UNIVERSITI MALAYA

WIE2003 : INTRODUCTION to DATA SCIENCE

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GROUP ASSIGNMENT PART 1

TITLE: SLEEP QUALITY PREDICTION

LECTURER: PROFESOR MADYA DR. MAIZATUL AKMAR BINTI ISMAIL

CLASS : OCCURENCE 1 GROUP 11

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Role

Members	Assigned Works
NG ZHI WEI	• Delegate Tasks and Monitor Progress • Data analysis and Data visualization
LIEW JIN SZE	• Outline the societal impact of the project • Detailing the ethical considerations
KUEH PANG LANG	• Provide an overview of overall the project • Identify the objectives and problems statement
SILVIA EVAFARINA ASUN	• Evaluate existing literature to identify their result whether it is consistent with the project.
ELAINE LEOW HUI XIN	• Responsible for exploring the dataset, identifying missing values, outliers, and inconsistencies, and cleaning the data.

1. Project background

Sleep is an important part of your daily routine as you spend about one-third of your time doing it. Quality sleep and getting enough of it at the right times is as essential to survival as food and water. During sleep, the body is working to support healthy brain function and maintain physical health. Without sleep you can't form or maintain the pathways in your brain that let you learn and create new memories, and it's harder to concentrate and respond quickly. Sleep is generally categorized into rapid eye movement (REM) sleep and non-REM sleep. The cycle through all stages of non-REM and REM sleeps several times during a typical night, with increasingly longer, deeper REM periods occurring toward morning. The need for sleep and the sleep patterns change as you age, but vary significantly across individuals of the same age. There is no magic number of sleep hours that works for everybody of the same age. Generally, people are getting less sleep than they need due to longer work hours and the availability of round-the-clock entertainment and other activities.

However, in today's fast-paced world, individuals often neglect the importance of quality sleep, leading to various health issues and diminished productivity. In the pursuit of productivity and success, individuals often sacrifice sleep, unaware of the detrimental effects on their well-being. The misconception that sleep can be "caught up" on weekends or compensated for with caffeine perpetuates a cycle of sleep debt and a culture of sleep deprivation. Depending on how sleep-deprived they are, sleeping longer on the weekends may not be adequate. Moreover, accumulating evidence underscores the irreplaceable role of consistent, high-quality sleep in promoting vitality, resilience, and longevity.

Therefore, our project focuses on analyzing sleep patterns, considering both health and lifestyle factors. We've utilized a dataset sourced from Kaggle, comprising a total of 374 rows and 13 columns. These columns contain diverse information including gender, age, occupation, sleep duration, sleep quality, physical activity level, stress levels, BMI category, blood pressure, heart rate, daily steps, and the presence or absence of sleep disorders. We opted for this dataset due to its comprehensive nature and relevance to our study. It can be segmented into four main categories and key features: detailed sleep metrics covering duration and quality, lifestyle factors such as activity levels and stress, cardiovascular health markers like blood pressure and heart rate, and assessment of sleep disorders like insomnia and sleep apnea.

Our project is suitable for various organizations towards achieving common goals in improving sleep health and lifestyle habits. These organizations include the National Sleep Foundation (NSF), Sleep Research Society (SRS), and Consumer Technology Association (CTA) to leverage their expertise, resources and technology to achieve common goals of improving sleep health and lifestyle habits. The project targets a diverse range of users, including researchers, healthcare professionals, individuals seeking to optimize their sleep, and technology developers. Researchers and data scientists can analyze the dataset to understand sleep patterns, while healthcare professionals can use it to assess and treat sleep disorders. Individuals can also gain insights into their sleep habits, and technology developers can innovate new sleep tracking tools and digital solutions. Together, we strive to enhance well-being and quality of life by promoting healthy sleep habits.

The project holds the promise of enhancing sleep health for individuals by providing personalized insights into sleep patterns and lifestyle factors, empowering them to make informed choices that can lead to better overall well-being and productivity. Furthermore, the findings from the analysis have the potential to drive innovation in technology, particularly in the development of more accurate and user-friendly sleep tracking devices and digital health solutions. This could revolutionize the way individuals monitor and manage their sleep, ultimately contributing to a societal shift towards prioritizing and valuing the importance of quality sleep for optimal health and performance.

