An investigation through statistical analysis of Migraine diseases factors among students in Bangladesh

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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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January 12, 2025

APPROVAL

This Project titled **"An investigation through statistical analysis of Migraine diseases factors among students in Bangladesh"**, submitted by **Md. Rayhan**, ID No: **211-15-14666** 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 12 January, 2025.

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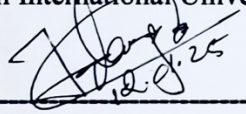

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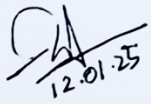

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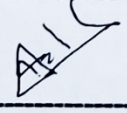

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We hereby declare that this project has been done by **Md. Rayhan, ID:211-15-14666** under the supervision of **Dr. Md. Taimur Ahad, Associate Professor and Associate Head**, Department of Computer Science and Engineering, Daffodil International University. We also declare that neither this projectnor any part of this project has been submitted elsewhere for the award of any degree or diploma.

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ACKNOWLEDGEMENTS

This work would not have been possible without the support and contributions of many individuals over the past two semesters. We are deeply grateful to everyone who has as- sisted us in one way or another.

First, we express our heartfelt thanks and gratefulness to the almighty for His divine blessing making it possible for us to complete the **Final Year Design Project(FYDP)** successfully.

We are grateful and wish our profound indebtedness to **Dr. Md. Taimur Ahad, Associate Professor and Associate Head**, Department of Computer Science and Engineering, Daffodil International University, Dhaka, Bangladesh. Deep knowledge and keen interest of our supervisor in the field of **Data Science and Machine Learning** to carry out this project. His endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior drafts, and correcting themat all stages have made it possible to complete this project.

We would like to express our heartfelt gratitude to the Head of the Department of Computer Science and Engineering, for his kind help in finishing our project and also to other faculty members and the staff of the Department of Computer Science and Engineering, Daffodil International University.

We would like to thank our entire course-mates at Daffodil International University, who took part in this discussion while completing the coursework.

Finally, we must acknowledge with due respect the constant support and patience of our parents.

ABSTRACT

Migraines are a debilitating neurological disorder that significantly affect university students, with factors such as irregular sleep patterns, medication usage, and lifestyle behaviors playing a key role in migraine severity. This study investigates the prevalence, triggers, and management strategies of migraines among university students in Bangladesh to address research gaps and provide actionable insights. Data were collected via an online survey using validated questionnaires, capturing demographic, behavioral, and migraine-specific variables. The analysis employed statistical tests, Principal Component Analysis (PCA), and K-means clustering to uncover significant factors and distinct subgroups among participants. Findings revealed that irregular sleep patterns and medication usage, including self-medication practices, were strongly associated with migraine severity. Gender-specific differences were observed, highlighting the nuanced impact of migraines across populations. These findings emphasize the need for targeted interventions to address migraines' impact on younger students' well-being. A composite Migraine_Score was developed to quantify the multidimensional burden of migraines, offering a standardized approach for assessment. Clustering analysis identified subgroups with distinct trigger-response patterns, enabling a more tailored approach to intervention. These findings provide localized insights into migraines in university students, suggesting targeted strategies for improved migraine management and prevention. Despite limitations such as reliance on self-reported data and a cross-sectional design, this research establishes a foundation for future studies involving longitudinal designs, real-time monitoring, and predictive modeling, ultimately contributing to enhanced well-being and daily functioning for this population.

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Chapter 1

Introduction

This chapter introduces the research by outlining its significance, context, and objectives. It provides a detailed exploration of the motivation behind the study, the research questions derived from the findings, the methodology employed, and the expected outcomes. The chapter concludes with an overview of the report's structure.

1.1 Introduction

Migraines are a complex neurological disorder that significantly impacts individuals' quality of life, particularly among students who face unique challenges such as academic stress, irregular sleep patterns, and lifestyle-related triggers. In Bangladesh, the prevalence and triggers of migraines remain under-researched, necessitating localized studies to address this gap. This research aims to explore the prevalence, triggers, and management strategies of migraines within this context, contributing to the development of effective interventions.

1.2 Motivation

The growing prevalence of migraines among students in Bangladesh highlights a significant healthcare challenge. This demographic is particularly vulnerable due to irregular sleep patterns, self-medication practices, and lifestyle-related triggers, which exacerbate the frequency and severity of migraines. While global research provides valuable insights into migraine triggers and management strategies, these findings often lack relevance to the unique cultural, behavioral, and environmental contexts of Bangladeshi students. This study is motivated by the need to bridge this gap by providing localized, evidence-based insights into migraine prevalence, triggers, and management strategies. By leveraging advanced analytical methods and addressing the specific needs of this population, the research aims to contribute to the development of tailored interventions that can enhance the well-being and daily functioning of students affected by migraines.

1.3 Objectives

The primary objectives of this research are:

i. To analyze the prevalence of migraines among students in Bangladesh.

ii. To identify and evaluate the significant triggers, including sleep patterns, and psychological factors.

iii. To assess gender-specific differences in migraine triggers and management approaches.

iv. To utilize advanced analytical methods, such as clustering and PCA, to segment migraine sufferers and uncover actionable patterns.

v. To propose data-driven strategies for effective migraine management and prevention.

Research Questions:

i. What are the statistically significant associations between migraine severity and key factors?

ii. How do clustering techniques reveal distinct subgroups among migraine sufferers based on their triggers and severity?

iii. What role do sleep-related factors?

iv. How do gender differences impact migraine triggers and response patterns?

v. Can a composite Migraine_Score effectively capture the multifaceted burden of migraines?

vi. What insights can be drawn from the clustering results to inform targeted interventions?

1.4 Methodology

The study employed a systematic approach, beginning with data collection through online surveys targeting university students. The collected data included demographics, migraine frequency, medication usage, treatment history, and lifestyle factors. Preprocessing steps included standardizing data, handling missing values, and encoding categorical variables. Statistical tests such as Chi-square were performed to identify significant factors, and dimensionality reduction techniques like PCA were applied for interpretability. Clustering methods, particularly K-means, were used to segment participants into distinct subgroups, enabling a deeper understanding of migraine patterns. Visualizations were developed to illustrate findings and provide actionable insights.

1.5 Project Outcome

This research delivers a comprehensive analysis of migraines among students in Bangladesh. The outcomes include:

i. Identification of significant triggers and their associations with migraine severity.

ii. Development of a composite Migraine_Score to assess the overall burden of migraines.

iii. Clustering analysis results revealing distinct subgroups for targeted interventions.

iv. Evidence-based recommendations for migraine prevention and management tailored to university students.

These outcomes contribute to the broader understanding of migraines in Bangladesh, paving the way for further research and policy development.

1.6 Organization of the Report

This research delivers a comprehensive analysis of migraines among students in Bangladesh. The outcomes include:

I. Chapter 1: Introduction

This chapter provides the foundation of the research, presenting the significance, motivation, objectives, and methodology. It introduces the research questions addressed in the study and provides an outline of the report structure.

II. Chapter 2: Background

The second chapter delves into the foundational aspects of migraines, focusing on their triggers, impacts, and prevalence among university students, particularly in Bangladesh. It synthesizes existing research, identifies gaps, and explains how the study addresses these gaps.

III. Chapter 3: Research Methodology

This chapter details the structured approach undertaken in the study, including data collection, preprocessing, statistical testing, and the application of advanced analytical techniques like PCA and clustering. It explains how each method contributes to achieving the research objectives.

IV. Chapter 4: Implementation and Results

This chapter presents the implementation of the methodology, detailing the tools and techniques used for analysis. It also discusses the results of the statistical tests and clustering, providing insights into the identified patterns and associations. Comparative analyses with previous studies are included to contextualize the findings.

V. Chapter 5: Engineering Standards and Design Challenges

This chapter discusses compliance with engineering standards, the challenges faced during the project, and their broader societal and environmental implications. It also covers the financial framework, project management strategies, and a mapping of complex problem-solving activities.

VI. Chapter 6: Conclusion

The final chapter summarizes the key findings of the study, reflecting on its contributions to the understanding of migraines. It discusses the limitations encountered and provides recommendations for future research, emphasizing the potential for extending the study's impact through subsequent investigations.

This structured organization ensures a logical progression through the research, guiding the reader from the background and objectives to the methodologies, findings, and broader implications. Each chapter builds upon the preceding one to create a cohesive and comprehensive report.

Chapter 2

Background

This chapter provides an in-depth analysis of the foundational aspects of migraines, focusing on their triggers, impacts, and prevalence particularly among students in Bangladesh. It synthesizes existing research findings, identifies gaps, and discusses how the present study contributes to filling these gaps.

2.1 Introduction

Migraine is a recurrent neurological disorder that impacts daily life, characterized by severe headaches and sensory sensitivities [3]. Among students, the prevalence is particularly concerning due to unique academic stressors, such as prolonged screen time and sleep deprivation [5]. Globally, triggers like mental stress and environmental factors have been widely documented [6]. However, in Bangladesh, specific triggers such as academic pressure, self-medication practices, and psychological impacts are still understudied [9], making it necessary to bridge these gaps through comprehensive local research [12]. Recent advancements in neuromodulation therapies, such as vagus nerve stimulation, offer promising treatment pathways but require further localized evidence [4].

2.2 Literature Review

The following table summarizes key studies related to migraine prevalence, triggers, and management, focusing on university students:

Table 2.1: Summary of Literature Reviewed.

Author (s)	Year	Title	Methodology	Key Findings
Rizzoli, S., et al.	2024	Chronic migraines and their cognitive impacts	Longitudinal study	Cognitive impairments linked to prolonged migraine episodes.
Myers, H., et al.	2024	Advances in non-invasive treatments for chronic migraines	Experimental study	Emerging treatments like vagus nerve stimulation show promise for migraine management.

