the impacts of sleep disorder on the mental well-being of individuals in the younger age bracket is essential. Insomnia or disturbed sleep rhythm can exacerbate other issues such as anxiety, depression and stress that are currently becoming prevalent among the youths.

As technology advances, machine learning is a potentially useful tool within the medical field, particularly in investigations of mental health. Through machine learning models, we can work through extensive sets of data and identify patterns that might not be evident with a more conventional method. The approach can lead to earlier diagnoses, more successful interventions, and better mental health outcomes in youth.

Given that a large population in Bangladesh faces mental health issues, and because it is difficult to diagnose and treat mental illness, this research problem seeks to know how machine learning may be applied to predict how sleeping disorders are connected to youth mental health. By examining survey data collected among the youth, we will develop a

powerful model that will be utilized in future research and potential interventions.

1.3 Objectives

The main goal of the research will be to come up with a machine learning model to identify how the problem of sleeping disorders affects the mental health of young people. To do this the research will initially explore the correlation between various forms of sleeping disorders i.e. insomnia and disturbances in sleep patterns and how it leads to the mental health indicators i.e. anxiety, depression, and stress among young people. The study will then consider developing and testing different machine learning algorithms such as Decision Tree Classifier, Random Forest Classifier, K-Nearest Neighbors Classifier, XG Boost, and Logistic Regression to determine the effect of these sleeping disorders on mental health. My study also seeks to determine the most important characteristics that influence mental health outcomes, including the duration and quality of sleep and age through analysis of survey results. To identify the most efficient model to predict mental health outcomes, the different models will be evaluated based on the accuracy, precision, recall, F1-score, and AUC-ROC metrics. Lastly, the research will offer some insight into early intervention strategies and recommend potential policy changes to mitigate sleep-related mental health problems in young people.

1.4 Methodology

In this study, the researchers employed machine learning to identify the influence of sleeping disorders on mental health among the youths. This survey data was obtained by receiving 999 survey answers that included questions related to sleep behavior and mental health among youth ages. Questions covered the duration of sleep, sleep quality, the frequency of sleep disturbances, and some mental health variables, like anxiety, depression, and stress. Informed consent and the ethics of confidentiality were observed during the process. The data was then preprocessed to be machine learning friendly. The missing values were dealt with by means imputation and mode imputation respectively. To prevent distortion of results, outliers were detected and eliminated. No normalization or standardization was applied, so the data was left in its original scale, which may affect the model performance, but does not alter the original data distribution. The most important factors influencing mental health outcomes were identified through the technique of feature selection, correlation analysis and mutual information. The models have been used to work with key features such as the length of sleep, quality of sleep, and age. Five machine learning models were trained to predict the effect of sleeping disorders on the mental health: Decision Tree Classifier, Random Forest Classifier, K-Nearest Neighbors Classifier (KNN), XG Boost, and Logistic Regression. The models were trained on 70% of the data, and the remaining two-fifths of the data were used as testing 30% and evaluation. The cross-validation methods were used so that to make the models robust and to avoid overfitting.

The results of the performance of each model were evaluated based on some evaluation measures such as accuracy, precision, recall, F1-score, and curve. These measures were applied to compare the models and identify the most effective one to predict the effect of sleeping disorders on mental health. Lastly, the importance of features analysis was conducted to determine the most important factors that could affect mental health outcomes, which could be helpful in identifying what interventions can be made.

1.5 Project Outcome

This paper focuses on the alarming consequences of sleep disorders on the psyche of teenagers. The results of this study clearly demonstrate the fact that, sleep-deprived adolescents have a much higher risk of experiencing anxiety, depressive, and stressful conditions. In particular, the negative impact on mood stability and cognitive issues is increased by poor sleep, which is defined by the delay of the onset of sleep, numerous night awakenings, and short sleep time. In turn, such problems lead to poor academic performance and interpersonal relationship problems.
The significance of prevention and early intervention, which is also noted, is that additional efforts must be made to resolve sleep disorders by implementing sleep hygiene education, early disease diagnosis, and psychotherapy against sleep disorders. Good sleep hygiene should be encouraged to minimize the adverse impact on mental health, especially targeting youth and workers. By treating sleep-related problems early and providing proper treatment, mental well-being can be greatly enhanced, resulting in overall improved functioning.

1.6 Organization of the Report

The present research report encompasses six chapters, each of which addresses a particular dimension of the study for input from clarity, coherence, and academic depth.

Chapter 1: Introduction gives the background of the study. It states the background of the study, motivation behind the study, aims or research objectives, methods applied, expected deliverables, and the chapter described the way forward. The chapter then sets the stage and direction toward further discussions in the paper. Chapter 2: Background sets the research area in context. It shall give a literature review of the past studies, similar application, and related work. Chapter 3: Research Methodology encompasses the overall research design as a theoretical and technical framework. Proposed methodology: system design, functional and non-functional requirements, and visual models such as context diagram, data flow diagram, and UI design. Moreover, matters concerning data collection strategies, task allocation, and project planning will be discussed. Chapter 4: Implementation and Results discusses the actual implementation of the machine-learning models used in the study, with an overview of the environment setup, model training, and testing, performance evaluation, and comparison of algorithms. Discussion of results relative to the objectives and their thorough interpretation. Chapter 5: Engineering Standards and Design Challenges looks at the technical and ethical aspects of the project. It examines compliance with software, hardware, and communication standards, as well as the societal, environmental, and ethical impacts of the research. It also looks at sustainability planning, project management strategies, and financial analysis, as well as how the research resolves complex engineering issues. Chapter 6: Conclusion describes the major finding of the study, recognizes the limitations, and provides pointers toward future research directions. Each chapter builds upon the previous to create a coherent and structured narrative that guides the reader from the identification of the problem to real insights and practical solutions.

Chapter 2

Background

The study will use machine learning to study the effect of sleep disorders on youth mental health with the goals of creating predictive algorithms that can support early identification and intervention approaches to wellness. Sleep disturbances are very common in the young population and strongly associated with onset and worsening of mental health problems including depression, anxiety, and bipolar disorder. Disrupted sleep, including insomnia and delayed sleep phase, frequently accompanies mood disorders among children and adolescents, frequently exacerbating symptoms and diminishing response to treatment. Early detection and treatment of sleep problems are important because they can have a major impact on the mental health of young people.

2.1 Introduction

Understanding the relationship between sleep and mental health has become extremely important in modern research. Sleep plays an important role in brain function, emotion regulation, and maintaining mental stability. Sleep deprivation and irregular sleep patterns in young people are often associated with anxiety, stress, and depression. This study provides a background for analyzing these relationships through technology-assisted machine learning.

2.2 Literature Review

Primary care providers are faced with a variety of sleep complaints including daytime sleepiness and initiation and maintenance of sleep. The prompts are proven pathways (cognitive behavioral therapy, medications, positive air pressure therapies). For these reasons, she says that perhaps the main take-home message from the present study "is that we need better tools to identify and treat children." The next steps will include performing new technology applications, as well as efficacy in the treatment with longer, future courses [1].

The predominant subgroup of clinical content is covered in this narrative review in relation to the different sleep disorders frequent in the older adult population and its classification, methods for diagnosis and management. Within that framework, the review emphasizes non-pharmacologic treatment and outlines the current clinical guidelines for the approach of sleep problems in this population. It also requires more pharmacologic studies, development of stronger screening tools and personalized care within advances in technology. The review notes that a substantial expansion of this area will be required to optimize sleep health in the older population. [2]

The purpose of the current study was to construct predictive models that can effectively categorize individuals at risk for sleep disorders using simple, easily-obtainable information collected with completion of a behavioral questionnaire containing demographic, bedtime habit, and lifestyle information. This nonbattery operated handheld device showed promise for early screening in clinic and mobile health environments. It is intended in future work to embed an increasing 'population reach' and

to refine the model by feedback [3].

In this paper, the authors present a machine learning model-based approach to discriminatively detect chronic insomnia using multi-night actigraphy data obtained from wearable devices. The model can accurately detect additional sleep features like night-awakenings, and sleep efficiency and serves as a non-invasive pre-screening apparatus. This work is part of future validation of our technique and further extension of other physiological information as stated above [4].

The article examines the effects of sleepiness, duration and variability on adolescents' psychological well-being. Findings indicate that heightened sleepiness is related to anxiety, depression, and ill health but not sleep quantity or variability. The observational nature of the cross-sectional design and self-reports may bias the study. [5].
In this context, we developed a machine-learning tool to predict the at-home ApnoeaHypopnea Index (AHI) from oximetry and airflow signals for OSA screening. We developed a two-channel SVM model and it was assessed for validity and reliability and gave the ICC value close to 0.93 indicating a promising performance (AUC = 0.985, accuracy = 94%), and competitive with the traditional invasive diagnostic strategy. In the future, the team hopes to rigorously demonstrate the value of their approach and incorporate additional biological data [6].

Sleep in the home may be linked with daytime anxiety and other problematic daytime behaviours for people with ASD, given that at the individual level such problems vary in ways that do not vary among broader clinical dimensions (Jeste et al., 2019). In this study, the elastic net regression has been applied to the career report and actigraphy data with an emphasis on the importance of sleep variability. This work also suggests an agenda for future work on the causal pathways and the development of intervention [7].
Exploring the possibilities of machine learning in deciphering medical health problems among higher educational students: an incremental approach nested with biomedical, psychological and environmental features in a multidisciplinary dimension. In other articles, we find descriptions of various ML models and the necessity for shared datasets as well as several papers calling for the introduction of ML tools in the educational support ecosystem for early prevention [8].