Through a holistic approach, this project aims to empower individuals to prioritize and enhance their sleep quality, recognizing both physiological and lifestyle factors that influence it. By fostering a culture that values and prioritizes sleep as a fundamental component of a healthy lifestyle, we aim to bring about positive change. By adopting a comprehensive approach that addresses both physiological and lifestyle factors influencing sleep health, this project endeavors to empower individuals to prioritize and improve their sleep quality, leading to enhanced overall well-being and productivity. Through education, community engagement, and targeted interventions, we aim to foster a culture that values and prioritizes sleep as an integral component of a healthy lifestyle.

2. Problem Statement

Sleep is a fundamental aspect of human health and well-being, yet it is increasingly undervalued and neglected in today's fast-paced society. The prevalence of sleep disorders and inadequate sleep duration has reached alarming levels, contributing to a host of adverse health outcomes and diminishing productivity. Despite growing awareness of the importance of sleep, misconceptions persist, perpetuating a culture of sleep deprivation and undermining efforts to prioritize restorative sleep. Addressing these challenges requires a comprehensive understanding of the multifaceted factors influencing sleep health and lifestyle habits, as well as targeted interventions to promote behavior change and foster a culture that values and prioritizes sleep.

The project stems from the growing concern over the prevalence of sleep disorders and inadequate sleep duration in modern society nowadays. Research indicates a concerning rise in sleep disorders and insufficient sleep duration, with profound implications for physical, mental, and emotional well-being. Chronic sleep deprivation has been linked to an increased risk of health problems, including obesity, cardiovascular diseases and mental health disorders. Lifestyle factors, including irregular sleep schedules, excessive screen time, high stress levels, and poor dietary habits further contribute significantly to sleep disorders, perpetuating a vicious cycle of sleep deprivation and compromised health outcomes. Despite the availability of evidence-based guidelines, the pervasive societal mindset that equates sleep with laziness and productivity with sacrifice perpetuates harmful behaviors and undermines efforts to promote healthy sleep habits. Recognizing the multifaceted nature of sleep health, this project adopts a holistic approach to address both physiological and lifestyle aspects affecting sleep quality.

In conclusion, the problem of inadequate sleep and its far-reaching consequences represent a significant public health challenge that demands urgent attention and collective action. By addressing the complex interplay of physiological, behavioral, and environmental factors influencing sleep health, this project aims to catalyze positive change and promote a culture of sleep wellness and resilience. Through collaboration, innovation, and advocacy, we aspire to create a future where restorative sleep is recognized as a fundamental human need and embraced as a cornerstone of overall health and well-being.

3. Project Objectives

The primary objective of this project is to address the pressing public health issue of inadequate sleep and its detrimental impact on overall well-being and productivity. Our goal is to cultivate a culture that values and prioritizes sleep as an essential component of a healthy lifestyle, thereby reducing the prevalence of sleep disorders, enhancing quality of life, and promoting resilience and vitality across diverse populations. Our main objectives of this project is to :

i. Predict the sleep quality by examining variables such as gender, age, occupation, physical activity level, stress levels, BMI category, blood pressure, heart rate, daily steps, and the presence or absence of sleep disorders

ii. To identify patterns and correlations of the relationships between various factors such as sleep duration, quality, physical activity, stress levels, and health metrics like BMI, blood pressure, and heart rate

iiii. Investigate how different lifestyle factors influence overall health and well-being, with a focus on sleep disorders and related health issues.

Ultimately, the objective is to use the findings from the dataset to inform interventions and strategies that can enhance individuals' overall quality of life by promoting better sleep, healthier lifestyles, and improved management of health conditions. By adopting a multifaceted approach, encompassing education, community engagement, and targeted interventions, we aim to empower individuals to prioritize and improve their sleep health and lifestyle habits.

4. Project Scope

For this project, we are required to discover patterns and trends in our sleep health analysis datasets to get insights. Then, we are able to create forecasting algorithms and data models and lastly, improve the quality of data or product offerings by utilizing suitable data science tools and machine learning techniques.