Roy, S., et al.	2024	Impact of academic stress and screen time on migraine among students	Analytical study	Academic stress and prolonged screen time significantly contribute to migraine prevalence.
Flynn, O., et al.	2023	Migraine in university students: A systematic review and meta-analysis	Systematic review	Identified common triggers and impacts of migraines on university students, including academic difficulties.
Saif, Z.B., et al.	2023	Exploring the Prevalence and Triggering Factors of Migraine in University Students of Bangladesh Using Machine Learning	Dissertation	Machine learning models predict migraine triggers based on demographic and behavioral factors.
Link, F., et al.	2022	Recent advances in migraine treatment approaches	Clinical review	Highlighted neuromodulation and medication options for chronic migraine treatment.
Rafi, A., et al.	2022	Prevalence and impact of migraine among university students in Bangladesh: findings from a cross-sectional survey	Cross-sectional study	High prevalence of migraines among university students, with significant academic and social impact.
Saha, A., et al.	2022	Self-medication for migraines in Bangladesh: a risk analysis	Cross-sectional study	Risky self-medication practices were prevalent, with little awareness of proper migraine treatment.

Rashid, S., et al.	2021	Impact of electronic gadgets on adolescent health in Bangladesh	Cross-sectional data analysis	Gadget use strongly associated with higher migraine occurrences.
Rafi, A., et al.	2021	Prevalence of Migraine and its associated factors among medical students of Bangladesh: A cross-sectional study	Cross-sectional study	Significant association between academic pressure and migraine onset among medical students.
Hossain, F., et al.	2021	Prevalence and Impact of Migraines among Students in Bangladesh	Survey study	Migraine is common among students in Bangladesh, with significant impact on academic performance.
Khan, A., et al.	2021	Prevalence of Migraine, its Common Triggering Factors, and Coping Strategies in Medical Students of Peshawar	Cross-sectional Study	Academic stress and sleep deprivation are major triggers for migraines among medical students.
Birkie, M., et al.	2021	Determinants of migraine headache among regular undergraduate students, of Wollo University, Dessie, Ethiopia: cross-sectional study	Cross-sectional study	Psychological and environmental factors play a major role in the prevalence of migraines among students.

Anuar, T.S., et al.	2021	Stress and mental health issues among health science students	Cross-sectional study	Mental health issues like anxiety and depression linked to migraine triggers.
Uddin, M., et al.	2018	Migraine prevalence and treatment patterns in Bangladesh	Survey study	High prevalence of self-medication practices and inadequate access to healthcare.
Chiang, C., et al.	2015	Functional impairments in migraine patients	Observational study	Chronic migraines associated with sleep disturbances and fatigue.
Bashir, S., et al.	2013	Migraine and structural changes in the brain	Meta-analysis	Chronic migraines linked to structural changes in the brain.
Haque, B., et al.	2012	Precipitating and relieving factors of migraine versus tension-type headache	Comparative study	Stress and physical exertion were leading triggers; rest was identified as a key relief strategy.
Ofovwe, G., et al.	2010	Prevalence and impact of migraines in African secondary school students	Cross-sectional analysis	High prevalence of migraines among adolescents, with impacts on academic performance.

2.3 Gap Analysis

Aspect	Existing Knowledge	Identified Gaps
Prevalence in Bangladesh	Limited studies on university students' migraine prevalence in Bangladesh.	Lack of comprehensive statistical data specific to this population group.
Migraine Triggers	Triggers such as stress, screen time, and sleep disturbances have been identified globally.	No clustering analysis of how these triggers interact and influence migraine severity.
Gender-Specific Analysis	Higher prevalence of migraines among females.	Insufficient data on how gender impacts trigger-response patterns among students.
Management Practices	Self-medication and use of over-the-counter drugs common in migraine patients.	Lack of awareness campaigns or analysis of effective management interventions for students.
Sleep and Psychological Factors	Chronic migraines linked to anxiety, depression, and sleep disturbances.	Limited integration of psychological factors into predictive migraine management frameworks.
Treatment Effectiveness	Advanced treatments like vagus nerve stimulation have shown effectiveness globally.	Lack of localized data on treatment practices or effectiveness among Bangladeshi students.
Holistic Metrics	Existing studies lack composite scoring systems to measure migraine burden.	Development of a composite *Migraine_Score* addressing severity, frequency, and impact.
Cluster Analysis	No segmentation of migraine sufferers based on triggers or severity.	Introduction of K-means clustering to identify subgroups for targeted interventions.

Table 2.2: Gap analysis.

2.4 Summary

This chapter provides a comprehensive overview of migraines among university students, with a particular focus on the Bangladeshi context. The prevalence of migraines in this group is notably high, with significant academic, social, and psychological impacts [9], [13]. Common triggers identified include academic stress, prolonged screen time, irregular sleep patterns, and risky self-medication practices [5], [11], [12]. While global studies have introduced advancements in migraine management, such as neuromodulation therapies, localized research on their effectiveness and applicability remains limited [4], [8]. Additionally, gaps exist in understanding gender-specific patterns, the interplay of multiple triggers, and the integration of psychological factors into management frameworks [6], [14], [16]. Emerging methodologies, such as the development of a composite migraine score and clustering analysis, offer promising approaches to addressing these gaps and enhancing intervention strategies for university students [7], [9].

Chapter 3

Research Methodology

This chapter provides a structured approach designed to achieve the objectives of this research. The methodology integrates data collection, preprocessing, statistical analysis, and clustering techniques to gain a deeper understanding of the prevalence, triggers, and impacts of migraines among university students. By combining these methods, the research delivers a comprehensive analysis, bridging existing gaps and offering actionable insights into migraine management and intervention strategies.

3.1 Methodology

3.1.1 Overview

This research follows a structured, multi-phased methodology to investigate the prevalence, triggers, and impacts of migraines among university students. The approach integrates data collection, preprocessing, statistical analysis, and machine learning techniques to ensure a comprehensive understanding of migraine-related factors.

Data is collected through a validated online survey, designed to capture demographic, behavioral, and migraine-specific information. Preprocessing involves standardizing entries, handling missing values, and encoding categorical variables to prepare the dataset for analysis. Chi-square tests are conducted to identify statistically significant features (p-value < 0.05) associated with migraine severity.

Dimensionality reduction is performed using Principal Component Analysis (PCA) to enhance interpretability, followed by K-means clustering to categorize participants into meaningful subgroups based on migraine attributes. Visualizations, including barplots, scatterplots, and heatmaps, are used to illustrate key findings and patterns.

The methodology ensures a robust analysis by combining statistical techniques with machine learning, leading to actionable insights and recommendations for migraine management among university students.

3.1.2 Proposed Methodology

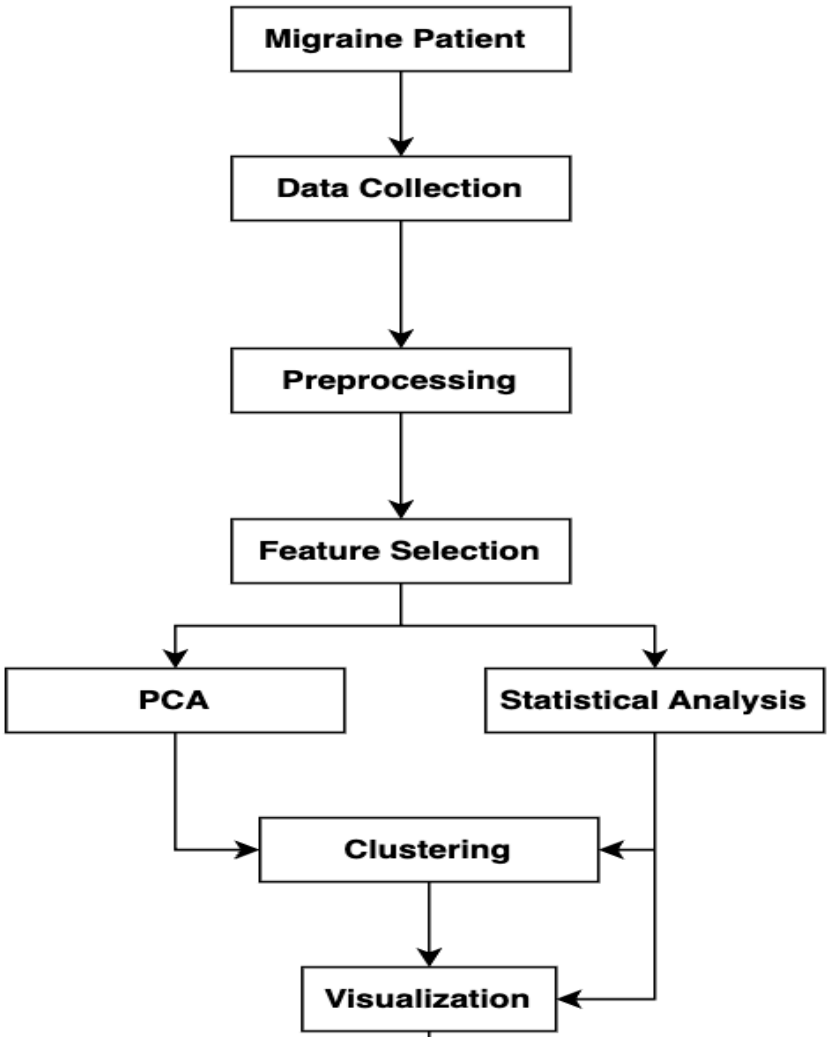

Figure 3.1: This is Proposed Methodology diagram

The proposed methodology (Figure 3.1) progresses systematically through a series of well-defined steps to ensure the accurate analysis of migraine data. Data is initially collected from migraine patients using validated questionnaires that capture demographic, behavioral, and neurological factors. The raw data undergoes preprocessing to address inconsistencies and standardize entries, making it suitable for analysis. Statistically significant features are then identified through Chi-square tests, and Principal Component Analysis (PCA) is applied to reduce dimensionality for better interpretability. Participants are categorized into distinct groups using K-means clustering, which identifies patterns based on migraine-related attributes. Alongside this, statistical techniques are employed to evaluate relationships between variables and migraine characteristics. Finally, the findings are visualized through scatterplots, heatmaps, and boxplots, and compiled into a comprehensive report that provides actionable insights.

