Sofia Georgieva

Analysis of Sleep Health, Physical Activity, and Stress Levels

21.02.2025

Abstract

Sleep health is influenced by various lifestyle factors, including physical activity, stress, and occupation. This study examined the relationships between sleep duration, sleep quality, stress levels, physical activity, and heart rate, as well as differences based on gender and occupation. Correlational analyses revealed a positive relationship between sleep duration and physical activity and a negative relationship between stress and sleep quality. Males reported higher stress levels than females, while females had better sleep quality. Occupational analysis found higher stress in Business and Healthcare professionals. Stress was also positively correlated with heart rate, particularly in females. These findings emphasize the need for stress management and workplace wellness programs to improve sleep health.

Keywords: Sleep duration, sleep quality, stress levels, physical activity, gender differences, heart rate

Introduction

This study explores the relationship between sleep quality, physical activity, and stress levels both in general population and per gender – male and female. There has been significant amount of literature that looks at stress and its various effects on health. For instance, it has been shown that there is a significant association between sleep quality and stress levels in medical students (Almojali et al., 2017). More specifically, the study showed that students who are not under a lot of stress are less likely to have decreased sleep quality. Similar findings were presented in the paper of Herawati and Gayatri (2019), suggesting that students with poor sleep quality are more likely to experience higher levels of stress, compared to students with better sleep quality. When it comes to the relationship between stress and physical activity, Burg et al. (2017) demonstrated that there is a significant negative effect of stress on exercise, suggesting that increase in stress levels reduced the probability of engaging in exercise. The researchers also found that there is a negative effect of anticipated stress on the physical activity level the next day, meaning that the more one is stressed, the less likely one will be to exercises the next day.

The current study aims to analyze the relationships between stress levels and various variables related to a person's health such as sleep quality, physical activity level and heart rate in order to identify patterns that contribute to better life quality overall. To conduct this analysis, a publicly available dataset from Kaggle was utilized, which contains data on sleep patterns, physical activity, and stress levels of individuals. The dataset includes variables such as sleep duration, stress levels, physical activity levels, BMI categories, and sleep disorders, making it suitable for the examining the connections between these factors. By analyzing this dataset, the aim is to uncover insights that could contribute to better decisions concerning an individual's life.

Data Overview

The dataset consists of 374 rows or entries and 13 columns. The key features of the dataset include sleep metrics such as sleep duration, sleep quality, and factors influencing sleep patterns. There are also lifestyle factors such as the physical activity level, stress levels, and BMI categories. There is also information about cardiovascular health in terms of blood pressure and heart rate measurements. Finally, there is information about sleep disorders like Insomnia and Sleep Apnea.

For the later analysis, the focus was on the following variables. Stress level which was self-reported on a scale from 1 to 10. Physical activity level which was the minutes a person engages in exercises per day. Quality of sleep was a self-reported scale from 1 to 10. Heart rate was measured as the resting heart rate of a person in beats per minute. Gender as a demographic variable. Occupation as the profession of the person.

The initial summary statistics could be found in Table 1. Males were 189 and females were 185.

Table 1

Descriptive Statistics

Variable	Mean	SD	Max – Min
Stress Level	5.39	1.59	8.00 – 3.00
Physical Activity	59.17	18.47	90.00 – 30.00
Heart Rate	70.17	3.93	86.00 – 65.00
Sleep duration	7.13	0.69	8.20 – 5.80

Methods

The data was firstly processed for missing values. The variable that was indicated to have missing values was "Sleep Disorder". Upon further investigation, it became clear that the people with no sleeping disorder were considered as having missing values. Thus, the missing values were substituted with the string "None". No other missing values were encountered afterwards.

For the columns "BMI category" there were three values that were supposed to be present. The entries "Normal Weight" were converted into the string "Normal" to make the data more consistent.

