

Research on the Relationship Between Sleep Quality and Health

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Abstract. Sleep quality is an important factor affecting human health, and more and more factors in daily life can affect sleep quality. Although there have been numerous studies demonstrating the relationship between sleep quality and health, there are still research gaps in different populations and key influencing factors. This study discusses the relationship between factors that affect sleep quality and health and conducts in-depth research on their impact on human health development. It conducted a correlation analysis on the open-source dataset of sleep quality and health using visualization analysis and the Pearson correlation coefficient method. The paper discussed the key factors affecting sleep quality and how sleep quality affects physical and mental health. The research results indicate that poor sleep quality directly affects human health, and multiple factors can cause sleep disorders, which in turn have a negative impact on health. In summary, there is a close relationship between sleep quality and health, and it provides a reliable basis for improving human health and happiness in the future.

Keywords: Sleep quality; human health; sleep disorders.

1. Introduction

Sleep quality is an important clinical construct since it is increasingly common for people to complain about poor sleep quality and its impact on daytime functioning [1]. Good sleep quality is not only related to an individual's physical health but also directly affects their psychological state and quality of life. As a fundamental human need, sleep stands out as one of the most pertinent emerging themes. Because there is strong evidence that sleep deprivation and sleep disturbances affect metabolic and inflammatory processes with a wide range of negative effects on health [2]. Especially with the increase in population, the rapid development of modern society, and the continuous iteration and updating of emerging industries and technologies, various pressures (such as academic, work, family, loans, children's education, interpersonal relationships, etc.) are gradually sweeping through. This rapid societal development has led to an accelerated pace of life, contributing to the widespread occurrence of sleep disorders as a common health concern. According to the World Health Organization, more than 27 percent of the world's population suffers from sleep disorders. According to the sleep survey released by the China Sleep Research Society in 2016, 38.2 percent of adults in China have insomnia, and 300 million Chinese people have difficulties in falling asleep, sleep interruption, and insufficient sleep duration. Many studies already show that the sleep duration variable is an important risk factor for the development of hypertension and other cardiometabolic disorders in children, adolescents, and adults [3-5]. Therefore, it is of great theoretical and practical significance to deeply study the relationship between sleep quality and health and to explore the factors affecting sleep quality. Numerous studies have explored the relationship between sleep quality and health; however, there remain some one-sided theories and areas of inquiry that have not been comprehensively investigated. For instance, there's a notable absence of comparisons across specific populations, as well as a deficiency in thorough investigation and discussion on the factors influencing sleep quality. Moreover, many existing studies focus on mental health, and the others are relatively few. This paper used visual analysis and Pearson correlation coefficient for the correlation between sleep quality and health using the open-source dataset Sleep Health and Lifestyle Dataset.

The initial step involved searching relevant literature, followed by processing the collected data through visual analysis and the application of Pearson's correlation coefficient method. This

facilitated the exploration of the impact of sleep quality on cardiovascular health, emotional well-being, and metabolic health. Through the correlation analysis, it becomes possible to gain a more intuitive understanding of the relationship between sleep quality and health, enabling further interpretation and discussion of the results. The content of the study covers the impact of sleep quality on multiple health problems, including but not limited to cardiovascular health, emotional state, and metabolic health. This paper aims to fill the gap in the current study and explore all aspects of the relationship between sleep quality and health. Through the comprehensive analysis of the existing literature, it can further explore the influence mechanism of sleep quality on health, and provide a scientific basis for developing sleep-promoting health strategies.

2. Method

2.1. Dataset

This study will use a correlation analysis to explore the relationship between sleep quality and health indicators. Its rigorous literature screening and data validation ensure its reliability. The dataset (sourced from the Sleep Health and Lifestyle Dataset on Kaggle) contains 400 rows and 13 columns, covering a wide range of variables such as gender, age, occupation, sleep duration, sleep quality, physical activity level, stress level, BMI category, blood pressure, heart rate, daily steps, and the presence of sleep disorders. This detailed information will provide an important data basis for understanding the relationship between sleep quality and health indicators.

2.2. Data Preprocessing

In the data preprocessing stage, the following ways to select the potential related papers: (1) screening title, (2) screening, (3) full retrieval and screening. This process aimed to determine whether the abstracts provided sufficient data or were unavailable to meet the inclusion criteria, further assessing their applicability and credibility. Subsequently, required data on sleep quality and health indicators were extracted. Utilizing the provided dataset, the data underwent cleaning, integration, and preparation. This process focused on variables including sleep duration, quality, physical activity level, stress level, BMI classification, blood pressure, and heart rate. The aim was to ensure data accuracy and consistency, thereby establishing a reliable foundation for subsequent correlation analysis.