3.2 Detailed Methodology

The methodology employed in this research encompasses the following steps:

i. **Data Collection:** Data was collected from university students experiencing migraines through an online survey using validated questionnaires, including the Migraine Surgery Intake Questionnaire [1] and Pre-Treatment Migraine Headache Questionnaire [2]. The dataset included demographic details (age, gender, education, employment), behavioral factors (sleep patterns, medication usage, health ratings), migraine-specific attributes (frequency, severity, treatment history), and financial impacts (monthly expenses related to migraines). The standardized and anonymized survey ensured comprehensive and reliable data for analyzing migraine triggers, severity, and management strategies.

ii. **Preprocessing:** Non-English text entries, such as Bangla text in specific columns, were removed to standardize the dataset. Inconsistent and missing values were addressed logically. Like- "None" in columns like "Prescription_Medicine_Usage" was replaced with "Never." Gender-based columns, such as "Women_Migraine_Factors," were populated with "Not Applicable" for male participants and "Never" for females missing responses. Leading and trailing whitespace was removed, and text entries were standardized for uniformity.

iii. **Feature Selection:** Statistical significance of features was evaluated using Chi-square tests, with a p-value threshold of 0.05. Features showing significant associations with migraine severity or neurological outcomes were selected for further analysis.

iv. **Variable Encoding:** Categorical variables, such as "Migraine Severity" and "Migraine Triggers," were encoded into numerical categories to enable statistical modeling.

v. **Composite Scoring:** A "Migraine Score" was developed as a composite measure of migraine severity, impact, and neurological assessments. This score facilitated clustering and visualization.

vi. **Clustering and Dimensionality Reduction:** Principal Component Analysis (PCA) was applied to reduce data dimensions, ensuring better interpretability of clusters. K-means clustering grouped participants based on migraine-related attributes, identifying distinct patterns and profiles.

vii. **Visualization and Reporting:** Data visualizations, including barplots, scatterplots, and boxplots, were created to illustrate variable relationships, clustering outcomes, and statistical findings.

3.3 Project Plan

The research was executed over 16 weeks, as detailed below:

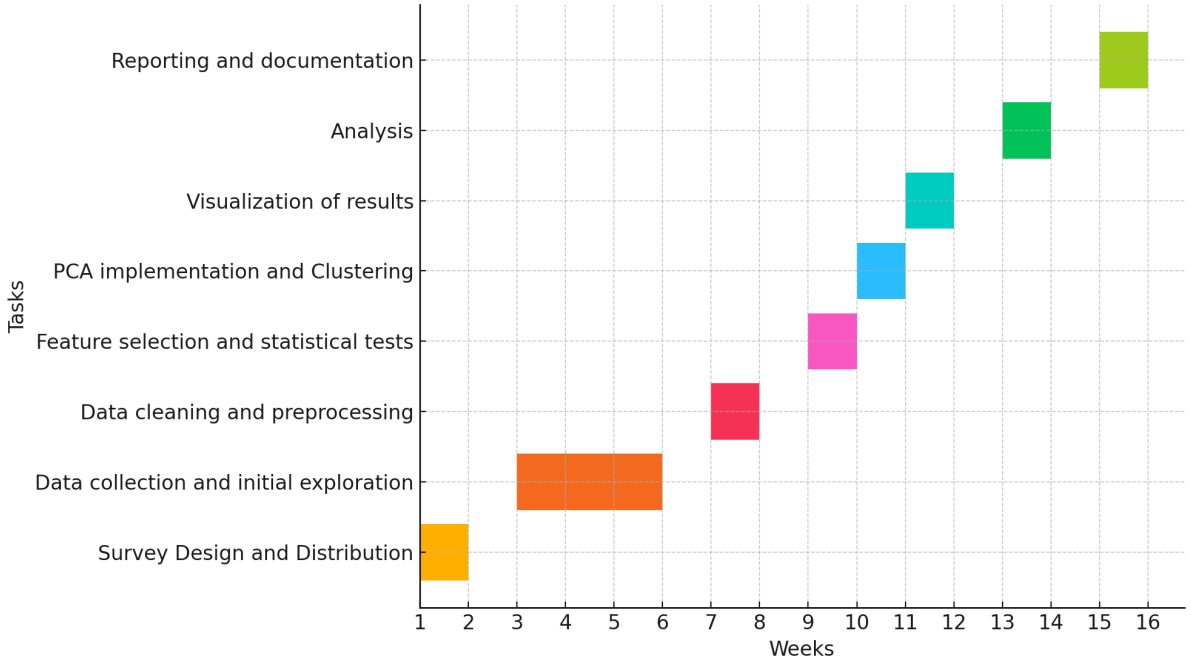

Figure 3.2: This is project plan diagram.

Over 16 weeks, the research followed a structured and methodical approach to achieve its objectives. The first two weeks focused on designing and distributing survey instruments tailored to gather comprehensive data on demographic, behavioral, and migraine-specific factors among university students. Weeks 3 to 6 involved data collection and initial exploration, ensuring that responses were complete and ready for analysis. In weeks 7 and 8, data cleaning and preprocessing were conducted to handle missing values, standardize variables, and encode categorical data, preparing the dataset for statistical analysis. Weeks 9 and 10 centered on feature selection and hypothesis testing to identify the most significant factors influencing migraine severity. Advanced techniques like Principal Component Analysis (PCA) and K-means clustering were implemented in weeks 10 and 11 to categorize participants into meaningful subgroups and reduce dimensionality, revealing intricate patterns in the data. Visualization of findings, including heatmaps and scatterplots, was carried out in weeks 11 and 12 to make trends and relationships within the data more interpretable. The analysis phase, during weeks 13 and 14, integrated the results to uncover meaningful insights and address the research objectives. Finally, in weeks 15 and 16, the research outcomes were synthesized into a comprehensive report, including actionable recommendations and insights for migraine management and prevention strategies among university students. This structured timeline facilitated a systematic exploration of the research problem and ensured the reliability and depth of the findings.

3.4 Task Allocation

All tasks were conducted independently

Tasks	Details
Data Collection	Collect Migraine Patients data.
Data Cleaning	Formatting, imputation, and removal of inconsistencies.
Statistical Testing	Conducted Chi-square tests and correlation analysis to identify significant associations on migraine characteristics.
Machine Learning	Applied K-means clustering and PCA for advanced pattern detection.
Visualization	Developed visualizations such as barplots, scatterplots, and pair plots to highlight key findings and clustering outcomes.
Report Writing	Compiled the methodology, results, and interpretations.

Table 3.1: Task Allocation.

3.5 Summary

This chapter described the research methodology adopted to analyze migraine-related data systematically. It outlined the step-by-step process, including data collection, preprocessing, statistical testing, and advanced clustering techniques such as PCA and K-means. Each stage was designed to extract meaningful insights into the prevalence, triggers, and severity of migraines among university students. By integrating statistical analysis with machine learning and effective data visualization, the methodology ensures a comprehensive understanding of the research problem, addressing significant gaps in existing literature and paving the way for informed interventions.

Chapter 4

Implementation and Results

This chapter presents the implementation details of the research methodology, followed by a comparative analysis with previous studies, and concludes with a discussion of the research results. The chapter highlights how the methods were applied and evaluates the findings in the context of the identified research gaps.

4.1 Environment Setup

To implement the model, the environment setup involved the following steps:

i. **Software and Tools:** The analysis was conducted using Python, with essential libraries including Pandas for data handling, Scikit-learn for statistical tests and clustering, and Matplotlib/Seaborn for visualization. Google co-lab was used for an interactive environment to develop and test the model.

ii. **Data Preparation:** The migraine dataset was collected through online surveys. Data preprocessing involved handling missing values, encoding categorical variables, and standardizing the dataset to ensure uniformity. Non-English text entries were removed, and inconsistencies such as "None" or "Not Applicable" were replaced logically.

iii. **Feature Selection:** Statistical hypothesis testing (Chi-square test) was performed to select significant features, followed by dimensionality reduction using Principal Component Analysis (PCA) to enhance interpretability.

iv. **Clustering and Analysis:** K-means clustering was applied to categorize participants into distinct groups based on migraine-related attributes. The results were visualized through heatmaps, scatterplots, and boxplots to identify patterns and trends within the data.

4.2 Comparative Analysis

Population-Specific Focus

While global studies such as Flynn et al. (2023) [6] and Rafi et al. (2022) [9] provide insights into migraine prevalence among university students, they lack detailed analysis of the specific academic and social stressors prevalent in the Bangladeshi context. This study addresses these gaps by focusing on university students in Bangladesh, emphasizing triggers such as academic pressure, irregular sleep patterns, and self-medication practices. Unlike Flynn et al., who highlighted global trends, this research explores localized factors, aligning more closely with the findings of Saif et al. (2023) [7] and Hossain et al. (2021) [13].

Integration of Neurological and Behavioral Variables

Previous studies, including Bashir et al. (2013) [19] and Myers et al. (2024) [4], emphasized the neurological and therapeutic aspects of migraines but lacked a comprehensive approach integrating behavioral factors. This study bridges that gap by combining demographic, behavioral, and neurological variables. For instance, the use of clustering techniques to identify migraine subgroups is a novel addition, allowing for a multifaceted understanding of how stress, sleep, and self-medication contribute to migraine severity. This aligns partially with Saif et al. (2023) [7], who used machine learning to predict triggers but did not focus on clustering analysis.

Environmental Triggers

Environmental factors such as noise and air quality have been mentioned in studies like Rashid et al. (2021) [11]. However, these factors were underexplored in the context of university-specific stressors. This research identifies academic environments and lifestyle patterns as key exacerbators of migraine symptoms, thereby extending the findings of Rashid et al. and providing a more nuanced understanding of environmental triggers tailored to student populations.

Methodological Advancements

The application of advanced statistical tools and clustering techniques, such as PCA and K-means, distinguishes this research from previous studies. While Saif et al. (2023) [7] used machine learning for trigger identification, this study's emphasis on segmentation and composite scoring systems (e.g., the Migraine_Score) provides a more holistic framework for understanding migraines. Furthermore, this approach highlights patterns and subgroupings that remain unexplored in earlier works, offering actionable insights for targeted interventions.

4.3 Results and Discussion

The analysis of the migraine dataset reveals critical insights into the prevalence, triggers, and management of migraines among students in Bangladesh. Through comprehensive statistical analysis, clustering techniques, and data visualizations, this study highlights significant patterns and relationships that address gaps in the existing literature and provide actionable recommendations for targeted interventions.