In the following paragraphs we discuss possible incorporation of mHealth and ML approaches that have been emerged during the COVID-19 pandemic to offer tailored care for asthmatics. These tools illustrate knowledge can be used to form a systematic and efficient way of monitoring and averting exacerbations. The authors describe opportunities for QoL improvement by many ML-driven applications and the need for standardized approaches across platforms (20). It also implies that before it can even be regarded as a field usable tool, these need to prove their worth in various clinical environments [9].

In this paper, a non-invasive approach to detecting a sleep disorder is proposed through the analysis of ECG signals with 86.27% accuracy, using an ensembled model of bagged trees and led to a conclusion that the DTB-SVM is an easier and non-invasive alternative for focusing on spectral features and sleep stage detection rather than polysomnography.

A solution like this would offer a potential method for sleep fitness tracking based on high explanatory pith, and is thus applicable to the clinical application [10].

Methods This was a retrospective study that developed a machine learning model of OSA severity with potential clinical features such as age, body mass index (BMI), and Epworth Sleepiness Scale (ESS) score. The models had acceptable prediction accuracy, and these models can be used as a non-invasive tool to predict OSA and its severity. Our results corroborate the utility of these models in the clinical setting to enhance the treatment planning and to offer health professionals resources to optimise the targeting of affected individuals [11].

Results The association between sleep deprivation and depression was studied in 4,175 adolescents. Findings indicate that baseline sleep deprivation predicts depressive symptoms and major depression, particularly weeknight sleep deprivation. Limitations are self-reports and the lack of objective measurement [12].

The study by Short et al. (2013) analysed the association between sleep timing, sleeping hours, and sleep quality with mood, alertness and school performance in adolescents. Circadian chronotype had the greatest influence and both poor sleep quality and academic performance were related to depression [13].

The authors introduced a machine learning model for sleep stage classification based on mandibular movement signals, which took into account the peculiarities of the OSA patients. Model accuracy was compared to polysomnography, which was found to agree within diagnostic accuracy. The encouraging results of the RSDNN approach indicate it as an alternative non-interventional tool for sleep stage classification and may offer a potential for cost-effective supervised home monitoring in clinical environment [14].

The objective of this study was to develop machine learning (including the random forest classifier) predictive models in the form of an effective screening tool for moderate-to-severe OSA using the simple and practical anthropometric indices such as body mass index (BMI) and neck circumference. We tested our machine-learning based model (up to 84.74% accuracy). Such findings seem to point out that this model could represent a relatively low-cost and non-invasive approach for the identification of OSA high-risk patients without necessarily referring them to polysomnography. It could be used as a potential screening test for high-risk patients with severe OSA for early diagnosis and therapy [15].

Therefore, in the current study, we presented a new approach for clustering 2277 obstructive sleep apnea (OSA) patients using a hybrid framework of unsupervised and supervised machine learning models to identify six phenotypic profiles based on the multidimensional dimension polysomnography (PSG). Phenotypes that could be identified using this novel approach were better associated with disease risk compared with the application of apnea-hypopnoea index (AHI) alone. This new score will then offer a more granulated tool for OSA stage than available now and permit a better stratification of patient risk and treatment planning [16]

This article shows the increasing relevance of arti cial intelligence (AI) in the eld of the management of obstructive sleep apnea (OSA). The issue is how AI can enhance clinical care, by predicting how various therapies will work, evaluating therapy effectiveness and providing guidance to refine therapy plans — delivered for each patient as an individual. Reported by authors who analyzed 30 different studies, it was concluded that "AI techniques can significantly improve patient adherence to their treatment and are generally beneficial to patient outcomes. (2018)] This would be possible by allowing the development of more bespoke, and ideally more effective therapies, targeting each OSA patient's unique characteristics.[17]

In the study of Karjalainen et al. In (2020), a deep learning model that was trained on the PPG dataset of the PPG dataset to categorize sleep stage in patients suspected for OSA. Traditional PPG and PPG-PSG staging agreement indicates that PPG is indeed a promising non-invasive automatic sleep analysis tool based on CNN architecture. Model tuning and hardware integration for wearable INR monitoring would be the steps to follow [18].

On a similar stream, Liang and Chapa-Martell (2021) recently developed a two-stage machine learning model to provide accurate sleep stage estimation from consumer-grade wearable, i.e. Fitbit tracker. Additional scrutiny uncovered 23.9% worsening (i.e., 73.1% accuracy bias) of Fitbit in the proposed scheme than those of processing SVM and XG Boost algorithms in terms of true classification of BMI categories. This modality improves the accuracy of sleep devices [19]

Table 2.1: Summary of Literature Reviewed.

Author(s)	Year	Title	Methodology	Key Findings
Ecler Ercole Jaqua[1]	2022	Common Sleep Disorders Affecting Older Adults	This article discusses sleep disorders in older patients including what clinicians should look for and how to diagnose, treat, and manage them."	Sleep disturbances among elderly individuals have adverse effects on quality of life and health outcomes.
Seokmin Ha [2]	2023	Predicting the Risk of Sleep Disorders Using a Machine Learning	"This research implemented and evaluated a computer-based questionnaire based on demographic and behavioural information to screen for sleep disorders.	The SLEEPS model was highly predictive, the area under the receiver operating characteristic curve (AUROC) exceeded 0.897 for all three sleep disorders.
S. Kusmakar [3]	2021	Multi-night actigraphic detection of chronic insomnia	To process actigraphy data recorded during several nights to define and categorize nocturnal awakenings	identified individuals with chronic insomnia with 80% accuracy and sensitivity.
Melisa Moore, PhD [4]	2009	Relationships Among Sleepiness, Sleep Time, and Psychological Functioning	For sleep duration , variability and self-report questionnaires analysis	Despite looking at sleep duration and variability, rather than sleepiness, sleepiness was significantly associated with anxiety, depression, and worse self-reported health."
Daniel Álvarez[5]	2020	Test for adult sleep apnoea screening at home using oximetry and airflow	Examined 38 time-, frequency-, non-linear characteristics of oximetry	finally achieved 0.93 and 4-class accuracy increased to 81.3% which is higher than single channels.

Abigail Bangerter [6]	2020	Relationship Between Sleep and Behavior in Autism Spectrum	Sleep mean and variability from actigraphy vs. caregiver	Sleep disturbances common (~70%); variations in sleep efficiency and awakenings predict anxiety
Nor Safika Mohd Shafiee[7]	2020	Prediction of Mental Health Problems among Higher Education Student	Review :Mental health issues	Identified social support, finance difficulty, and learning environment as the primary Mental aspects".
Tsang KCH [8]	2022	Asthma Management with mHealth	Literature review of PubMed articles on mental health	Asthma attack prediction
Edita Rosana Widasari [9]	2020	Sleep Disorders Classification Using Ensemble of Bagged Tree Based	sleep stages are identified, sleep disorders are classified using ensemble bagged trees	Classifying multiples sleep disorder very reliably
Antonino Maniaci [10]	2023	Identification of Obstructive Sleep Apnea	Retrospective study with 498 patients clinical scores	Accuracy of SVM was 86%, and it showed a sensitivity of 93% and specificity of 80%;
Robert E. Roberts, PhD [11]	2014	Association between Sleep Deprivation and Depression among Adolescents	Community two-wave study; 4175 adolescents at baseline	Baseline decreased sleep time predicted major depression
Michelle A. [12]	2013	Impact of sleep on adolescent depressed mood, academic performance.	interrelated sleep effects were tested using path analysis	Evening chronotype and poor sleep quality, not sleep duration, predicted.
Nhat-Nam Le-Dong [13]	2021	Sleep Staging in Patients with Sleep Apnea	Developed and trained ML sleep-staging algorithm with PSG and patients."	Proven feasibility of accurate sleep staging.
Cheng-Yu Tsai[14]	2022	Screening for Obstructive Sleep Apnea Risk	PSG and anthropometric data of 3503 patients divided	"Random forest best: predicting moderate–severe OSA with 84.74%
Eun-Yeol Ma [15]	2021	phenotyping complex diseases with its application to	Constructing a novel multimetric	Framework facilitated a reliable OSA phenotyping

		obstructive sleep apnea	phenotype of obstructive sleep apnoea	and comorbidity risk predicting
Henri Korkalainen [16]	2020	sleep staging from photoplethysmogram for patients with suspected sleep apnea	Analyze nocturnal breathing signals and generate hypnograms of sleep,	photoplethysmogram for sleep/awake detection, sleep stage and apnea-hypopnea estimation
Zilu Liang [17]	2021	A Multi-Level Classification Approach for Sleep Stage Prediction	A two-level model was reported to accurately estimate sleep stages	The level-wise classification model obtained moderate agreement and better sleep stage accuracy

2.2.1 Similar Applications

- Machine learning has been used in recent health information technology to determine sleep-based predictions.
- Zhang et al. predicted insomnia using decision trees by analyzing smartphone usage patterns and sleep routines.
- Another study used neural networks to detect mood changes by analyzing sleep tracker data.
- Random Forest and XG Boost have been frequently used in mental health prediction due to their reliability and interpretability.
- However, these studies have mostly been applied to adults, with little research on young people.