2.3. Model

This study will use a comprehensive approach, including the Pearson correlation coefficient method, thermal map analysis, and visual analysis, to fully explore in-depth the association between sleep quality and health indicators. First, Pearson's correlation coefficient method will be used to quantify the linear relationship between sleep quality and various health indicators, which will provide an intuitive and objective analysis for research, so that the degree of association between variables can be presented. Pearson correlation coefficient (PCC) is a statistical metric that measures the strength and direction of a linear relationship between two random variables [6]. Secondly, thermal map analysis will show the correlation between data in an intuitive form, helping researchers to better understand the complex relationship patterns, to more fully grasp the correlation between sleep and health. At the same time, visual analysis will present the relationship and trends between the data in a graphic way, further enhance the interpretability and visual effect of the research results, and make the research results more convincing and understandable. The integrated application of these three methods will provide us with a comprehensive and in-depth perspective to help with a deeper understanding of the effects of sleep on health. A comprehensive analytical method will provide a reliable basis and guidance for health management and prevention, and provide a solid foundation for developing sleep-related health policies and interventions.

3. Result

Fig. 1 generated based on the Pearson correlation coefficient method show that, Person ID, Gender, Age, Occupation, Sleep Duration, Quality of Sleep, Physical Activity Level, Stress Level, BMI Category, Heart Rate, Daily Steps, and Sleep There are significant correlations between Disorder, BUV (BloodPressure_Upper_Value) and BLV (BloodPressure_Lower_Value). These associations may show a trend of positive or negative correlation, revealing the potential associations between these variables and their possible mechanisms of influence.

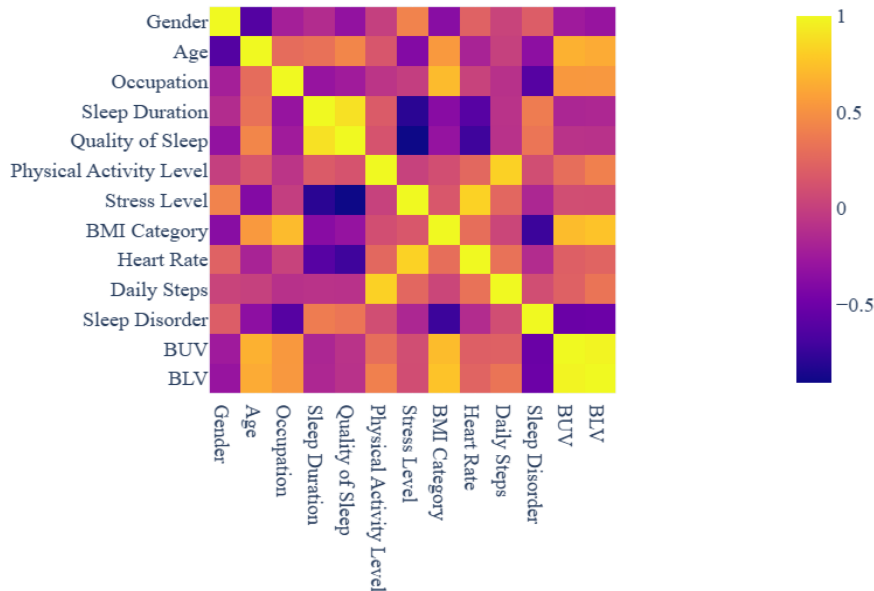


Figure 1. The heat map displays the correlation between variables in the dataset

Fig. 2 indicates the relationship between sleep length (Sleep Duration) and sleep disturbance (sleep disorder). The histogram will show the distribution of sleep duration while representing different types of sleep disorders in different colors (blue: severe sleep disorders, red: minor sleep disorders, green: no sleep disorders). By observing the histogram, it can understand the distribution of sleep duration under different sleep disorders, and then infer the possible effects of sleep disorders on sleep duration. (Horizontal axis: sleep duration, unit: hours; Vertical axis: number of people, unit: number).