Key Findings:

i. **Hypothesis Testing Results:**

Migraine and Headache Characteristics:

The analysis (Figure 4.1) explored the association between several features and Worst_Headache_Severity. For Migraine_Monthly ($Chi^2 = 122.59$, $p < 0.0001$), Headaches_Monthly ($Chi^2 = 68.55$, $p < 0.0001$), Migraine_Medicine_Usage ($Chi^2 = 38.67$, $p < 0.0001$), Migraine_Severity ($Chi^2 = 270.48$, $p < 0.0001$), Mildest_Headache_Severity ($Chi^2 = 300.31$, $p < 0.0001$), and Headache_score_today ($Chi^2 = 158.71$, $p < 0.0001$), the null hypothesis was rejected, suggesting statistically significant associations with Worst_Headache_Severity. Correlation analysis confirmed the strongest associations for Mildest_Headache_Severity ($r = 0.614$) and Migraine_Severity ($r = 0.574$), followed by Headache_score_today ($r = 0.503$), while weaker associations were observed for Migraine_Monthly ($r = 0.418$), Migraine_Medicine_Usage ($r = 0.283$), and Headaches_Monthly ($r = 0.270$). These results suggest that these features collectively influence or correlate with the severity of headaches.

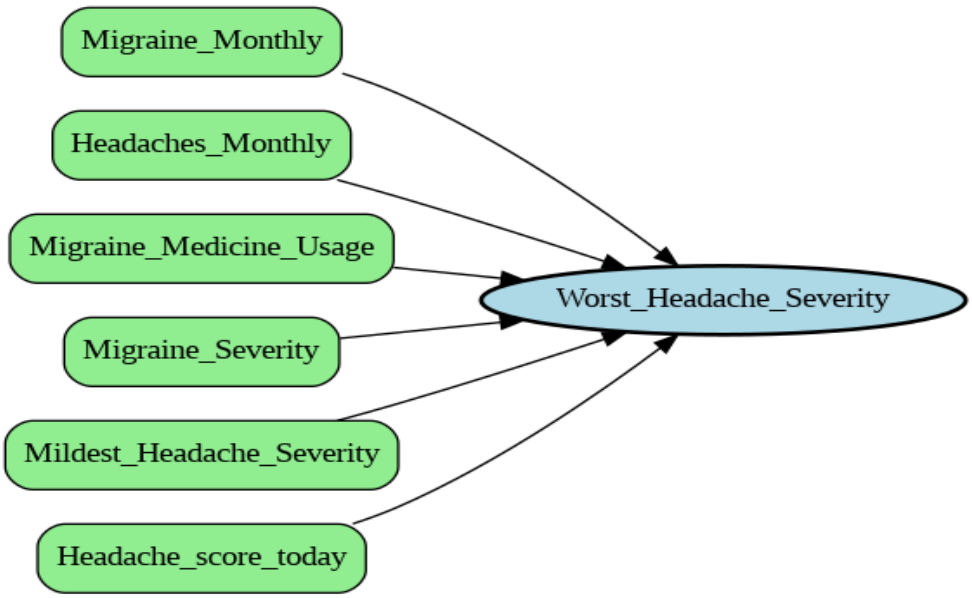

Figure 4.1: This is a migraine and headache characteristics diagram.

Migraine Trigger Factors:

The relationship (Figure 4.2) between Migraine_Triggers and its features was examined using chi-square tests. Significant associations were identified for Migraine_Symptoms (Chi^2 = 17,078.18, $p < 0.0001$) and Migraine_Relief_Methods (Chi^2 = 9,823.90, $p < 0.0001$), where the null hypothesis was rejected. However, for Women_Migraine_Factors (Chi^2 = 343.79, $p = 0.6693$), the null hypothesis was not rejected, indicating no significant association with Migraine_Triggers. Correlation analysis revealed a moderate positive relationship between Migraine_Relief_Methods ($r = 0.237$) and Migraine_Triggers, whereas Migraine_Symptoms ($r = -0.106$) and Women_Migraine_Factors ($r = -0.079$) exhibited weaker correlations.

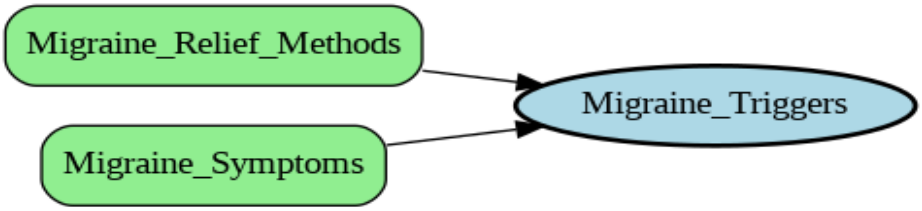

Figure 4.2: This is a migraine trigger factors diagram

Medical History and Neurological Assessment:

Chi-square testing demonstrated (Figure 4.3) significant associations between Neurologist Evaluation and Family_Migraine_History (Chi^2 = 11.16, $p = 0.0008$), Health_Disorder_History (Chi^2 = 20.93, $p < 0.0001$), Botox_Effectiveness (Chi^2 = 18.90, $p = 0.0001$), Past_Migraine_Treatments (Chi^2 = 111.89, $p < 0.0001$), and Past_Migraine_Tests (Chi^2 = 133.18, $p < 0.0001$), while no significant relationships were observed for Botox_Migraine_Treatment (Chi^2 = 5.55, $p = 0.0623$) and Botox_Injection_Site (Chi^2 = 12.38, $p = 0.0541$). Correlation analysis identified Past_Migraine_Treatments ($r = 0.309$) and Health_Disorder_History ($r = 0.268$) as having stronger positive associations with Neurologist Evaluation.

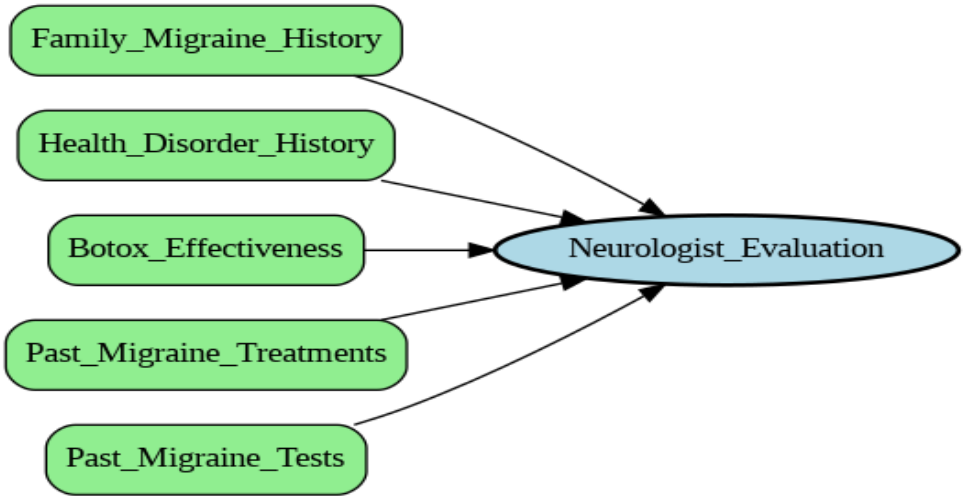

Figure 4.3: This is a medical history and neurological assessment diagram

Pain Perception and Relief:

This analysis (Figure 4.4) examined factors associated with migraine medicine usage. Significant associations were found for Migraine_Night_Awaken ($Chi^2 = 51.46$, $p < 0.0001$), Prescription_Migraine_Medicine ($Chi^2 = 24.93$, $p = 0.0001$), OTC_Migraine_Medicine ($Chi^2 = 17.82$, $p = 0.0013$), Mildest_Headache_Severity ($Chi^2 = 174.86$, $p < 0.0001$), Headache_score_today ($Chi^2 = 130.24$, $p < 0.0001$), Migraine_Monthly ($Chi^2 = 110.96$, $p < 0.0001$), and Headaches_Monthly ($Chi^2 = 47.43$, $p = 0.0001$). However, no significant associations were identified for Monthly_Migraine_Cost ($Chi^2 = 19.30$, $p = 0.2533$) or Monthly_Health_Rating ($Chi^2 = 16.56$, $p = 0.1671$). The strongest correlations with migraine medicine usage were observed for Mildest_Headache_Severity ($r = 0.614$), followed by Headache_score_today ($r = 0.503$).

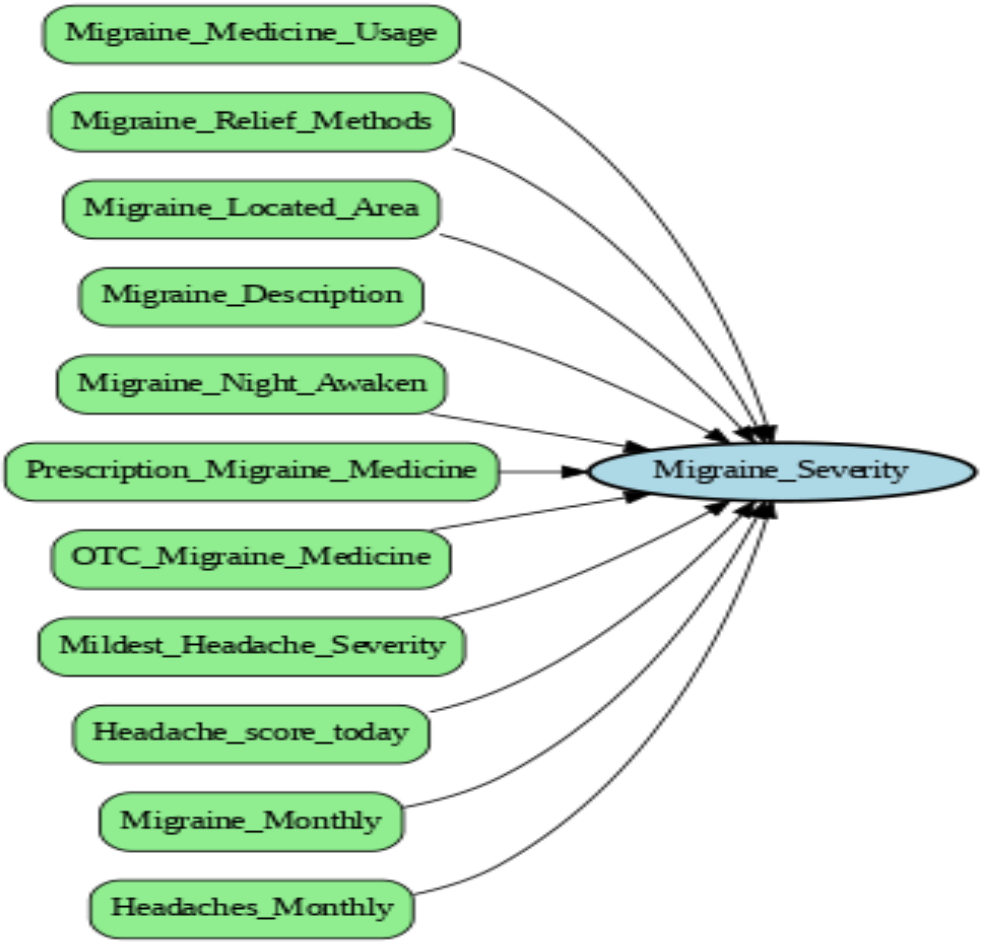

Figure 4.4: This is a pain perception and relief diagram

Sleep and Lifestyle:

Sleep-related factors were significantly associated with Neurologist Evaluation (Figure 4.5). Both Sleep_Hours_Impact_Migraine ($Chi^2 = 42.61$, $p < 0.0001$) and Migraine_Night_Awaken ($Chi^2 = 39.16$, $p < 0.0001$) showed strong associations, suggesting that sleep disturbances and lifestyle choices play a critical role in migraine management.