2.3 Gap Analysis

This chapter lays the foundation for the research through a review of existing literature and identifies the shortcomings of previous research. It appears that sleep plays an important role in the mental health of young people, but the application of machine learning models to analyze this relationship is very limited. The next chapter will present in detail the process and test setup for applying the Decision Tree Classifier, Random Forest Classifier, K-Nearest Neighbors Classifier (KNN), XG Boost, and Logistic Regression. models to the collected dataset.

Table 2.2 : Short Gap Analysis of Existing Impact of Sleeping Disorder System

Features	Existing Solution	Proposed system
Data Analysis and Processing	No	Yes
Mental Health Prediction with Sleep Data	No	Yes
Identification of Sleep Patterns	No	Yes
Personalized Recommendations for Treatment	No	Yes
Early Detection of Sleep Disorders	No	Yes
Integration with Wearable Devices	Yes	Yes
Real-Time	No	Yes
Stress and Anxiety	No	Yes

Visualizing Mental Health Trends	No	Yes
User-Friendly Interface	No	Yes

2.4 Summary

This chapter provides the background of the research by reviewing the literature available and defining the weaknesses of the prior research. It turns out that sleep has a significant implication on the mental health of youth, yet the use of machine learning models to estimate this correlation is limited. Chapter two will outline and show the procedure and test configuration of applying the Decision Tree Classifier, Random Forest Classifier, K-Nearest Neighbors Classifier (KNN), XG Boost, and Logistic Regression models to the gathered dataset.

Chapter 3

Research Methodology

This study takes a machine learning approach to understanding the impact of sleep disorders on the mental health of youth. Multiple domains of sleep parameters, including sleeping hours, quality of sleep, frequency of sleep disturbances, along with mental health indicators, including stress, anxiety and depression, will be measured with questionnaires and standardized instruments. The data will next be preprocessed by cleaning, normalizing, and transforming it into an analyzable form. Classification models like Decision Tree, Random Forest, KNN, XG boost and Logistic Regression will be trained and evaluated to predict effect of sleep disorder on mental health. We will compare effectiveness of these model variants using accuracy, precision, recall, and F1-score measures. Insights emerging from these findings are anticipated to highlight critical cross-cutting factors that connect sleep problems and mental health problems in youth which can be utilized in the context of prevention and future intervention.

3.1 .1 Overview

The approach employed in this paper followed the methodology of a quantitative study that entailed supervised machine learning in order to examine the relationship between sleeping disorders and mental health in the young population. The adequately constructed questionnaire was administered to 999 young people, and it was able to provide data on such crucial aspects as sleep time, lifestyle preferences, and mood. The questionnaire was structured in such a way that it describes the relationship between sleep behavior and signs of mental health, including depression and sadness.

The study utilized several machine learning models to determine the patterns in mental health pertaining to sleep behavior, including Decision Tree Classifier, Random Forest Classifier, K-Nearest Neighbors Classifier (KNN), XG Boost, and Logistic Regression. These models were trained to identify depression and sadness patterns, according to the information gathered in the survey. Using these models, the study aimed to reveal how sleeping disorders have a major influence on the psychological well-being of the young people, and what can be done about it.

3.1.2 Proposed Methodology

There are several ways of collecting dataset including online or offline. We got our dataset by creating a google form which had 25 questions for our paper. We shared the Google form link with the youth to submit their answers using their mail. The submission data of the youth was stored in the spreadsheet. There are some limitations we found out, some youths are not responding to all the questions. Also, after removing the invalid or null response we removed that response and now our dataset is ready for training the model. After solving this problem, then our dataset is ready for the preprocessing and model training. We used “Google Colab” websites to process the dataset to feed into the model. The end results will be a discovery process of links between sleep disorders and mental health during youth.

Table 3.1: Survey Question collection

No	Questions	Options
2	Age Group (আপনার বয়সের গ্রুপ নির্বাচন করুন):	15-18 years (১৫-১৮ বছর) 19-22 years (১৯-২২ বছর) 23-26 years (২৩-২৬ বছর) 27-29 years (২৭-২৯ বছর)
3	Gender (আপনার লিঙ্গ নির্বাচন করুন):	Male (পুরুষ) Female (মহিলা) Other (অন্যান্য)
4	Occupation (আপনার বর্তমান পেশা):	Student (শিক্ষার্থী) Employed (চাকরিজীবী) Self-employed (স্বনির্ভর) Unemployed (বেকার)
5.	Sleep Patterns & Habits (আপনার ঘুমের ধরণ ও অভ্যাস) On average, how many hours do you sleep per night? (গড়ে প্রতি রাতে আপনি কত ঘণ্টা ঘুমান?)	Less than 4 hours (৪ ঘণ্টার কম) 4-6 hours (৪-৬ ঘণ্টা) 6-8 hours (৬-৮ ঘণ্টা) More than 8 hours (৮ ঘণ্টার বেশি)
6.	Do you experience difficulty falling asleep? (আপনার কি ঘুমাতে সমস্যা হয়?)	Yes, frequently (হ্যাঁ, প্রায়ই) Sometimes (মাঝে মাঝে) Rarely (কদাচিৎ) No, never (না, কখনো না)
7.	Do you wake up multiple times during the night? (আপনি কি রাতে ঘন ঘন জেগে ওঠেন?)	Yes, every night (হ্যাঁ, প্রতি রাতে) Occasionally (মাঝে মাঝে) Rarely (কদাচিৎ) No, I sleep continuously (না, আমি নিরবিচারে ঘুমাই)
8.	Do you feel refreshed after waking up? (জেগে ওঠার পর কি আপনি সতেজ অনুভব করেন?)	Yes, always (হ্যাঁ, সবসময়) Sometimes (মাঝে মাঝে) Rarely (কদাচিৎ) No, never (না, কখনো না)
9.	Do you often feel anxious or stressed due to lack of sleep? (আপনার কি ঘুমের অভাবে উদ্বেগ বা মানসিক চাপ অনুভূত হয়?)	Yes, very often (হ্যাঁ, প্রায়ই) Sometimes (মাঝে মাঝে) No, never (না, কখনো না)
10.	Do you use electronic devices (phone, laptop) before sleeping? (আপনি কি ঘুমানোর আগে মোবাইল বা ল্যাপটপ ব্যবহার করেন?)	Yes, always (হ্যাঁ, সবসময়) Sometimes (মাঝে মাঝে) No, never (না, কখনো না)
11.	Does lack of sleep affect your academic or work performance? (ঘুমের অভাব কি আপনার পড়াশোনা বা কাজের পারফরম্যান্সকে প্রভাবিত করে?)	Yes, significantly (হ্যাঁ, অনেক বেশি) Sometimes (মাঝে মাঝে) No, not at all (না, একদমই না)
12.	Do you experience nightmares or disturbing dreams? (আপনার কি দুঃস্বপ্ন বা ভয়ের স্বপ্ন হয়?)	Yes, frequently (হ্যাঁ, প্রায়ই) Sometimes (মাঝে মাঝে) No, never (না, কখনো না)
13.	"Do you have breathing difficulty while sleeping?" (ঘুমের মধ্যে শ্বাসকষ্ট হয় কি না?)	Yes No
14.	"Do you sleep a lot during the day?" (আপনি কি দিনের বেলায় বেশি ঘুমান?)	Yes No
15.	How does it feel when you don't get enough sleep? (পর্যাপ্ত ঘুম না হওয়ার জন্য কেমন অনুভব হয়?)	Feel tired (ক্লান্ত লাগে) Feel dizzy or lightheaded (মাথা ঝিম ঝিম করে) Feel low or moody (মন খারাপ থাকে)
16.	What is your primary way of managing sleep issues? (আপনি কীভাবে ঘুমের সমস্যাগুলো সামলান?)	Meditation/Yoga (মেডিটেশন/যোগ ব্যায়াম) Taking sleep medication (ঘুমের ওষুধ নেওয়া) Listening to music (সংগীত শোনা) No strategy (কোনো ব্যবস্থা নেই)
17.	How often do you go to bed and wake up at the same time every day? (আপনার কি প্রতিদিন একই সময়ে ঘুমানো ও ওঠার অভ্যাস আছে?)	Always (সবসময়) Sometimes (মাঝে মাঝে) Never (কখনো না)
18.	Have you noticed increased feelings of sadness or depression due to poor sleep? (আপনার কি কম ঘুমের কারণে মন খারাপ বা হতাশা বেড়েছে?)	Yes, significantly (হ্যাঁ, অনেকটা) Sometimes (মাঝে মাঝে) No, not at all (না, একদমই না)