To start our project, we first collect our data by sourcing our data from Kaggle, a renowned platform for data scientists and machine learning practitioners to access high-quality, resourceful and reliable datasets. Following data collection, we embark on the crucial step of data cleaning, which involves the process of fixing or removing incorrect, corrupted, incorrectly formatted, duplicate, or incomplete data within a dataset. By rectifying or eliminating these data, it improves the data quality and reliability for analysis and reporting, which in turn enhances the model performance. Subsequently, we delve into exploration data analysis (EDA), a pivotal phase that empowers us to comprehend the dataset's structure, patterns, and relationships among variables. Through summary statistics, data visualization techniques, correlation analysis, and group comparisons, we gain insights into the data's characteristics so that we can figure out the course of actions and areas that we can explore in the modeling phase. EDA serves as a cornerstone for informed decision-making, guiding us towards selecting pertinent features, designing effective models, and formulating hypotheses to drive our project forward.

Next, we will identify the most predictive features by selecting relevant variables and exploring interactions between them. Then, we'll develop forecasting algorithms and data models to predict health outcomes based on demographic, lifestyle, and health metrics data. By interpreting model predictions and extracting actionable insights from the results, we aim to understand the significance of predictive features, visualize model outputs, and identify factors contributing to sleep health analysis.

5.Literature Study/Information Gathering Analysis

In August 25, 2023, Shulan International Medical College and Zhejiang Shuren University in Hangzhou, China had employed a cross-sectional analytical approach on a convenience sample of 255 medical students from a private university to study the factors that influence sleep quality. Research has indicated a noteworthy negative correlation between sleep quality and stress levels (Alotaibi et al., 2020), where reducing stress can lead to improved sleep quality, while heightened stress can severely degrade it (Van Laethem et al., 2017). Also, in January 13, 2020, according to Abdullah D. Alotaibi, Faris M. Alosaimi, Abdullah A. Alajlan, and Khalid A. Bin Abdulrahman, poor quality of sleep was significantly associated with elevated mental stress levels and daytime naps. According to Dr Annise Wilson, sleep loss triggers our body's stress response system, leading to an elevation in stress hormones, namely cortisol, which further disrupts sleep. Psychological effects of stress, such as feeling overly alert and tense can also make it difficult to fall asleep as higher stress can make it harder to fall asleep and cause more frequent nighttime awakenings that lead to poor sleep quality.

In 2019, research was conducted among students of The University of Alicante, a public University in south-east Spain. The final sample comprised 337 participants of over 18 years old. The sleep quality was measured by means of the Pittsburgh Sleep Quality Index (PSQI). The results show that poor sleep quality has been linked with a higher BMI where it seems that poor sleep quality leads to an increase in BMI (Madrid-Valero J.J. et al., 2017). Sleep quality may affect BMI through hormonal and biochemical changes such as variations in leptin, ghrelin and cortisol levels or increased resistance to insulin (Spiegel K. et al., 2004). According to an article by the Sleep Foundation, sleep quality affects BMI due to sleep loss can create a hormone imbalance in the body that promotes overeating and weight gain. Leptin and ghrelin are hormones that regulate appetite, and when you aren't getting sufficient sleep, the production of these hormones is altered in a way that creates increased feelings of hunger.

The research about sleep disorder effects on sleep quality was also conducted among the same students from The University of Alicante, Spain. Based on their research, some sleep disorders are more related to physical health problems, such as sleep apnea, whereas some are

more related to mental health problems, such as insomnia (Darchia N. et al., 2018). Some mechanisms that underlie the relationship between poor sleep quality, depression and anxiety are, the corticolimbic circuitry, which is a part of our brain, was affected by poor sleep quality and it is related to difficulties in emotion reactivity and regulation (Blake M.J. et al., 2018). According to an article from Sleep Foundation, Insomnia is a condition of ongoing difficulty to fall or remain asleep despite wanting and having enough time to sleep. On the other hand, sleep apnea is a breathing disorder that disrupts breathing at night. People with this condition often snore heavily and may wake up choking or gasping for air.

While much of the existing literature on sleep quality has centered around college students, there is a notable lack of research focusing on predictors of sleep quality among adult populations. After reviewing the available literature, we have decided to examine the roles of stress levels, BMI, and sleep disorders as potential predictors of sleep quality in adults.Stress levels, both from work and personal life, are known to contribute to sleep disturbances and insomnia. Similarly, an individual's BMI and weight status have been strongly linked to sleep-related breathing disorders like obstructive sleep apnea, which can reduce sleep quality and increase daytime sleepiness.This gap in the literature on how these crucial factors may differentially impact sleep quality in adults compared to students presents a limitation. This research should therefore aim to bridge this gap by exploring the predictive roles of stress, BMI, and sleep disorders on adult sleep quality.