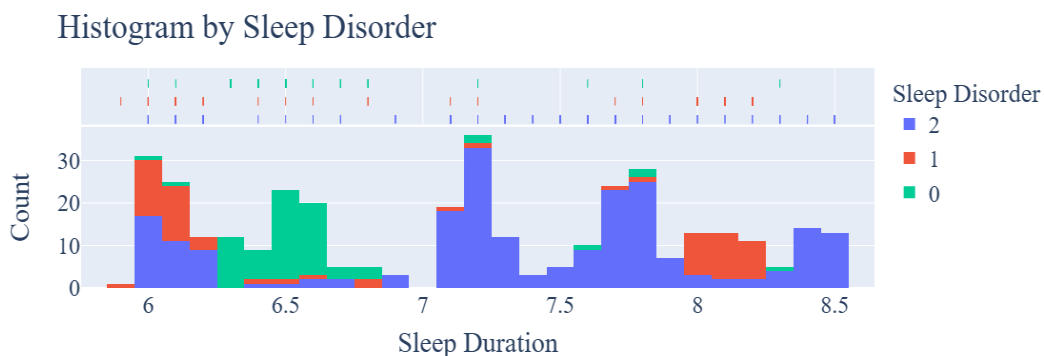


Figure 2. The distribution of sleep duration under different sleep disorders

The relationship between Sleep Duration and BMI Category in Fig. 3. The histogram will display the distribution of sleep duration and represent individuals with different BMI classifications in different colors. By observing histograms, it can understand the distribution of sleep duration under different BMI classifications and infer the possible impact of BMI classification on sleep duration. (Horizontal axis: sleep duration, unit: hours; Vertical axis: number of people, unit: number).

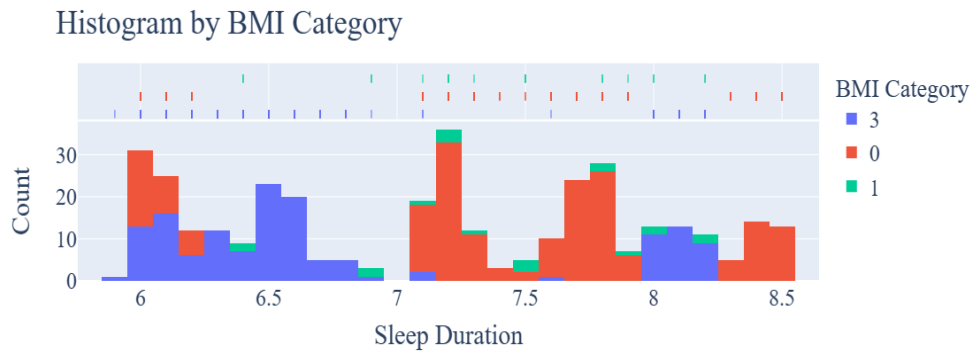


Figure 3. The distribution of sleep duration under different BMI categories

Sleep duration (Sleep Duration) under different BMI categories (BMI Category). The distribution of sleep duration in different BMI classification groups can be visually compared by Fig. 4. (Horizontal axis: sleep duration, unit: hours; Vertical axis: number of people, unit: number) (Blue: overweight, red: normal weight, green: underweight).

Median comparison: observing the median level of each BMI classification gives a preliminary understanding of the central trend of sleep duration in different BMI classification groups.

Comparison of distribution range: By comparing the box size of the boxplot and the line segment length, it can judge the difference in the distribution range of sleep length of different BMI classification groups.

Outlier analysis: observing the outlier situation in the boxplot shows whether the individual sleep duration in some BMI classification groups significantly deviates from the overall trend, which may require additional attention.