19.	Have you ever felt paralyzed (unable to move) right after waking up or before falling asleep? (আপনি কি কখনো ঘুম থেকে উঠার সময় বা ঘুমানোর আগে শরীর প্যারালাইজড (অচল) মনে করেছেন?)	Yes, frequently (হ্যাঁ, প্রায়ই) Sometimes (মাঝে মাঝে) Rarely (কদাচিৎ) No, never (না, কখনো না)
20.	Do you experience excessive daytime sleepiness or feel drowsy even after a full night's sleep? (আপনার কি পুরো রাত ঘুমানোর পরও দিনের বেলা ঘুম ঘুম লাগে?)	Yes, every day (হ্যাঁ, প্রতিদিন) Sometimes (মাঝে মাঝে) Rarely (কদাচিৎ) No, never (না, কখনো না)
21.	Do you experience mood swings due to lack of sleep? (আপনার কি ঘুমের অভাবে মেজাজের পরিবর্তন হয়?)	Yes, frequently (হ্যাঁ, প্রায়ই) Sometimes (মাঝে মাঝে) Rarely (কদাচিৎ) No, never (না, কখনো না)
22.	"Do you use sleeping pill regularly?(আপনি কি ঘুমের ওষুধ নিয়মিত সেবন করেন?)	Yes No
23.	"You had something important to do, but you went to bed late and woke up late, so you couldn't do it. Do you feel guilty because of that?" (আপনার কোনো কাজ করার কথা ছিল, কিন্তু আপনি রাতে দেরিতে ঘুমিয়েছেন এবং সকালে দেরিতে উঠেছেন, ফলে সেই কাজটি করতে পারেননি। এই কারণে কি আপনি নিজেকে অপরাধী মনে করেন?)	Yes, I feel very guilty (হ্যাঁ, আমি খুবই অপরাধবোধ করি) I feel a little bad, but I get over it (একটু খারাপ লাগে, কিন্তু ঠিক হয়ে যায়) No, I don't think about that(না, আমি সেটা নিয়ে ভাবি না) Sometimes I feel bad, but I try to do better next time (মাঝে মাঝে খারাপ লাগে, কিন্তু পরের বার ঠিক করার চেষ্টা করি)
24.	"Do you follow a proper daily food routine? "(আপনি কি সঠিকভাবে আপনার খাবারের দৈনিক রুটিন অনুসরণ করেন?)	Yes No Sometimes
25.	"Do you live with your parents?" ("আপনি কি আপনার বাবা মার সাথে থাকেন?)	Yes No

24. "Do you follow a proper daily food routine	25. "Do you live with your parents?" ("আপা	Email Address
Sometimes	No	mafidur15-4350@diu.ed
No	No	das15-4498@diu.edu.bd
Yes	Yes	ashraf15-3950@diu.edu
Yes	No	elma15-4342@diu.edu.b
No	No	arafathkhanabir@gmail.

Fig 3.1: Survey dataset with E-mail

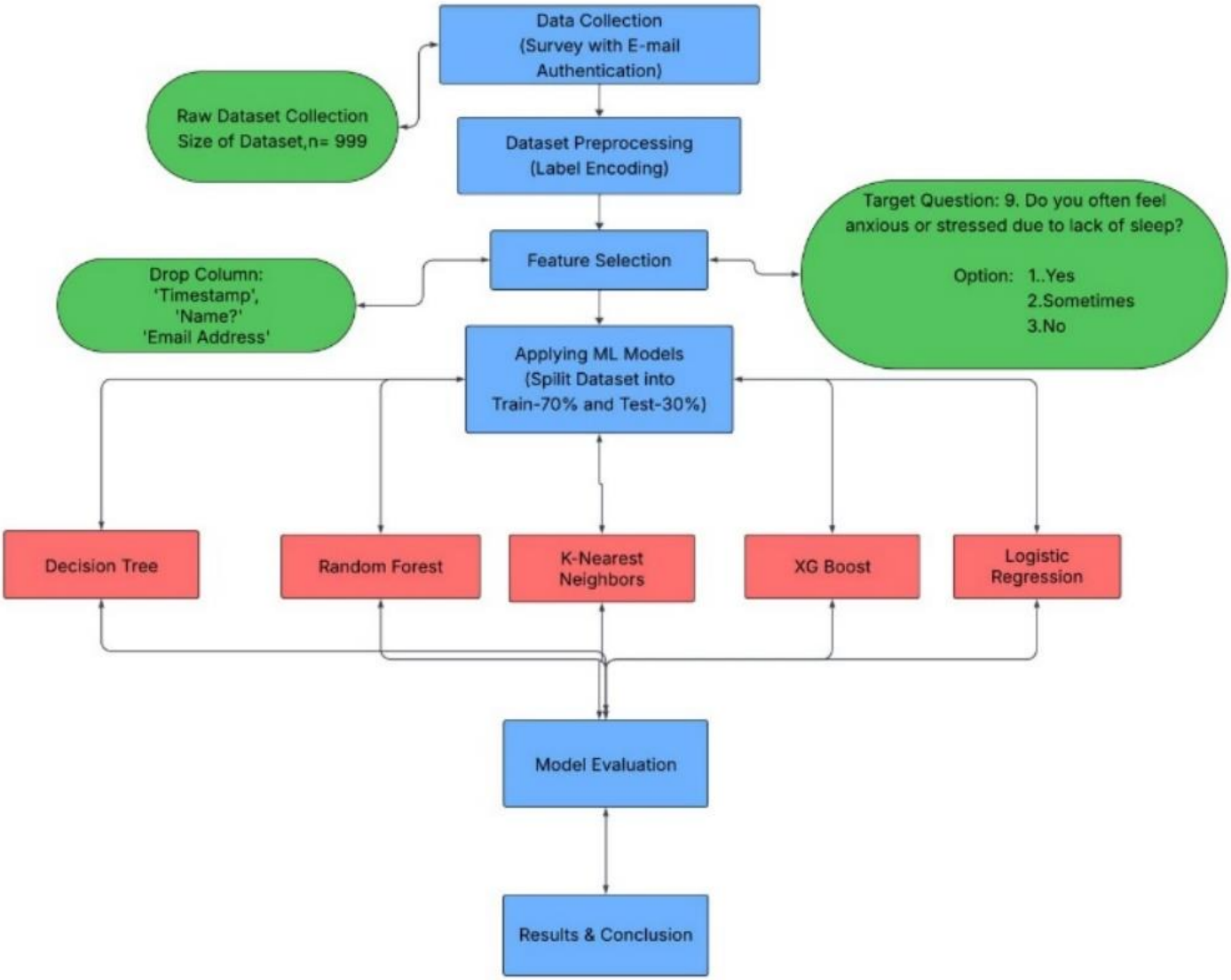

Fig 3.2 : Propose Method Diagram

3.1.3 Functional and Nonfunctional Requirements

Functional requirements:

Data Collection: Collect sleep and mental health information from surveys questions.

Data Processing: Clean, and convert data in to useable format for machine learning.

Model Training and predictions: The system should deploy all possible machine learning models are Decision Tree Classifier, K-Nearest Neighbors Classifier, XG Boost Classifier and Logistic Regression.

User Interface: Provide an intuitive user interface for using the system by users and health professionals.

Non-functional requirements:

Usability: Flexible, user-friendly dashboard for youth and professional access from any device.
Performance: Fast processing and effective model predictions.
Scalability: It should be able to scale with the data increasing and not make the system slow.
Reliability: Ensure high prediction accuracy and keep testing.
Data Privacy: Keep data storage and transfer safe in accordance to privacy laws.
Maintainability: Easy to update and maintain with low down time.

3.2 Detailed Methodology and Design

The research is systematic, beginning with the data collection process that includes a structured questionnaire among 999 youths, emphasizing sleep quality, lifestyle, and mental health measures. Preprocessing operations such as missing value treatment, encoding and feature selection were carried out on the data.
Python was used in training and evaluation of machine learning models such as Decision Tree Classifier, Random Forest Classifier, K-Nearest Neighbors (KNN), XGBoost and Logistic Regression. These models were evaluated on 70% of the data and the remaining 30% was utilized as test data. The measures of model performance were accuracy, precision, recall, F1-score, and curve.
In the predictive model, the system design also considers the academic and the socio-cultural in order to ensure the output is correct, clear and realistic.

3.3 Project Plan

Table 3.2: The timeline shows the phases and tasks for the project plan:

Phase/ Task	Description
Data Collection	Survey Distribution, data collect, initial cleaning
Data Preprocessing	Handling missing value, normalization, feature selection
Model Training	Training ML models(Decision Tree Classifier, Random Forest Classifier, K-

	Nearest Neighbors (KNN), XGBoost and Logistic Regression.)
Test & Evalution	Model validation, cross-validation, performance metrics
Result Analysis	Comparative study with previous works, interpretation
Demo Application	Prototype demo preparation for prediction system
Report Writing & Submission	Documentation, formatting, and final submission

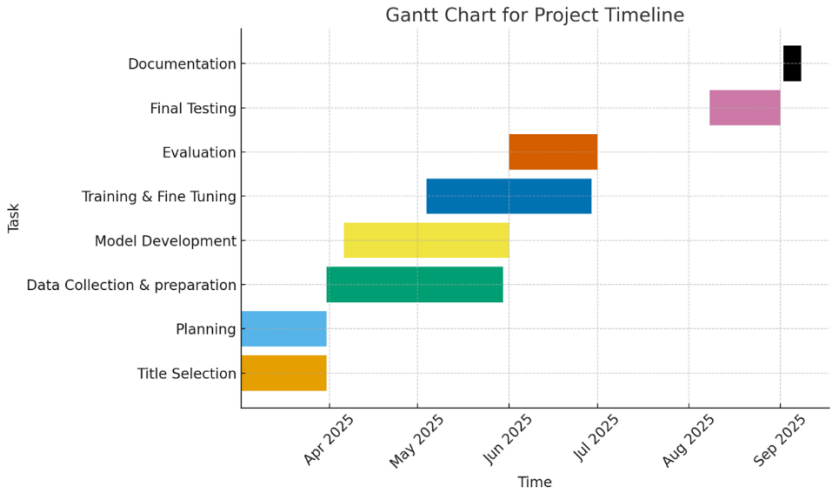

Fig 3.3 : Project Timeline Gantt Chart

3.4 Task Allocation

Effective task allocation is vital for the smooth execution of the Impact of sleeping disorder project. The team is organized into distinct roles based on individual expertise to ensure a seamless workflow and collaboration throughout the project.