6.Description of Methodology

A. Obtain - Types of Data Collected, Sources, Reliability

In our project, we detail the methodology employed in the study of "Sleep Health and Lifestyle," outlining the types of data collected, their sources, and the reliability of the data.

I. Types of Data Collected: The study collected both quantitative and qualitative data to provide a comprehensive understanding of the phenomenon under investigation.
•Quantitative Data: Person ID, Age, Quality of Sleep, Sleep Duration ,Stress Level ,Blood Pressure, Heart Rate, Daily Steps ,Physical Activity Level.
•Qualitative Data: Gender, Occupation, BMI Category, Sleep Disorder .

II. Sources of Data: The dataset utilized in this study, titled "Sleep Health and Lifestyle," was obtained from Kaggle, a prominent platform for data science and machine learning resources.
• Author: Laksika Tharmalingam (machine learning engineer)
• Contributor:Amal Yasser,Abdelhalim Ashraf,Alnour Abdalrahman
• Platform: Kaggle
• URL: https://www.kaggle.com/datasets/uom190346a/sleep-health-and-lifestyle-dataset/data
• Version: Version 2.0

III. Reliability of Data: While Kaggle datasets are often curated and shared by reputable sources, it is crucial to assess the reliability of the specific dataset used for the study. To ensure the reliability of the Kaggle dataset, several steps were undertaken:

•Data Source Verification: The dataset's authenticity and credibility were rigorously evaluated by thoroughly examining its source information on Kaggle. This involved scrutinizing the dataset's description, usability, metadata, license, and accompanying documentation. Additionally, the author verified the dataset's legitimacy by seeking additional provenance sources from Google.

•Engagement Metrics Analysis: The data set's level of engagement, including views, downloads, and comments, was thoroughly analyzed. Notably, the dataset has garnered significant attention, with over 226K views and 41.6K downloads, underscoring its relevance and popularity within the data science community.
•Peer Validation: To bolster the dataset's credibility, it underwent rigorous scrutiny by peers and domain experts within the Kaggle community. Notably, experts such as Amal Yasser, a student specializing in Artificial Intelligence at the University of Kafr El-Sheikh, Egypt, provided invaluable feedback and validation.

B. Scrub – Processes done to clean the dataset, types of imputation used etc

1. Checking for Null Values:

   Upon initial dataset examination, missing values (NaN) were found in the 'Sleep Disorder' column. To address this, the fillna() method was employed, replacing these missing values with the string "No Sleep Disorder". This ensured uniformity and completeness in the dataset regarding sleep disorder information.

2. Removing Duplicates:

   Upon dataset analysis, 242 duplicate rows were discovered, potentially skewing analysis results due to redundancy. To rectify this, the drop_duplicates() function was utilized, eliminating redundant entries. This ensured each dataset entry uniquely represented an individual, enhancing the accuracy and reliability of subsequent analyses.

3. Checking for Categorical Variables:

   To identify categorical variables, we iterate through a list of specified columns, extracting unique categorical values. For example, 'Gender' includes categories like 'Male' and 'Female', while 'Occupation' encompasses professions such as 'Software Engineer', 'Doctor', 'Sales Representative', 'Teacher', 'Nurse', 'Engineer', 'Accountant', 'Scientist', 'Lawyer', 'Salesperson', and 'Manager'.

4. Removing Unnecessary Columns:

   The 'Person ID' column, while serving as a unique identifier, was determined to be unnecessary for the analysis at hand. As a result, it was removed from the dataset. Removing the 'Person ID' column ensures that the dataset focuses solely on relevant attributes related to sleep health, demographic, and lifestyle characteristics, facilitating more meaningful insights and analysis outcomes.

5. Replace Unnecessary Values:

   To enhance data accuracy and reliability, redundant values within the BMI Category, such as 'Normal' and 'Normal Weight', were identified. To address this redundancy, 'Normal Weight' was replaced with 'Normal' using the replace() method. This ensures consistency in the BMI category and avoids potential skewing of analysis results due to unnecessary distinctions.