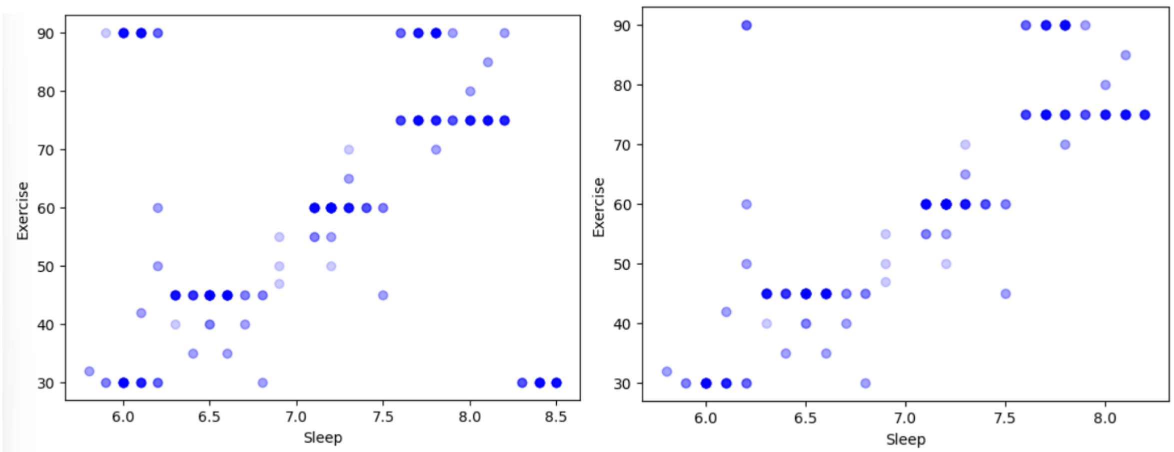
After this preprocessing, the data was ready to be analyzed. Firstly, correlational analysis was performed to investigate the relationship between sleep duration and physical activity level. A scatterplot was generated to inspect the data and look for possible outliers. Secondly, another correlational analysis was performed to investigate the relationship between sleep quality and stress levels. A scatterplot was generated to inspect the direction of the relationship. Thirdly, another correlational analysis was performed to see what the is the relationship between sleep quality and stress level for males and females. Scatterplots were generated to visualize the relationship. Further, an independent sample two-sided t-test was performed to investigate whether the mean sleep quality of males is different than the mean sleep quality of females. A box plot was used as a visualization tool. Another independent sample two-sided t-test was performed to check whether the differences in mean values of stress for males and females were statistically significant. This result was visualized with the help of a bar graph. Furthermore, the stress levels of different job occupation were investigated to see whether some jobs are more stressful than others. A Walch's ANOVA was performed followed by post-hoc test to see which mean differ from each other. Finally, a correlational analysis was performed on the relationship between stress level and heart rate and the same analysis but looking at the two genders separately.

Analysis of the findings

After a correlational analysis was performed to test what the relationship between sleep duration and physical activity was, the scatterplot revealed possible outliers in the data. The outliers were identified and then removed from the analysis (*Figure 1*). The scatterplot was regenerated, and the Pearson's r was calculated ($r = 0.86$, $p < .05$), suggesting that sleep duration and physical activity level were strongly and positively correlated. Thus, increase in sleep duration was associated with increase in exercise.

Figure 1

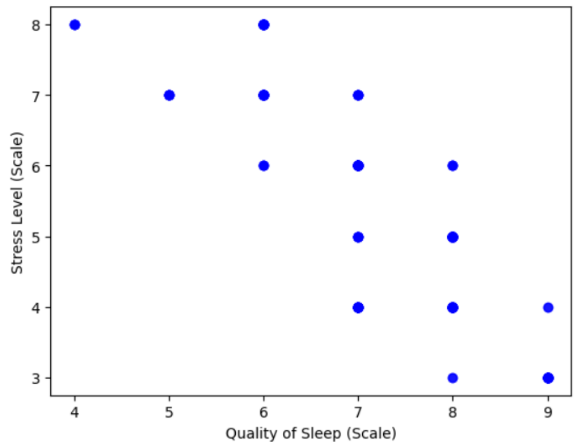
(Left) Scatterplot between sleep duration and exercise with outliers. (Right) Scatterplot between sleep duration and exercise without outliers.



A correlational analysis was performed to answer the question about the relationship between sleep quality and stress level. The scatterplot (*Figure 2*) revealed that the direction of the association is negative. Further analysis found the Pearson's r to be strong and significant ($r = -0.87$, $p < .05$). This suggests that increase in stress levels is associated with decrease in sleep quality.