Table 3.3: Task Allocation

Task	Shah. Md. Mafidur Hasan	Sazal Das
Dataset Collection and Preprocess	✓	✓
Model Development	×	✓
Model Fine Tuning	×	✓
Human Evaluation	✓	×
Literature Review	✓	×
Documentation & Reporting	✓	✓

3.5 Summary

This chapter outlines how several methodologies are employed to explore how sleep disturbances contribute to youth mental health, as well as the objectives of each measure

to determine construct validity. In the dataset we analyzed 999 students and employed several machine learning methods to identify the trends and possibly predict mental health risks based on the sleep disorder data. The procedure will ensure an evidence-based quantitative study of the effects of sleep disorders on the state of mental health, yielding specific recommendations of interventions. The strategy is still scholarly, but gives valuable real-world knowledge.

Chapter 4

Implementation and Results

In this chapter we describe the application of machine learning methods to analyze data related to sleeping disorders and their influence on the mental health of youth. The dataset processed was further processed for preprocessing, dealing with missing values, transforming categorical data of input features and provided to machine learning models for training and testing. The models used in this study are Decision Tree Classifier, Random Forest Classifier, K-Nearest Neighbors (KNN) Classifier, XG Boost Classifier and Logistic Regression. All the models were trained diligently by tunning the parameters right for getting the best of them. Results obtained during the training and testing are reported in details including the classification accuracy and other performance measures for each approach. Measures of predictive performance, including accuracy, precision, recall, and F1-score, were employed to compare the performance of models for predicting the association between sleep disorders and mental disorders. The findings of the simulations and test results are the main focus of the chapter, showing how well models can capture patterns across time and provide estimates of parameters in the models. The appropriate model for the research question is elucidated through the comparative analysis of the models, and discussions for the implications of sleep problems on youth mental health are presented. This chapter is used to introduce not just the technical aspect but equally explains the results back to objectives, so as to give an insight of how good are machine learning approaches in solving the issue.

4.1 Environment Setup

The study will be carried out in a cloud-system on Google Colab as the coding software, Python being the programming language. Such an arrangement enables a high-performance implementation and a straightforward combination of different machine learning models. Some of the main Python packages that will be used in the environment include Scikit-learn to run machine learning algorithms, Pandas to process and manipulate data, and Matplotlib to visualize data. Google Colab is an easy way to run the models because its interface will have provided dependencies, meaning that there is no need to install them locally, and that the models will run without problems.

4.2 Testing and Evaluation

The dataset must be splitted into folders to get the training and testing. For splitting our dataset, we splitted the dataset into two folders training and testing with percentages of 70% and 30% respectively. After splitting the dataset our dataset is now ready for model training. For model training we use the question no. 9: "Do you often feel anxious or stressed due to lack of sleep?", as our target value. We select all the columns as the features from the dataframe except that specific column 9 for our training dataset. Then we choose 5 Machine Learning (ML) models to train and test our dataset. These are - Decision Tree Classifier, Random Forest Classifier, K-Nearest Neighbors (KNN), XG Boost and Logistic Regression.

4.3 Results and Discussion

Below is a comparison of the five machine learning models tested on the sleeping disorder dataset:

Table 4.1: Model results

Model	Accuracy	Precision	Recall	F1-Score
Decision Tree	0.79	0.76	0.79	0.74
Random Forest	0.80	0.77	0.80	0.76
K-nearest Neighbors	0.77	0.74	0.77	0.73
XG Boost	0.80	0.77	0.80	0.77
Logistic Regression	0.78	0.76	0.78	0.76

Table 4.2: Accuracy for Classification

Model Architecture	**Accuracy (%)**
Decision Tree	0.79
Random Forest	0.80
K-nearest Neighbors	0.77
XG Boost	0.80
Logistic Regression	0.78

Random Forest Classifier Model and XG Boost Classifier both provides us the best accuracy with (accuracy-80%). The lowest accuracy we got in the Decision Tree Classifier model is 79%. After applying the hyper tuning for these 2 models, accuracy is enhanced for random forest classifier (Accuracy-81.1%) and XG Boost classifier (80.3%). Here the K-nearest Neighbors model provides us the lowest accuracy with (accuracy -77%).

Overfitting handling for Decision Tree Classifier: The overfitting is avoided using the Decision Tree Classifier through pruning and hyperparameter tuning. Introducing parameters such as max depth=10 restricts how much the tree can grow – the tree is no longer allowed to memorize the training data exactly, so the model becomes simpler. The min samples leaf=5 will guarantee that leaf nodes at least contain 5 samples, avoiding fitting to noise in very small datasets. We also employ min impurity decrease=0.01 and ccp alpha=0.01, which allow the model to prune branches that do not increase purity or that have little impact on cost complexity, restricting overfitting. These combined constraints give rise to a less overfitting model, seen from the levels train and test accuracy scores. This is how to bring in a prior, this is a pre-pruning technique, we stop

training early by complexity budget, we reduce variance, we enhance robustness on unseen data.

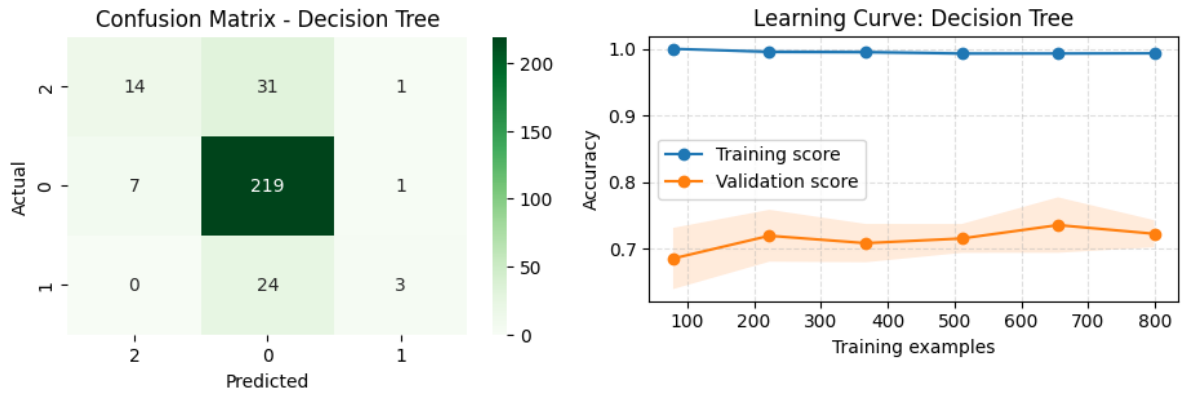

Fig 4.1 : Confusion matrix and learning curve for Decision Tree.

Overfitting handling for Random Forest Classifier: The Random Forest Classifier prevents overfitting through the use of multiple individual decision trees based on random samples of data and random sample of features, which add randomness to the model, decreasing model variance. It employs regularization such as max depth (maximum depth of the tree), min samples split (minimum samples required at a node to be considered to be split) and min samples leaf (minimum samples required in a new node). Also, cost-complexity pruning (ccp alpha) prunes trees and weeds out branches that don't benefit enough. These techniques together help model from getting too complex and memorizing noise in the training data resulting in better generalization to unseen data. This method can well balance accuracy and avoid over-fitting in the classification problems.