6. Merge

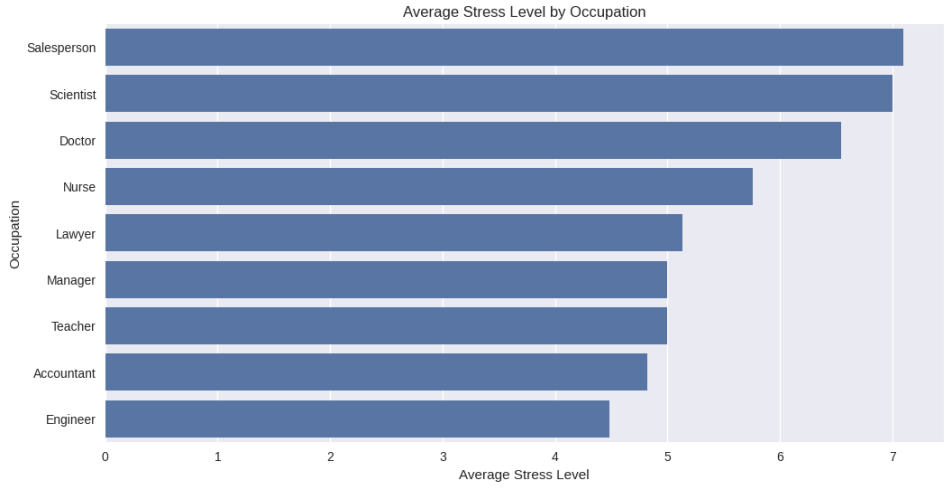
   To streamline the dataset and enhance its representativeness, the occupations 'Salesperson' and 'Sales Representative' were merged into one category, as were 'Software Engineer' and 'Engineer'. Additionally, due to their poor representation, rows related to the occupations 'Scientist' and 'Manager' were identified then drop() method is applied to remove the identified rows.

7. Checking for outliers

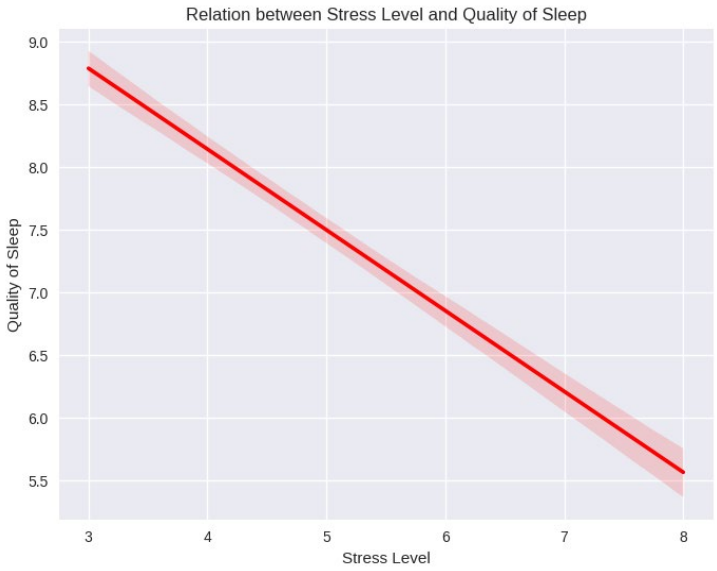
   We specify numerical columns to plot and create a 7x2 subplot grid to visualize these columns, aiming to detect outliers. Outliers, primarily in the 'Heart Rate' column, are visually identified. The main objective is to recognize and understand data points deviating significantly from the majority, aiding in anomaly detection and error identification.

C. Explore – Exploratory Data Analysis

Relationship between occupation, stress and quality of sleep

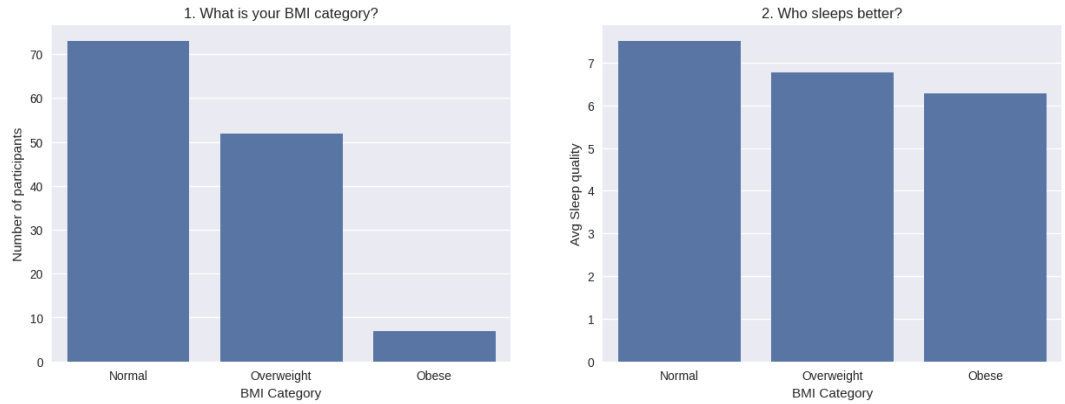


Engineers, teachers, and accountants exhibit lower stress levels compared to sales representatives, salespersons, and scientists. This observation prompts an analysis of how stress levels influence the quality of sleep.