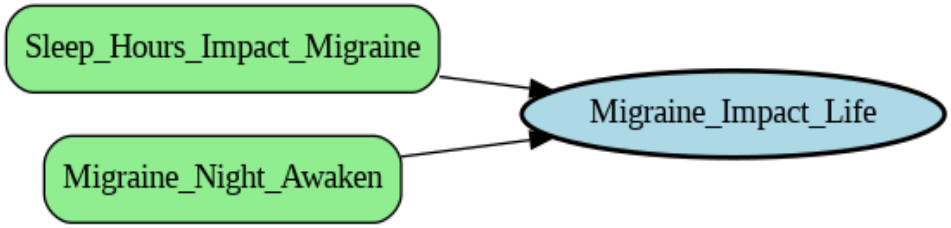

Figure 4.5: This is a sleep and lifestyle diagram

Treatment and Medication Effectiveness:

The effectiveness of Botox treatment was significantly associated (Figure 4.6) with Prescription_Migraine_Medicine ($Chi^2 = 20.17$, $p < 0.0001$), OTC_Migraine_Medicine ($Chi^2 = 23.86$, $p < 0.0001$), Past_Migraine_Treatments ($Chi^2 = 323.61$, $p < 0.0001$), and Migraine_Relief_Methods ($Chi^2 = 144.30$, $p = 0.0079$). However, Migraine_Medicine_Usage ($Chi^2 = 0.72$, $p = 0.6961$) failed to show a significant relationship. Correlation analysis revealed that OTC_Migraine_Medicine ($r = 0.218$) and Prescription_Migraine_Medicine ($r = 0.169$) positively correlated with Botox Effectiveness.

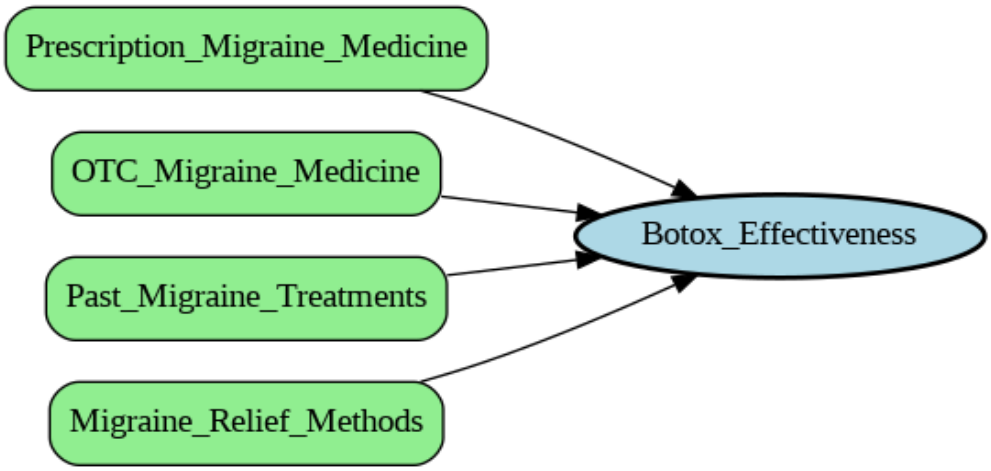

Figure 4.6: This is a treatment and medication effectiveness diagram

Migraine-Related Cognitive and Psychological Factors:

Several cognitive and psychological features were associated (Figure 4.7) with Migraine Symptoms. Migraine Symptoms serve as the central outcome influenced by five primary factors: Migraine Triggers, Migraine Description, Women Migraine Factors, Headache Score Today, and Migraine Night Awaken. Statistical analyses revealed significant associations for all variables ($p < 0.05$), with the strongest association observed for Migraine Triggers ($Chi^2 = 17,078.18$, $p < 0.0001$), suggesting that trigger identification may be vital for symptom prediction and treatment optimization. While moderate correlation was noted for Migraine Description ($r = 0.180$), weaker negative correlations were found for Women Migraine Factors ($r = -0.020$) and Migraine Night Awaken ($r = -0.110$), highlighting potentially complex or indirect influences. These findings underscore the need to integrate psychological and cognitive features into tailored treatment approaches for enhanced Botox efficacy.

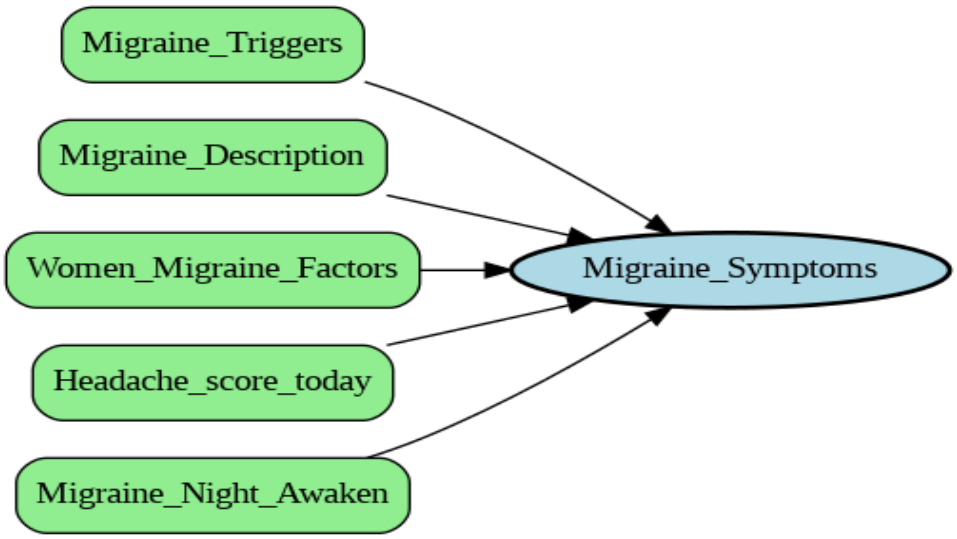

Figure 4.7: This is a cognitive and psychological factors diagram

ii. Development of the Composite Migraine_Score

The composite Migraine_Score was developed to quantify the overall impact of multiple migraine-related factors, integrating severity, frequency, and treatment dimensions into a single metric (Figure 4.8). This score was calculated by summing the numerical values of key features, including Worst_Headache_Severity, Migraine_Triggers, Neurologist Evaluation, Migraine_Severity, Migraine_Impact_Life, Botox Effectiveness, and Migraine Symptoms. Features were mapped to numerical scales: Migraine_Impact_Life was ordinally scaled from 0 ("Not At All") to 3 ("Extremely"), while Migraine_Severity and Worst_Headache_Severity ranged from 0 (Mild) to 4 (Extremely Severe). Binary mappings for Neurologist Evaluation and Botox Effectiveness (0 for absence, 1 for presence) allowed representation of these categorical features. Additionally, the counts of migraine triggers and symptoms were computed using custom functions that parsed

comma-separated values, providing detailed insights into the diversity of these factors. This holistic score captures the multifaceted burden of migraines, facilitating standardized patient assessments and enabling deeper exploration of relationships among migraine characteristics, triggers, and treatment responses. The transformed dataset, enriched with the new Migraine_Score, provides a robust foundation for future predictive modeling and comparative analysis in migraine research.

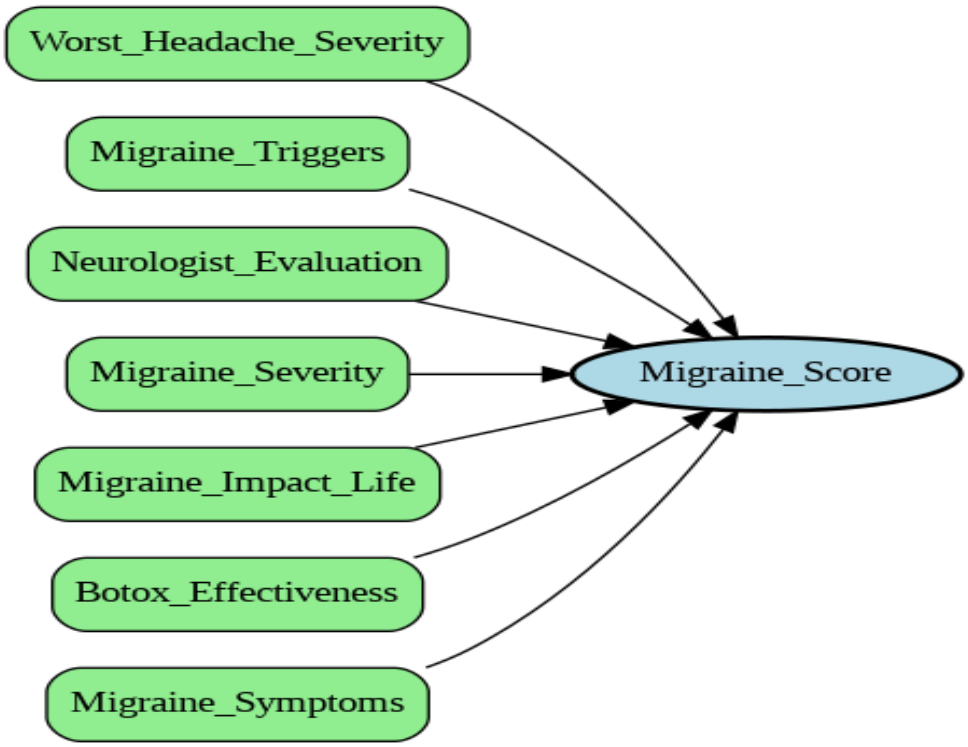

Figure 4.8: This is a development of the composite migraine_score diagram

iii. Clustering Analysis:

Clustering analysis was conducted to explore patterns and subgroupings within the migraine dataset, leveraging the Migraine_Score and associated features. The K-means clustering algorithm was employed, and the optimal number of clusters was determined using the Elbow Method (Figure 4.9), which plots the Within-Cluster Sum of Squares (WCSS) against the number of clusters. The elbow point, where the rate of decrease in WCSS diminishes, clearly indicated that four clusters best represent the data structure.