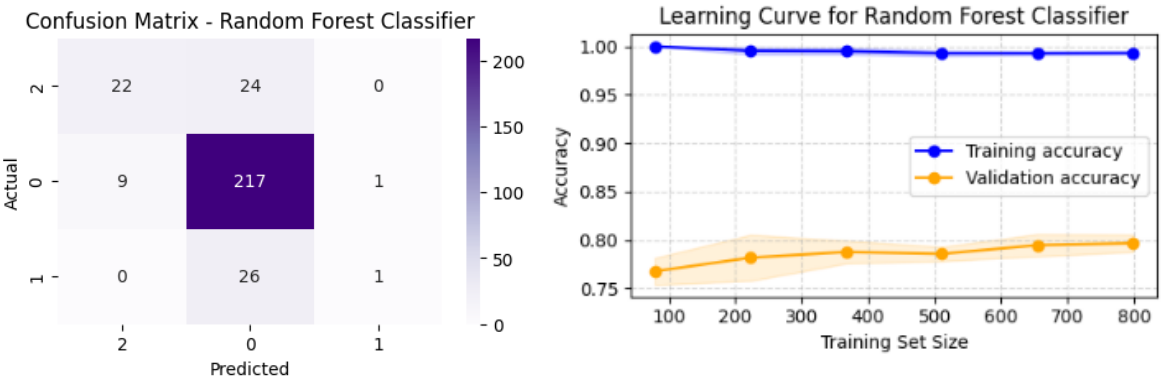

Fig 4.2: Confusion matrix and learning curve for Random Forest

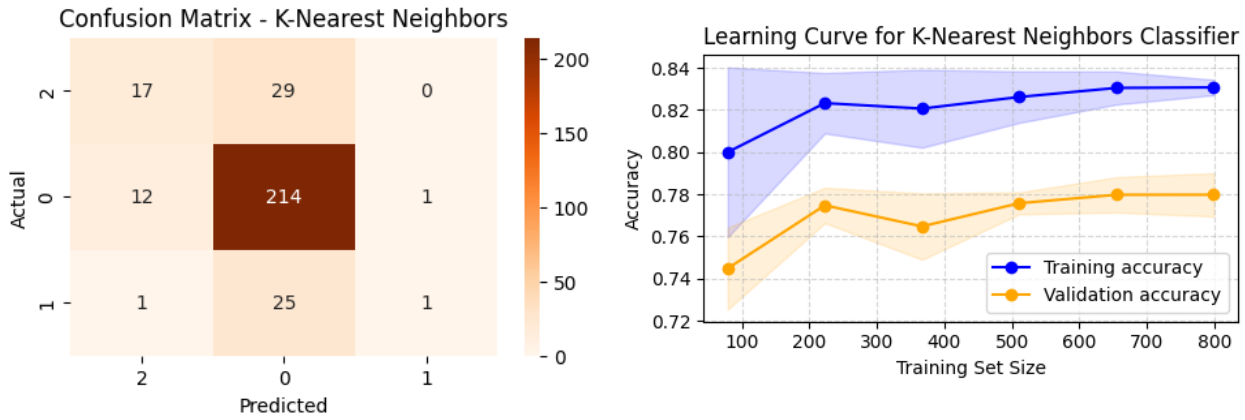

Fig 4.3: Confusion matrix and learning curve for K-Nearest Neighbors

Overfitting handling for XG Boost Classifier: Here the XG Boost code the overfitting of gradient boosting is controlled using two methods: regularization and early stopping. Reg alpha (L1) and reg lambda (L2) are regularization parameters that penalize complexity in an attempt to minimize overfitting. Early stopping is used with early stopping rounds=20, which aborts the training process if no progress is made during 20 consecutive rounds on the validation set, avoiding overfitting. Parameters like subsample and colsample bytree, on the other hand, deal with random behavior in the data; with subsample corresponding to the fraction of training samples, and colsample by tree to the fraction of the features that is used. We train the model quietly (verbose eval=False) and use the accuracy and the classification report to evaluate the performance on the train and test sets. This regularization, subsampling and early stopping approach effectively reduces the possibility of overfitting.

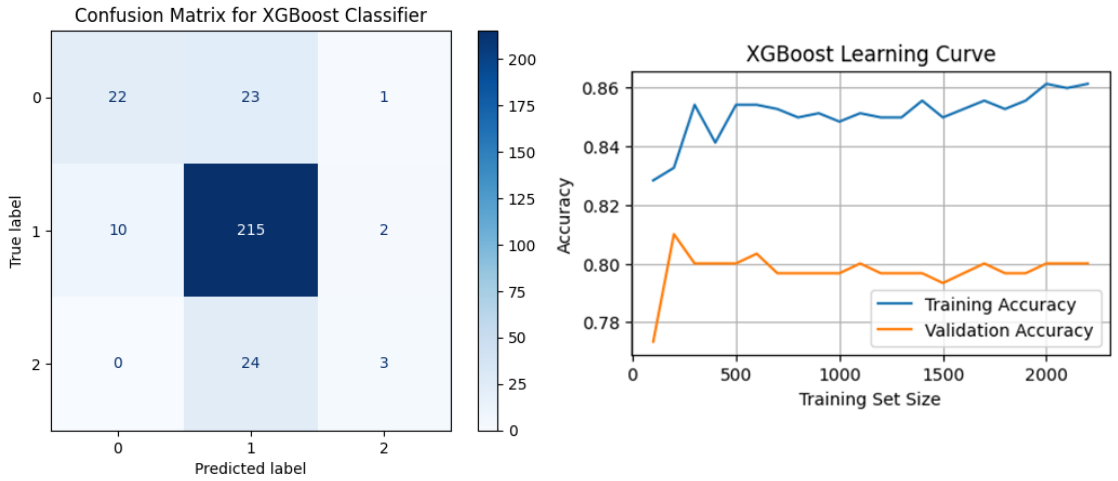

Fig 4.4: Confusion matrix and learning curve for XG Boost

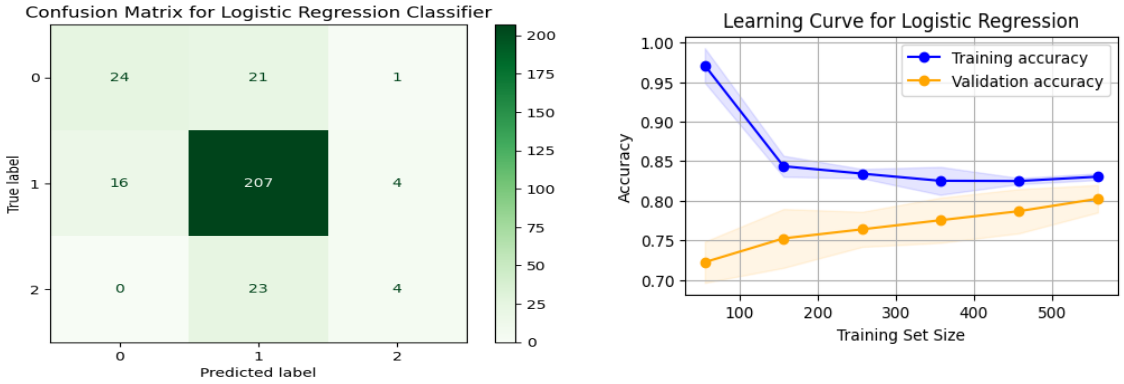

Fig 4.5: Confusion matrix and learning curve for Logistic Regression

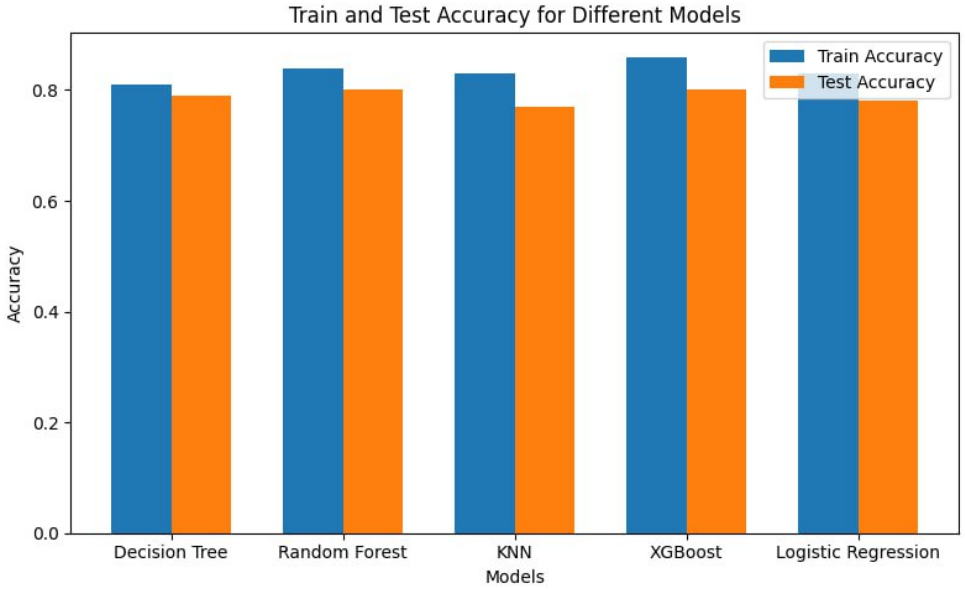

Fig 4.6: Train and Test accuracy for different models

4.4 Summary

This work focused on using a machine learning algorithm to mine the effect of sleeping disorder for mental health among youth. The classification algorithms are accepted as Decision Tree, Random Forest, KNN, XG Boost and Logistic Regression. Of which, Random Forest and XG Boost achieved the best accuracy of 0.80, then came Decision Tree at 0.79. Logistic Regression and K-Nearest Neighbors model also yielded lower (0.78, 0.77) accuracies compared to the proposed slicing models. Our results show that ensemble methods such as Random Forest and XG Boost slightly outperform the simpler models in this case, but all of them obtain decent performance. Such results highlight the promise of machine learning for detecting the impact of sleeping disorders on youth mental health.

Chapter 5

Engineering Standards and Design Challenges

The effect of sleep issues on the mental health of adolescents is the subject of our research, which means that it is necessary to examine multiple engineering standards and design issues. Meanwhile, the devices or sensors that are to be used as sleep monitors must be produced within international standards. Design issues include developing technology or devices that are convenient to operate, precise, and affordable by all the people. The biggest challenge is to develop user-friendly applications or portals, in particular, those that work with youth, and apply machine learning algorithms to identify the influence of mental health by sensor data. Simultaneously, the minimization of costs and efficient spread of the technology is the major engineering issue of this study.