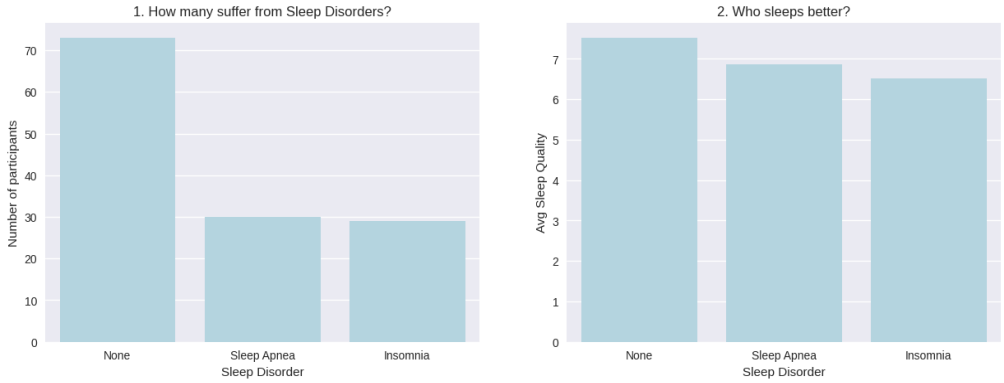
We have observed a significant negative correlation between stress levels and the quality of sleep. This discovery is not unexpected, as a negative relationship implies that heightened stress levels may impede individuals' ability to fall asleep, lead to more frequent awakenings during the night, or contribute to overall disrupted and poorer sleep quality.

Relationship between BMI and quality of sleep



The table above displays the average sleep quality across different BMI categories. Additionally, the second bar chart illustrates that participants with a normal BMI exhibit superior sleep quality compared to those classified as overweight or obese. Notably, individuals classified as obese demonstrate the lowest average sleep quality. This implies that higher BMI is associated with poor sleep quality.

Relationship between sleep disorders and quality of sleep



The table above presents the average sleep quality across various sleep disorders. The first bar chart provides insight into the distribution of people with different sleep disorders, while the second bar chart examines the relationship between sleep disorders and average sleep quality.

From the first graph, it's evident that the majority of people experience normal sleep patterns, with insomnia and sleep apnea being less prevalent among participants.

In the second graph, people without any sleep disorders exhibit the highest average sleep quality, as anticipated. Interestingly, among those with sleep disorders, individuals with sleep apnea report better sleep quality compared to those experiencing insomnia.

Here is the link for our data cleaning & data analysis process
https://github.com/zhiweing/WID2003-INTRO-TO-DS-/blob/main/Sleep_Health_Analysis.ipynb

7. Impact of The Project to The Society

The impact of the project to the society can be expressed in many expects. First of all, it improves public health awareness. By analyzing sleep quality and its relationship with factors like gender, age, occupation, physical activity, stress levels, and health metrics, the project can raise awareness about the importance of sleep for overall health. This knowledge empowers individuals to make informed lifestyle choices that prioritize sleep. It also benefits the public by providing customized health recommendations. Insights gained from the project can lead to personalized health recommendations tailored to individuals' specific needs and lifestyle factors. For instance, recommending adjustments in physical activity levels, stress management techniques, or sleep hygiene practices based on data analysis.

Furthermore, this project brings forth early detection and intervention. The project's predictive capabilities can facilitate early detection of sleep disorders and related health issues. Timely intervention and treatment based on identified risk factors can prevent more serious health consequences down the line. This is vital as it can help to rapidly decrease the risk of developing illness and provide immediate treatment if discovered. Our project aims to introduce long-term health benefits. By investigating lifestyle factors and their impact on overall health, including sleep disorders, the project promotes preventive healthcare strategies. This can lead to improved long-term health outcomes and reduced burden on healthcare systems.