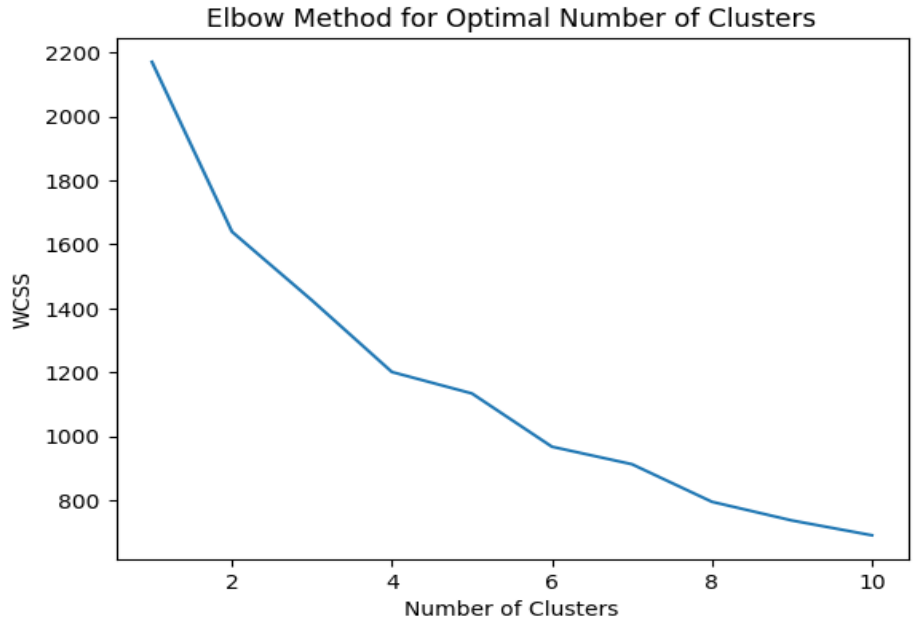

Figure 4.9: This is an elbow method diagram

To visualize the clustering results, Principal Component Analysis (PCA) was applied to reduce the data's dimensionality, projecting the data into two principal components. Figure 4.10 illustrates the clusters in a 2D space, highlighting distinct groupings of patients based on their migraine characteristics. Additionally, cluster centroids were overlaid (Figure 4.11) to depict the central tendencies of each cluster, ensuring clear visual differentiation. The clustering process used four clusters, capturing the heterogeneity of migraine impacts among patients.

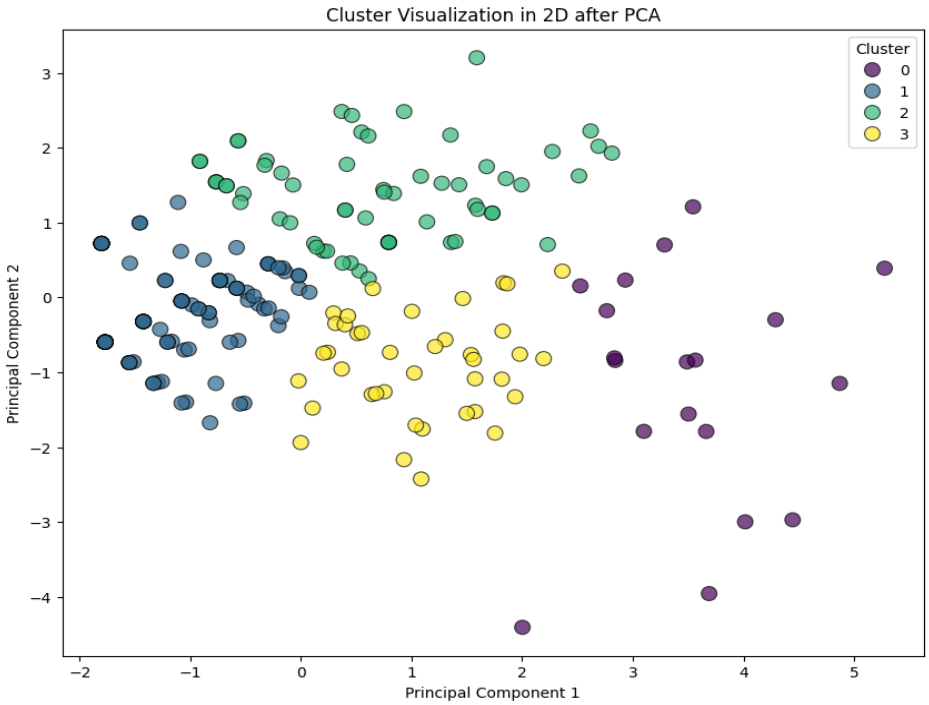

Figure 4.10: This is a clustering diagram

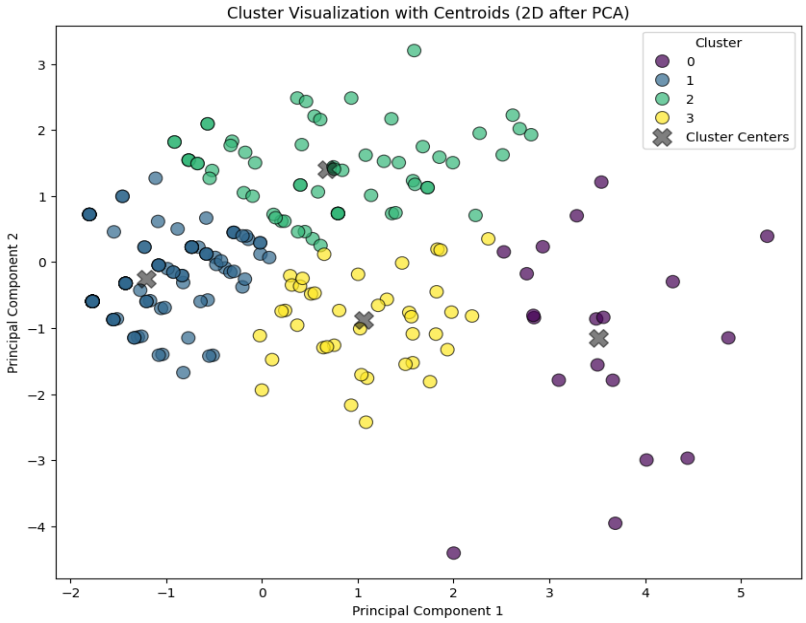

Figure 4.11: This is a clustering center diagram

An analysis of the Migraine_Score distribution across clusters (Figure 4.12) revealed significant variability. Cluster 0 predominantly included individuals with low Migraine_Score, reflecting minimal migraine impacts. Cluster 1 represented moderate scores, suggesting a mid-range severity and burden. Cluster 2 comprised individuals with high Migraine_Score, indicating severe migraine effects, while Cluster 3 encompassed patients with the highest scores, representing those experiencing the most severe and multifaceted impacts of migraines.

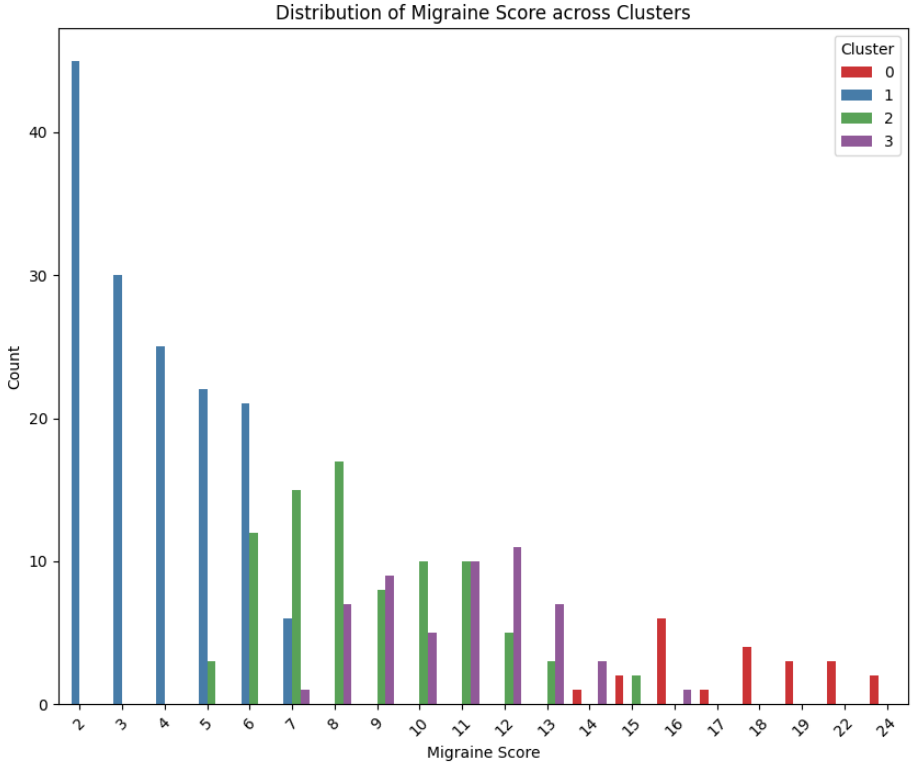

Figure 4.12: This is a distribution of migraine_score across clusters diagram

The clustering analysis was further explored using a pair plot (Figure 4.13), which provides a comprehensive visualization of the relationships among key migraine-related features across the four identified clusters. The pair plot highlights the distinct grouping patterns of clusters, revealing how features such as Worst_Headache_Severity, Migraine_Triggers, Neurologist_Evaluation, Migraine_Severity, Migraine_Impact_Life, Botox_Effectiveness, and Migraine_Symptoms interact within and across clusters. Cluster 0 demonstrates higher values for severity and triggers, reflecting patients with more severe migraines and diverse symptoms. Conversely, Cluster 3 shows consistently lower values, indicating less severe migraines and reduced impact on daily life. Cluster 2, characterized by the highest engagement with Botox treatment, illustrates a unique subgroup with targeted treatment responses. The pair plot also captures the overlapping and distinct relationships among features, such as the alignment of higher Migraine_Symptoms with Migraine_Severity and the divergence in Neurologist_Evaluation participation across clusters. This multidimensional visualization underscores the heterogeneity within the migraine population, emphasizing the importance of tailored approaches to treatment and management. The inclusion of the pair plot in the results highlights the interplay of features and provides a nuanced understanding of cluster characteristics, serving as a visual foundation for interpreting the clustering outcomes in the context of migraine burden and clinical responses.