5.1 Compliance with the Standards

In this research, machine learning model is created and deployed in relation to accepted standards. The data was treated in an ethical manner, keeping all the participants confidential and private. It used industry standards in data processing to select features, which improved data quality and model accuracy. Though necessary preprocessing procedures have been undertaken to ensure that data integrity is preserved. The analysis was performed based on proven machine learning algorithms whose performance was measured according to important metrics like accuracy, precision, and recall. During the implementation and evaluation processes, we adhered to best practices, and ethical, legal, and technical rules were observed.

5.1.1 Software Standards

Software standards on data privacy and security First, to maintain the privacy and security of the data, it is necessary to follow internationally accepted standards, including GDPR (General Data Protection Regulation), to make sure that the personal data of the users are encrypted and stored safely. Second, to reduce the risk of data breaches, it is required that the software should meet the standards established in OWASP (Open Web Application Security Project). Third, the user interface design should comply with the accessibility guidelines, like WCAG (Web Content Accessibility Guidelines) so that various categories of users can use the software without any inconveniences and at the same time, the software should be free of errors and malfunctions. Lastly, it is important to implement proper validation and verification criteria so that the validity of algorithms, as well as the consistency of findings, of a study on sleep disorders and mental health may uphold the usefulness and the reliability of programs and devices. Lack of standards may endanger the usefulness and reliability of software-based studies and tools.

5.1.2 Hardware Standards

- Processor (CPU): It needs a fast multi-core processor, e.g., Intel i7 or AMD Ryzen 7, to be able to use large datasets in a short period of time.

- Graphics Processing Unit (GPU) : The training of machine learning models requires a dedicated GPU, i.e., NVIDIA GTX/RTX series or Tesla/Quadro series.

- Memory (RAM): A minimum of 16GB RAM is needed to work with big data.32GB or larger RAM is recommended in larger or complicated models.

- Storage: In SSD (Solid State Drive) it will increase the speed of loading and processing data. Should be at least 512GB SSD or better 1TB SSD.

- Data Storage & Backup: Besides saved information in the hard drive, one may also save in the external HDD or cloud storage.

- Peripherals: The easy visualization or graphical display of the data requires the high-resolution monitors. USB 3.0 ports are helpful to make quick data transfer.

- Cooling & Power Supply: Long model training takes a lot of time and needs to be adequately cooled and with a powerful power supply unit.

- Network: Online data or cloud platform requires connection that is stable and high-speed.

5.1.3 Communication Standards

The machine learning system as used in this research is trained and deployed to a cloud-based system, i.e., in Google colab, which is not based on on-premise computer hardware. High performance hardware, such as Graphics Processing Unit (GPU) and Tensor Processing Unit, are potentially exposed to us through Google colab Cloud infrastructure and can enable a substantial increase in model training. This makes the model suitable to be optimally trained using large aggregate datasets and also due to the level of scalability needed in case of performing machine learning tasks. It is based on industry standard hardware, and thus it is significantly computationally powered, reliable and efficient to test and validate machine learning models.

5.2 Impact on Society, Environment and Sustainability

5.2.1 Impact on Life

Sleep disorders have a strong impact on the mental health and the general wellbeing of youths as they interfere with most facets of their lives. Inadequate or low-quality sleep may interfere with cognitive abilities i.e., memory, attention and decision making, with the effects of poor academic performance and increased productivity. Emotional regulation is also impaired and this predisposes the adolescent to mood disorders such as anxiety and depression that are common among adolescents. The youth that are deprived of sleep tend to be irritable, lack motivation and have a hard time coping with stress, which puts a strain on interpersonal relationships with peers and family. Moreover, physical health problems, including poor immunity or obesity, may worsen mental health issues when caused by chronic sleep problems. Socially, sleep disorders can lead to withdrawal to extracurricular activities or social activities which promote isolation. These disturbances may result in the experience of personal stunted growth, poor self-image, and trigger a vicious circle of worsened mental and physical damage. It is important to

treat sleep disorders in order to enhance the quality of life and resiliency among young people.

5.2.2 Impact on Society & Environment

Sleep disorders in the youth not only impact on the health of the individual, but also extensively impact both the society and the environment. Sleep deprivation or low quality of sleep causes psychological problems like anxiety, depression, and emotional instability that prevent socialization among the young people. This leads to poor friendships, family ties and community bind that boosts social isolation. In the case of students, sleep difficulties reduce cognitive functions such as attention, memory and problem-solving capabilities, hence, causing poor performance in school. It reduces productivity in learning institutions and in the long-term, it has negative impacts in the efficiency of the workforce as well as economic development. Besides, such sleep problems may worsen the behavioral problems in young people, including irritability and aggression, or violation of communal norms, which can lead to conflicts or unrest in schools and neighborhoods. These acts cause tension in social relations and other measures need to be put in place to ensure safety and peace is maintained in communities. Environmentally, if sleep problems are not addressed, there is a tendency to use electronic gadgets (e.g., smartphones, tablets, or computers) at night, which increases the electricity usage, subsequently leading to more carbon emissions and adverse effects on the environment. Moreover, sleep deprivation frequently propels the youth into an unhealthy lifestyle like consuming fast food or packaged foods, which enhances the plastic wastes and other pollutants to the environment. It also has a big impact on the healthcare system. Treatment of sleep disorder and other mental health conditions amplify the workload on the medical facilities and medical experts and increase the cost of healthcare and burden the economy of the society. To overcome these problems, social awareness should be increased, sleep education programs should be implemented in schools, and the need to promote the environmentally friendly lifestyles. Proactive efforts to curb sleep disorders can increase stability and sustainability of the entire society and minimize undesirable effects on the environment.

5.2.3 Ethical Aspects

There are enormous ethical implications of a study that aims to improve mental health, particularly concerning the impact it can have on the society. This machine learning method can be applied so as to define the correct limits between temperament disorders and mental illness. It is necessary to add that however the model can not be considered as diagnostic in its findings as it cannot firmly diagnose such disorders as schizophrenia. The project shall explore raising awareness of the long-term mental health consequences of the model that may guide more specific and individual interventions. The other ethical consideration is that it is of critical importance to raise awareness of how insomnia and other sleeping disorders can affect mental health. The research has the potential to benefit the healthcare practitioners by making them aware of these concerns so that they can possibly develop more individualized strategies to assist in the treatment of the individuals. It is highly desirable that the effect of the model on individual care must be well understood since it may result in professionals offering better care to their patients, which in the long run may help to improve the entire society. With increased awareness and understanding of these issues, health practitioners will implement more appropriate intervention and improve mental health overall.

5.2.4 Sustainability Plan

Long-term Vision: The machine learning model developed in the context of the provided study is to be constantly improved and revised with time passing because with time some new data is going to be found and it will guarantee the long-term efficiency of the machine learning model. It is a universalized model which can be implemented in numerous populations and health care environments. Through cloud computing platforms, e.g. Google colab, local hardware usage has been reduced to the bare minimum, potentially reducing energy consumption and promoting environmental friendliness. This will assist the model become sustainable in the long run since it will be less harmful to the environment.

Moreover, the findings of the present study might be utilized in the health promotion program, that upholds the notion of mental health care on a sustainable basis. Indeed, the model will be tracked and revised periodically as a routine practice in consultation with policymakers, mental health professionals, and healthcare organizations. The partnership will ensure that the model still gains momentum and is embraced in the long run, and ultimately make a long-term impact of improving the sustainability of mental health care.

5.3 Project Management and Financial Analysis

The project was handled on a well-structured schedule with clear milestones, keeping the project on track and according to schedule. This was achieved by reducing software expenses by using open-source software Google colab. The major spends were on data collection, cloud resources, and researcher time. An elaborate budget was drawn up initially and the project was done within the financial constraints. To scale and/or improve the model using more data, infrastructure, and human resources ahead will be necessary.

Table 5.1: Financial Research Budget

Component	Estimated Cost (BDT)
Google Form Setup & Data Collection	0
Internet and Software Use	2,000
Research Tools (Colab)	0
Data Cleaning, Model Training	0
Model Retraining & Updates	2,000
Feedback Collection & Final Editing	2,000
Report Writing & Analysis	1,000
Printing and Binding	1,000
Total Budget	**8,000 BDT**

5.4 Complex Engineering Problem

The topic of this study is a socially and technologically actual issue: how the sleeping disorders affect the mental health of young people according to the survey-based method. Although the research does not imply any complicated engineering systems or sophisticated machine learning algorithms, it still deals with a complex problem that needs to be collected, analyzed, and interpreted with the help of structured data.

Multidimensional Nature: Sleep and mental health depend on numerous factors including

lifestyle, school-related pressure, screen time and emotional health. The surveys in which these are captured would need to be carefully designed and categorized.

Data Reliability: Survey replies can be subjective, unfinished or contradictory. One of the challenges is to guarantee data quality and validity.

Youth-Centric Focus: This age group (youth) is specific to the study and requires the sensitivity of question framing and ethical management of responses associated with mental health.

Survey Design:
The development of a questionnaire in a structured form that is effective in the capture of sleep habits and indicators of mental health.
Data Processing: Sifting and sorting of the data collected to create trends and correlations.