Besides, a reduction of healthcare costs can be achieved through our project. Improved sleep health can potentially lead to a reduction in healthcare costs associated with treating sleep disorders and their related comorbidities. Prevention and early intervention treatments can be more cost-effective compared to treating chronic health conditions. This is because early intervention treatments only rely on medicines and medical products while late stage illness may require more advanced treatment methods what are more costly. Our project can enhance productivity and quality of life. Better sleep quality positively impacts productivity, cognitive function, mood, and quality of life. The project's findings can inform strategies to optimize these outcomes for individuals and society as a whole.

From another perspective, this project can promote data-driven policy decisions. Insights from the project can inform public health policies related to sleep health, workplace wellness programs, and healthcare system improvements. Evidence-based policymaking can lead to more effective interventions and support structures. The public will be more supportive if evidence were

given and that is one of the objectives of the project, providing evidence-based data that show the current public health conditions. In this case, the public will have more confidence in the policy decisions and also persuade higher management of the importance of these policies.

Moreover, this project promotes holistic health. By studying correlations between sleep quality, physical activity, stress levels, and health metrics like BMI, blood pressure, and heart rate, the project promotes a holistic approach to health. It emphasizes the interconnectedness of lifestyle factors and overall well-being. It relates our daily activities with our health, showing how it affects us and what we can do to get a positive impact. It also enhances public awareness and understanding of how these affect our health and well-being.

Apart from that, our project can bring ample economic benefits to society. Improved sleep can lead to increased productivity and focus at work, potentially boosting economic output. Development of new technologies and interventions based on the project's findings could create new jobs and economic opportunities. Not only that, the introduction of more advanced medical instruments and medicine products can also increase the economic situation in our country and at the same time improve our people's health situation, hence it is a kill two birds with one stone situation undoubtedly.

Last but not least, our project can promote advancement of scientific knowledge. The project's data and findings can contribute to a deeper understanding of sleep and its complex interplay with various health factors. This knowledge can pave the way for further research and development of new diagnostic tools and treatment options for sleep disorders. These data findings are very important as they can bring us to a closer understanding of our health system and by doing that, we will obtain more treatment methods in the future through this scientific research.

8.Ethical Consideration

Ethical considerations of our projects includes informed consent. It ensures that participants fully understand the purpose, procedures, and potential risks of the study before agreeing to participate. Obtain informed consent from all participants, clearly explaining how their data will be used and ensuring their anonymity and confidentiality. This is to ensure that all participants of the project are fully informed and committed to the project, preventing any unexpected circumstances.

Other than that, privacy and confidentiality is also vital in order to protect the privacy of participants' sleep data and health information. The usage of secure storage and transmission methods is introduced to prevent unauthorized access or disclosure of sensitive personal data. The same goes for data security. Robust data security measures are implemented to safeguard collected data against breaches or unauthorized access. This measure is to adhere to relevant data protection regulations and ethical guidelines.

Furthermore, we can avoid bias and discrimination by analyzing and interpreting data in a manner that avoids perpetuating biases related to gender, age, occupation or other demographic factors. It is necessary to ensure that findings are presented objectively and also avoid reinforcing stereotypes or discriminatory attitudes.

In addition, the beneficence and non-maleficence of the project is vital as we strive to maximize the benefits while also minimizing the potential harm to participants. In doing that, we should consider the potential impact of the study findings on participants' well-being and monitor closely to ensure that any intervention or recommendations are evidence-based and beneficial.

Besides, we practice respect for autonomy. We respect participants' right to make informed decisions about their involvement in the study. At the same time, participants should also be allowed to withdraw from the study at any time without consequences if any emergency occurs. We are not to force participants to carry out any activities against their will and only proceed if participants are involved willingly.

We should also maintain transparency throughout the study process. This includes data collection, analysis, and dissemination of results. Communications regarding the limitations of the study and potential implications of the findings should be transparent and clear to prevent any unwanted problems during the implementation of the project. In another perspective, equitable

access and benefit sharing is introduced considering how the results of the study can benefit broader communities or populations beyond the participants. We should ensure equitable access to any interventions or recommendations resulting from the study.

Lastly, ethical review and oversight is utmost important. Seeking ethical approval from relevant institutional review boards or ethics committees before initiating the study is a must as it adheres to ethical guidelines and regulations applicable to research involving human participants.

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