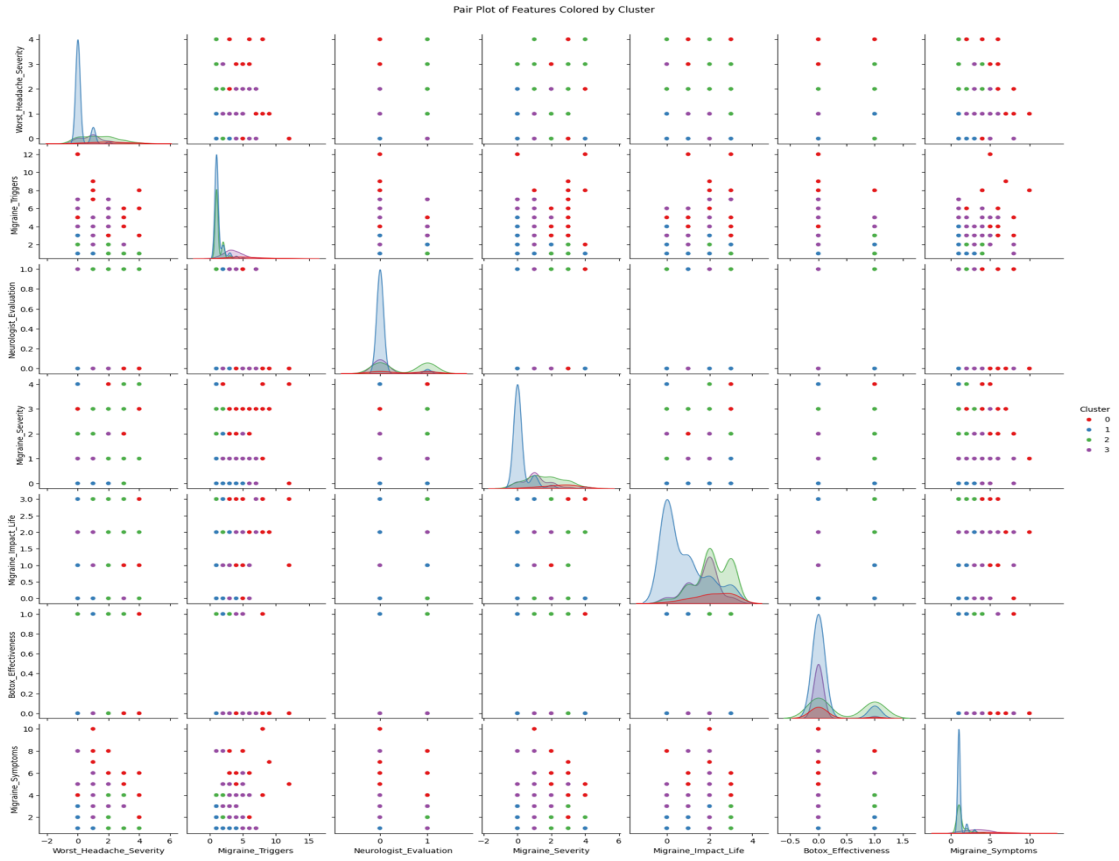

Figure 4.13: This is a pair plot diagram

iv. Visualizations:

To analyze the categorization of the Migraine_Score and its relationship with demographic variables, two key visualizations were generated. The Migraine_Score was categorized into three groups: Low (score 0–8), Moderate (score 9–17), and High (score 18 or above). These categories were analyzed across age ranges and genders to identify patterns and disparities.

Figure 4.14 depicts the distribution of Migraine_Score across different age ranges. The 18–24 age group overwhelmingly exhibited Low scores, with a smaller proportion falling into the Moderate and High categories. This distribution suggests that younger individuals may experience a lower migraine burden compared to older individuals, such as those in the 25–34 age group, which shows a slight increase in Moderate and High scores. This visualization highlights potential age-related differences in migraine severity, emphasizing the need for age-specific migraine management strategies.

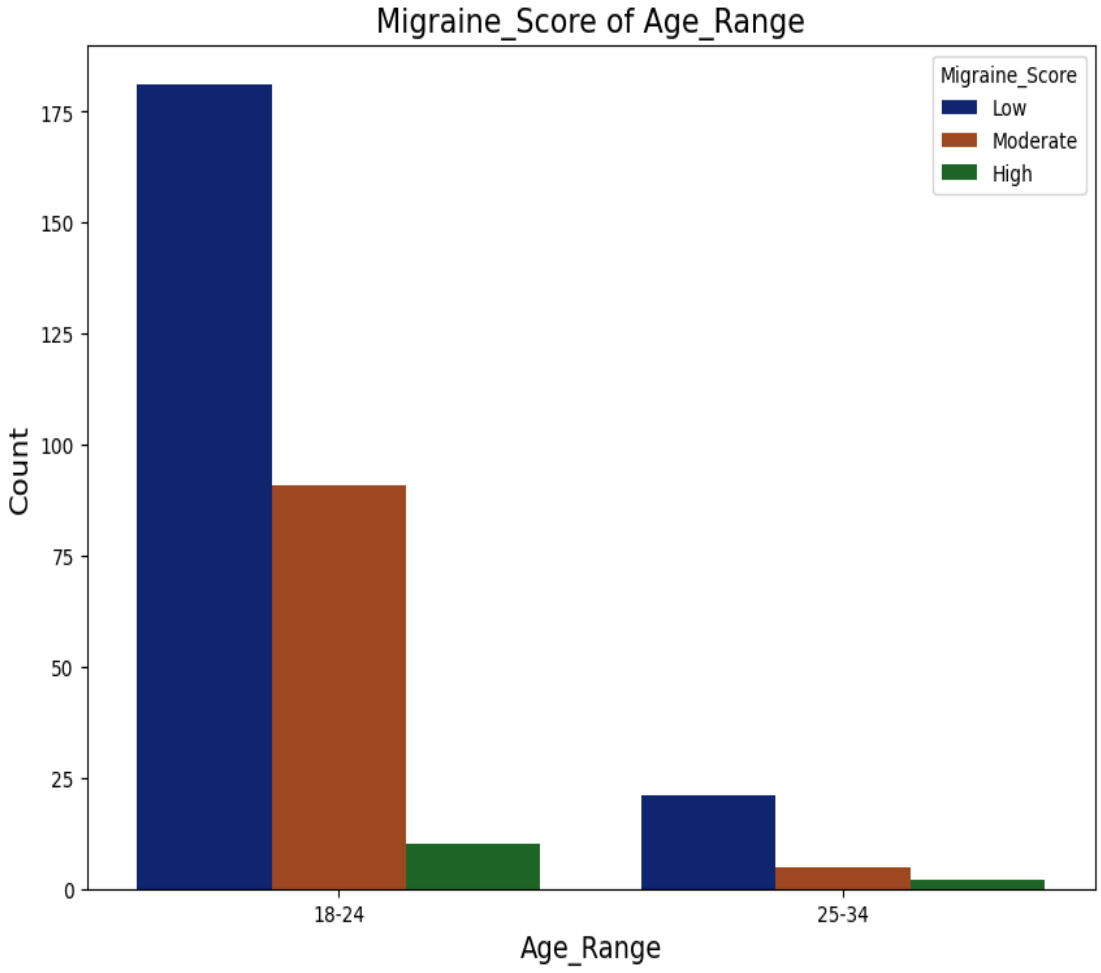

Figure 4.14: This is an age-based differences diagram

Figure 4.15 explores the relationship between Migraine_Score categories and gender. Males predominantly fall within the Low score category, while a notable proportion also experiences Moderate scores. In contrast, females show a more balanced distribution across Low, Moderate, and High scores, albeit with smaller absolute counts. This indicates that females may be more likely to experience higher migraine burdens compared to males, aligning with existing research on gender disparities in migraine prevalence and severity.