Statistical Analysis: The impact of sleep disorders on mental health could be interpreted with the help of simple statistical techniques (e.g., frequency distribution, correlation analysis). Complexity is justified.

Even though the study does not involve complex level of engineering tools, it can be classified as a complex problem because of Interdisciplinary aspect of the topic with the integration of both psychology and health science and data analysis. The necessity of considering subjective information with great care to come up with meaningful conclusions. The social significance of the problem with mental health being a rising concern on the global scale.

5.4.1 Complex Problem Solving

This study addresses the complex problem of identifying the impact of sleep disorders on the mental health of young people using machine learning. Below is a map of the different aspects of the complex engineering problem,

Table 5.2 : Mapping with Complex Engineering Problem.

EP1: Dept of Knowledge	EP2: Range of conflicting requirements	EP3: Depth of Analysis	EP4: Familiarity of Issues	EP5: Range of applicable codes	EP6: Range of stake-holder participation	EP7: Interdependence
Knowing sleep patterns.	Trade off between data and sample size.	Statistical modeling	Sleep disorder recognition	Health data standards	Youth, healthcare providers, researchers	Model and outcomes

EP1:(Knowledge Department): This project requires expertise in machine learning, data science, mental health, and sleep disorders. Collaboration across disciplines is essential to solve the problem.

EP2:(Range of conflicting requirements): Balancing model accuracy and interpretability, using data from diverse populations, and ethical considerations in handling sensitive health data are important conflicts.

EP3: (Depth of Analysis): Understanding the subtle relationships between sleep patterns and mental health requires in-depth analysis of large datasets, which is possible through complex statistical and algorithmic methods.

EP4: (Familiarity of Issues): Mental health and sleep disorders have been widely researched, but using machine learning to identify mental health impacts in youth is a new field.

EP5: (Range of applicable codes): It is essential to adhere to machine learning coding standards, which ensure reproducibility and transparency.'

EP6:(Range of stakeholder participation): Stakeholders include healthcare professionals, mental health experts, researchers, and policymakers, whose participation is essential to verify the results and ensure applicability in real life.

EP7:(Interdependence): The effectiveness of the model depends on several interdependent factors, including data quality, algorithm selection, healthcare systems, and societal awareness of mental health issues.

Mapping with Knowledge Profile

This study addresses the Mapping with knowledge profile of identifying the impact of sleep disorders on the mental health of young people using machine learning

Table 5.3: Mapping with knowledge Profile.

K1: Natural Sciences	K2: Mathematics	K3: Engineering Basic Knowledge	K4: Expert knowledge	K5: Engineering Design	K6: Engineering Practice	K7: Comprehension	K8: Research Literature
understand the biological processes related to sleep and mental health.	require mathematical modeling and statistical analysis.	machine learning algorithms and mental health research	machine learning algorithms and mental health research	model design and system architecture	Implementing real-life solutions using machine learning technology	Understanding the impact of research	Reviewing previous research

K1- Natural Sciences: Knowledge necessary to understand the biological processes related to sleep and mental health.

K2- Mathematics: Data analysis and model evaluation require mathematical modeling and statistical analysis.

K3-Engineering Basic Knowledge: Basic engineering knowledge for machine learning model development and data processing.

K4-Expert knowledge: Expert knowledge in the field of machine learning algorithms and mental health research

K5 -Engineering Design: Engineering principles for model design and system architecture, which must be scalable and efficient.

K6-Engineering Practice: Implementing real-life solutions using machine learning technology and software tools.

K7-Comprehension: Understanding the impact of research on youth mental health and public health systems.

K8-Research Literature: Reviewing previous research on sleep disorders, mental health, and machine learning.

5.4.2 Engineering Activities

The chief tasks of this research were:

Data Preprocessing: This is the process of collecting and cleaning data and generalizing the data to guarantee the quality and consistency of the data.

Model Development: The model Development involves the selection and training of the right machine learning models depending on data and problem.

Feature Engineering: Relevant features are created and dimension reduced to increase model performance and interpretability.

Model Evaluation: Model accuracy and robustness, and the cross-validation techniques to test generalization should also be tested and verified.

Deployment: This machine learning model was deployed on a cloud platform, which is easy to access and scale to use in the future.

Improvement: Ongoing additions to the model by incorporating new data and feedback, to keep the model relevant and useful.

Mapping with Complex Engineering Activities

This study addresses the Mapping with complex Engineering Activities the impact of sleep disorders on the mental health of young people using machine learning.

Table 5.4: Mapping with Complex Engineering Activities.

EA1: Range of assets	EA2: Level of correlation	EA3: Innovation	EA4: Impact on society and the environment	EA5: Introduction
required resources are computational power, datasets, and machine learning frameworks	Collaboration between mental health and sleep	use of machine learning in relation to sleep disorders and youth	quickly identifies mental health problems in young people	combination in this context is new and requires further research.

EA1- Range of assets: The required resources are computational power, datasets, and machine learning frameworks, such as Google colab.

EA2- Level of correlation: Collaboration between data scientists, mental health professionals, and researchers was essential.

EA3 -Innovation: The use of machine learning in relation to sleep disorders and youth mental health is an innovative approach.

EA4-Impact on society and the environment: The research quickly identifies mental health problems in young people, which can help improve public health

EA5- Introduction: Although the components (mental health, sleep disorders, machine learning) are established, their combination in this context is new and requires further research.

5.5 Summary

This chapter talks about the standards used in engineering and the difficulties in the development of machine learning models. It highlights morality, cross-disciplinary work, issues to do with quality of data and model correctness, real-world use and ongoing enhancement. It also touches on resource limitation, feedback of the stakeholders, and the necessity of powerful validation to make sure of credible results in identifying the effects of sleep disorder to the mental well-being of the youths.

Chapter 6

Conclusion

This work demonstrates the high potential of machine learning approaches for the identification and quantification of the influence of sleep disorders on mental health in youths. By using a number of classification models, the study shows that sleep data can be used to predict mental well-being, allowing for intervention at the appropriate time/place. It is critical that the impacts are detected as early as possible because it will give health care professionals and careers the opportunity to manage a problem with sleep-related mental health disorders before they develop further. The results highlight the importance of integrating data-driven strategies in public health interventions targeting youth well-being. Moreover, the machine learning-based methodology is not only flexible to take on larger data size and more potential predictors but also payload the potential to enhance prediction performance. On the whole, the research helps inform the intricate relationship between sleep problems and mental health issues and provides a hopeful resource for early interventions to promote good mental health catered to young people.

6.1 Summary

In this study, we mainly show the reason for sleeping disorders and how the sleeping disorder creates problems in our daily life. We mainly focused on the sleep patterns, such as irregular sleep cycles, the increasing risk of anxiety, depression and stress in young people. In this study, we find out some reasons for sleeping disorders, like- use electronic devices (phone, laptop) before sleeping, don't follow the proper food routine and also don't live with parents and mainly don't follow the sleep patterns. Sleeping disorder had a great impact on youth academic performance, anxiety, mood swings, sadness or depression, regular activities etc. In the long term, the risk of chronic diseases like- diabetes, obesity, and high blood pressure can be increased because of sleeping disorders. Sleep disorders also have a great negative impact on social relationships. Without enough sleep, people become irritable, restless, and easily emotional, making it difficult to maintain healthy relationships with family, friends and colleagues. Our Studies have shown that people who regularly sleep 7-8 hours or more are much healthier mentally and physically than others. Therefore, to improve the quality of sleep, it is essential to live a healthy lifestyle, limit the use of electronic devices, and follow a regular routine. Sleep disorders not only harm mental health, but also severely impair brain function, memory, and decision-making ability. Not getting enough sleep reduces young people's attention span, increases the risk of accidents, and significantly reduces academic performance. Therefore, collective efforts and awareness raising among families, educational institutions, and society are essential to prevent sleep disorders. It is necessary to create awareness about the importance of sleep and take concerned steps to develop healthy sleep habits. For example, creating opportunities for rest at specific times along with studying, practicing meditation and exercise to reduce stress and engaging young people in healthy recreation. Controlling technology use and ensuring adequate physical activity can play a significant role in improving sleep quality. Seminars, workshops and public awareness programs can be conducted on the importance of sleep health through government and private initiatives. This will pave the way for preventing sleep disorders and building a healthy generation.

6.2 Limitation

Our dataset (N=999) was fairly small, and since the information was self-reported, there is a risk that the respondents introduced biases.

The major drawback of the study is that no AI-based model can recognize the stages of sleeping disorders.

It may be possible to include such a model in future research to gain a better understanding of the development and intensity of sleeping disorders, which would improve the overall working efficiency of the method.

The investigation was based on a very restricted behavior of youth, including only youth of a certain age of region. Another major drawback of this study is that no wearable device mechanism is used for recognize of the sleeping disorder.

6.3 Future Work

This research could be enhanced in the future by:

Real-time Data Collection Systems: Incorporating real-time data collection systems with wearable gadgets or mobile applications.

Clinical Verification: Introducing clinical validation by using psychiatrists or sleep experts to confirm the findings.

Increasing the Dataset: Another strategy that can be employed to enhance generalizability is increasing the size of the dataset by considering more diverse populations.

Mobile Interface: Developing an interface that is mobile friendly and which provides individual health advice to users.

Appendix:

Google Colab QR code:

Survey Question QR code:

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