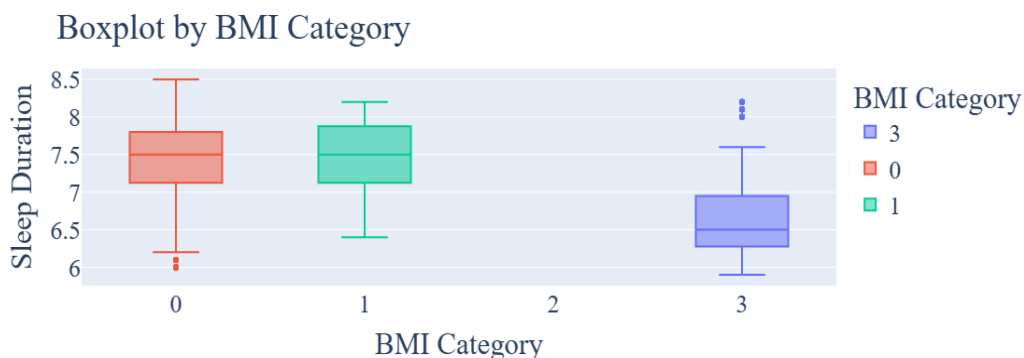


Figure 4. The distribution of sleep duration under different BMI categories

The relationship between gender (Gender) and sleep length (Sleep Duration) was analyzed. Fig. 5 shows the distribution of sleep duration between the different sexes and shows the different sexes in different colors (blue: male, red: female). Means, interquartile, and outliers between the sexes were compared by observing box plots. (Horizontal axis: gender; vertical axis: sleep duration, unit: hours).



Figure 5. The distribution of sleep duration among different gender groups

4. Discussion

The results showed that sleep quality directly affects people's health. According to the thermal map generated by Pearson's correlation coefficient method (Fig. 1), the most important factors are sleep duration, sleep disturbance, stress, and heart rate. From the analysis of physical health indicators, being overweight or underweight will directly affect the quality of sleep. However, overweight people are more likely to have sleep problems, such as sleep apnea syndrome (SDB). Excessive people will lead to changes in the structure of the upper respiratory tract, so it will compress the respiratory tract, obstruction, suspension of breathing, and other problems. Overweight people's sleep duration is shorter (Fig. 3) (Fig. 4), and less sleep duration can also directly affect the quality of sleep, many epidemiological studies meta-analyses, and system evaluation provides evidence that sleep state, such as sleep duration and sleep quality, is associated with overweight and obesity [7-10]. Heart rate is also one of the important factors affecting the sleep quality problem, an abnormal heart rate may lead to an increase in the number of wakes up at night, studies have shown that the continuity and depth of sleep are the factors that affect the quality of sleep, arrhythmia, atrial fibrillation, and other cardiovascular disease people will be more likely to produce sleep disorders. In addition, moderate physical exercise (such as daily steps) helps to improve sleep duration and thus improve sleep quality. Studies have shown that women sleep a little longer than men (Fig. 5). Gender may influence sleep structure, and the distribution ratio may differ in each stage of sleep. For example, studies have found that women have a relatively high proportion of rapid eye movement (REM) sleep stages, while men have a high proportion of non-REM sleep stages. Combined with mental health measures, men have higher stress levels than women, which may lead to shorter sleep duration and worse sleep quality in men. Furthermore, the relationship between high stress and sleep quality is bidirectional. Excessive stress can cause increased heart rate and muscle tension, and long-term stress can hurt health, as continuous activation of the sympathetic nervous system suppresses the parasympathetic nervous system, which is responsible for rest, digestion, and repair. On the other hand, the decline of sleep quality will also affect the brain, resulting in reduced clarity of the brain, great loss of energy, and accompanied by emotional instability, unable to regulate emotions, and other problems. Adequate sleep duration helps improve sleep quality (Fig. 2), ensuring that multiple sleep cycles, including important REM and non-REM sleep stages, facilitate the repair and regulation of the body's systems. However, insufficient sleep or insufficient duration of sleep can lead to decreased sleep quality, disturbed sleep structure, and insufficient deep sleep stages, which in turn affects the daytime mental state and work efficiency. On the other hand, good sleep quality helps to maintain a longer sleep duration and ensure adequate rest and recovery. Conversely, decreased sleep quality may lead to shorter sleep duration, as frequent awakenings and disturbed sleep architecture can affect sleep effects throughout the night. Therefore, to obtain adequate and high-quality sleep, people need to pay attention to the reasonable arrangement of sleep duration, and pay attention to and improve sleep quality.

5. Conclusion

Based on the above research results, it can be concluded that there is a close mutual relationship between sleep quality and health. Sleep is an important process of recovery and regulation of the body, and the quality of sleep directly affects the function and health of the body system. This study explored the association between sleep quality and various health indicators through a variety of methods and found that factors such as sleep duration, heart rate, and body weight were closely related to sleep quality. In particular, the influence of mental health factors such as high stress and abnormal heart rate on sleep quality further highlights the close link between mental health and sleep. These findings suggest that improved sleep quality not only contributes to the prevention and treatment of various health problems, but also provide an important rationale for promoting overall health. Therefore, future research and clinical practice should focus more on the improvement of sleep quality and promote individual physical and mental health development through comprehensive health management and interventions.

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