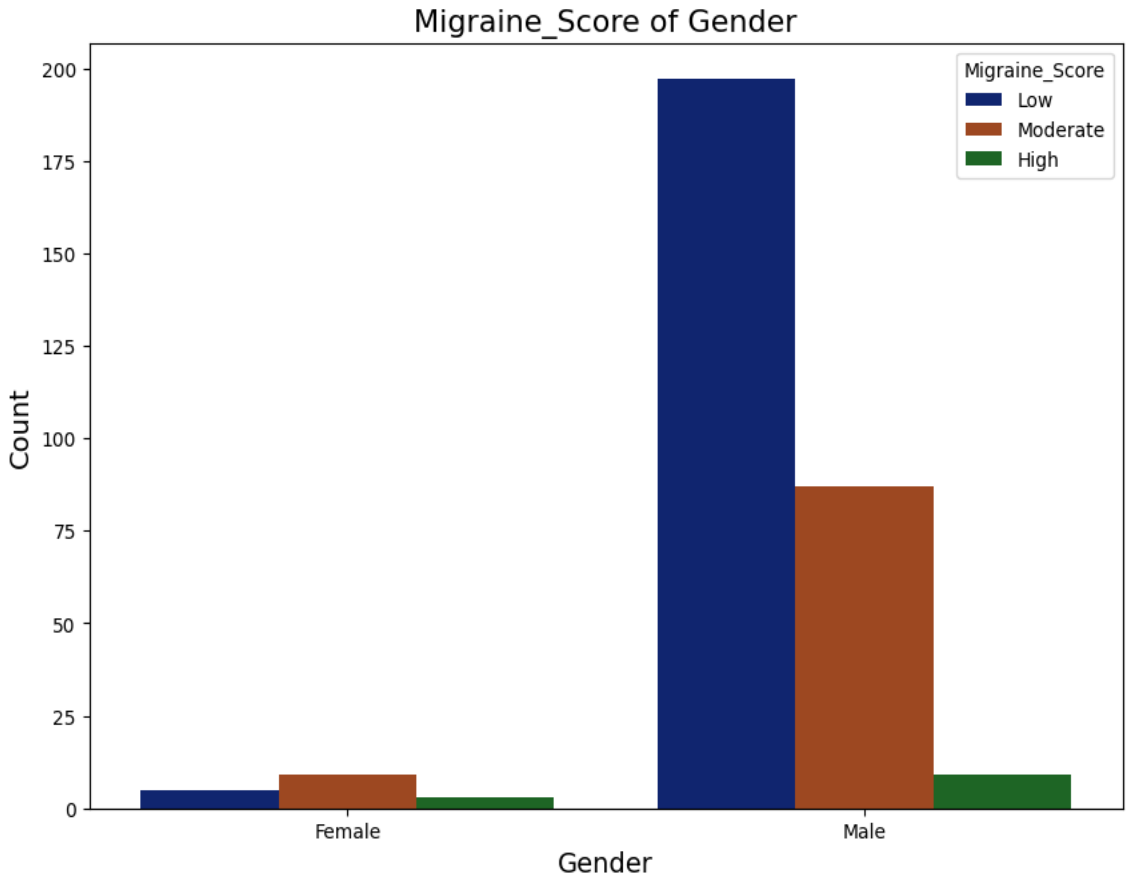

Figure 4.15: This is a gender differences diagram

These visualizations provide important insights into demographic factors influencing migraine burden, suggesting that age and gender play significant roles in shaping migraine experiences. The findings underline the importance of personalized migraine management approaches that account for demographic variability.

4.4 Summary

This chapter outlined the implementation and findings of the research methodology, focusing on students in Bangladesh. The use of Python tools and statistical techniques such as Chi-square testing and PCA enabled efficient data preprocessing, feature selection, and clustering. The analysis uncovered distinct patterns in migraine severity, triggers, and environmental factors, revealing the interplay of academic stress, sleep irregularities, and lifestyle in exacerbating migraines. By integrating behavioral, neurological, and demographic data, this study addressed gaps in previous research and provided a holistic understanding of migraine severity, offering valuable insights for targeted interventions and management strategies.

Chapter 5

Engineering Standards and DesignChallenges

This chapter discusses the engineering standards adhered to during the project, the design challenges encountered, and their implications for compliance, society, and sustainability. It further explores the project's management strategies, cost analysis, and the alignment of complex problem-solving and engineering activities with appropriate standards. These considerations ensure the research meets professional, ethical, and societal requirements.

5.1 Compliance with the Standards

5.1.1 Communication Standards

Clear and effective communication was integral to this research. During the data collection process, participants were provided with comprehensive information about the study's objectives, ensuring informed consent and active engagement. Ethical guidelines were strictly followed, including maintaining transparency, protecting anonymity, and adhering to professional standards for interaction with research participants. This facilitated the accurate collection and analysis of data, contributing to the reliability of the study outcomes.

5.2 Impact on Society, Environment and Sustainability

5.2.1 Impact on Life

The findings of this study offer actionable insights into managing migraines among university students, focusing on triggers such as academic stress and sleep disturbances. These insights contribute to improved academic performance, mental health, and overall well-being. By addressing these prevalent challenges, the study has the potential to enhance the quality of life for affected individuals.

5.2.2 Impact on Society & Environment

Migraines impose significant societal and economic burdens through decreased productivity and increased healthcare costs. This research emphasizes early detection and preventive strategies to alleviate these burdens. By integrating the analysis of lifestyle factors, the study raises awareness of how behavioral adjustments can mitigate migraine severity, promoting healthier communities and reducing healthcare system strain.

5.2.3 Ethical Aspects

The research adhered to strict ethical guidelines to ensure participant well-being and data integrity. Informed consent was obtained from all participants, and data anonymization techniques were employed to protect privacy. Transparency in the research process upheld the ethical standards, ensuring that the findings are both credible and responsibly obtained.

5.2.4 Sustainability Plan

The sustainability of this research lies in its emphasis on non-invasive, long-term interventions for migraine management. By focusing on preventive care and behavioral modifications, the study reduces reliance on resource-intensive medical treatments. This approach supports a sustainable healthcare model by prioritizing efficiency, affordability, and patient-centered solutions.

5.3 Project Management and Financial Analysis

The project's financial framework ensured efficient use of resources while maintaining high standards of quality. The cost analysis reflects the comprehensive yet cost-effective approach taken to execute the study.

SN	Components	Estimated Cost (BDT)
01	Hardware/Infrastructure	4,500 - 6,000
02	Software and Tools	2,000 - 3,000
03	Data Collection and Processing	5,500 - 6,000
04	Documentation and Report Writing	500 - 1,000
	Total Estimated Cost	**12,500 - 16,000**

Table 5.1: Estimated Cost

5.4 Complex Engineering Problem

5.4.1 Complex Problem Solving

In this section, provide a mapping with problem solving categories. For each mapping add subsections to put rationale (Use Table 5.2). For P1, you need to put another mapping with Knowledge profile and rational thereof.

EP1 Dept of Knowledge	EP2 Range Of Conflicting Requirements	EP3 Depth of Analysis	EP4 Familiarity of Issues	EP5 Extent of Applicable Codes	EP6 Extent Of Stake-holder Involvement	EP7 Interdependence
√	√					√

Table 5.2: Mapping with complex problem solving.

Justification of EP1: The research integrated neuroimaging, behavioral patterns, and statistical methods, such as PCA and K-means clustering, to comprehensively analyze migraines. This required a detailed understanding of computational and statistical techniques, as well as domain-specific knowledge in healthcare.

Justification of EP2: Balancing technical depth and medical context posed challenges. As a CSE student conducting research in a medical domain, integrating statistical modeling with ethical and contextual nuances highlighted conflicting requirements, demonstrating the interdisciplinary nature of the study.

Justification of EP7: The study heavily relied on prior research to build its methodology and findings. Simultaneously, the generated insights provide a foundation for future studies, creating a cycle of interdependence essential for advancing the domain.

Mapping with Knowledge Profile for EP1

This table (5.3) is designed to map the EP1 to the Knowledge Profile.

K3 Engineering Fundamentals	K4 Specialist Knowledge	K5 Engineering Design	K6 Engineering Practice	K8 Research Literature
√				√

Table 5.3: Mapping with knowledge Profile.

Justification of K3: The application of tools such as Chi-square tests, PCA, and clustering required fundamental engineering knowledge, ensuring robustness in the analysis and results.

Justification of K8: The research extensively reviewed and built upon existing literature to identify gaps and propose actionable strategies, advancing the understanding of migraine triggers and management.

5.4.2 Engineering Activities

In this section, provide a mapping with engineering activities. For each mapping add subsections to put rationale (Use Table 5.4).

EA1 Range of re-sources	EA2 Level of Interaction	EA3 Innovation	EA4 Consequences for society and environment	EA5 Familiarity
√			√	√

Table 5.4: Mapping with complex engineering activities.

Justification of EA1: The research utilized diverse resources, including computational tools, statistical techniques, and healthcare data, to explore migraines' multifactorial nature comprehensively.

Justification of EA5: The use of familiar tools and methodologies, such as Python and Scikit-learn, ensured efficient data processing and analysis, contributing to the validity and reliability of the research findings.

Justification of EA4: The study emphasized societal and environmental impacts, such as academic stress and noise, offering insights that can drive healthier community practices and reduced healthcare burdens.

5.5 Summary

This section summarized the integration of engineering standards and challenges addressed through the research. The study mapped its problem-solving and engineering activities to established frameworks, highlighting the interdisciplinary nature of the work. By addressing societal and environmental impacts, relying on innovative methods, and leveraging familiar tools, the research demonstrated the complexity and importance of engineering in solving healthcare challenges like migraines.

Chapter 6

Conclusion

This chapter provides a detailed summary of the key findings of this research, discusses its limitations, and suggests potential directions for future work. It reflects on the contributions of this study in advancing the understanding of migraines among students in Bangladesh.

6.1 Summary

This study investigated the prevalence, triggers, and management strategies of migraines among students in Bangladesh, providing a comprehensive analysis through statistical and clustering techniques. Key findings highlighted that academic stress, irregular sleep patterns, and self-medication practices significantly contribute to migraine severity. The clustering analysis revealed distinct subgroups of migraine sufferers, emphasizing the interplay between behavioral, psychological, and neurological factors. Moreover, the development of a composite Migraine_Score provided a standardized approach to assessing the multifaceted burden of migraines. These findings align with and extend prior research, such as studies by Rafi et al. (2022) [9] and Saif et al. (2023) [7], by offering localized insights and actionable recommendations tailored to this demographic.

6.2 Limitation

Despite its contributions, this study has several limitations. The reliance on self-reported data introduces potential biases, as participants may have underreported or misrepresented their migraine experiences. The study's scope was limited to university students, restricting the generalizability of findings to other populations. Additionally, resource constraints precluded the inclusion of more diverse data sources, which could have enriched the analysis. Furthermore, the cross-sectional design limits the ability to infer causal relationships between triggers and migraine severity.

6.3 Future Work

To build on this research, future studies should aim to address its limitations. Expanding the participant pool to include diverse populations, such as working professionals and adolescents, would enhance the generalizability of findings. Longitudinal studies could provide a deeper understanding of the temporal relationships between migraine triggers and severity. Incorporating wearable technology could uncover real-time behavioral and physiological patterns of migraines, complementing the insights obtained in this study. Additionally, advanced machine learning techniques could be leveraged to refine the clustering models and develop predictive frameworks for early intervention. Further exploration of gender-specific differences and the role of environmental factors, such as noise and air quality, could offer more nuanced recommendations for migraine management and prevention strategies tailored to specific subgroups.

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