Figure 2

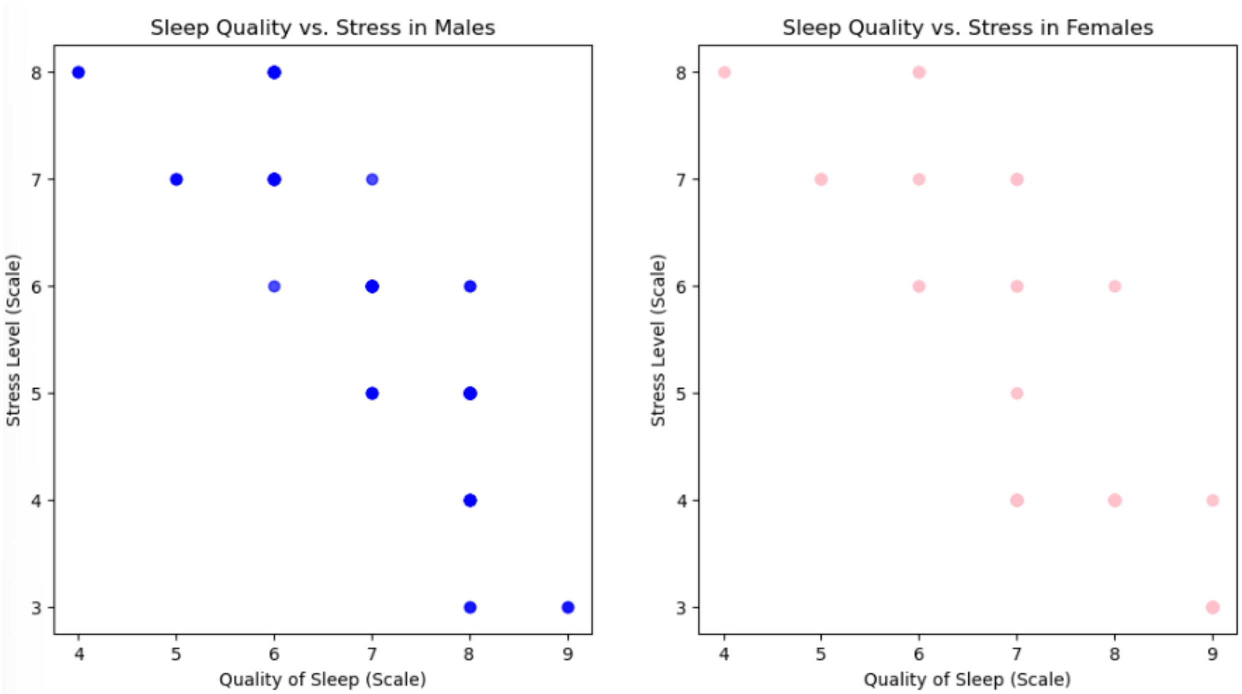
Scatterplot between sleep quality and stress level.



Following the previous analysis, another correlation analysis was performed to check whether the same negative trend between sleep quality and stress levels will be seen for the males and females. A scatterplot (*Figure 3*) for the two genders showed that the negative association was still present, and the next step was to check what the strength of that relation would be. The Pearson's r for males was negative, strong and significant (r = -0.89, $p < .05$) and the same result was found for the females (r = -0.83, $p < .05$). This suggests that for both genders when stress levels go up, sleep quality goes down.

Figure 3

(Left) Scatterplot between sleep quality and stress level for males. (Right) Scatterplot between sleep quality and stress level for females.



Given the previous results, it was interesting to see whether there is a significant difference in the mean sleep quality between males and females. To test a two-sided independent sample t-test was performed with sleep quality being the dependent variable and gender the independent variable. The result rejected the null hypothesis that males and females do not differ in their average sleep quality levels (M_{males}= 6.67, $M_{females}$ = 7.68, t = -5.73, p < .05, *Figure 4*). An effect size was calculated to measure the practical significance of the results using Cohen's d (d = 0.66) which showed a medium to high effect size. Thus, gender has a moderate impact on sleep quality.

Figure 4

Box plots for the average sleep quality based on gender.

Given the difference in sleep quality, it would be useful to see whether there are differences in the stress levels between the two genders and whether those differences would be statistically significant. A two-sided independent sample t-test was performed, and its results suggest that there is indeed a significant difference in the stress levels between the genders, with males being on average more stressed than women (t = 10.76, p < .05, *Figure 5*). An effect size was calculated and showed that there is a large impact of gender on stress levels (d = -1.25).

Figure 5

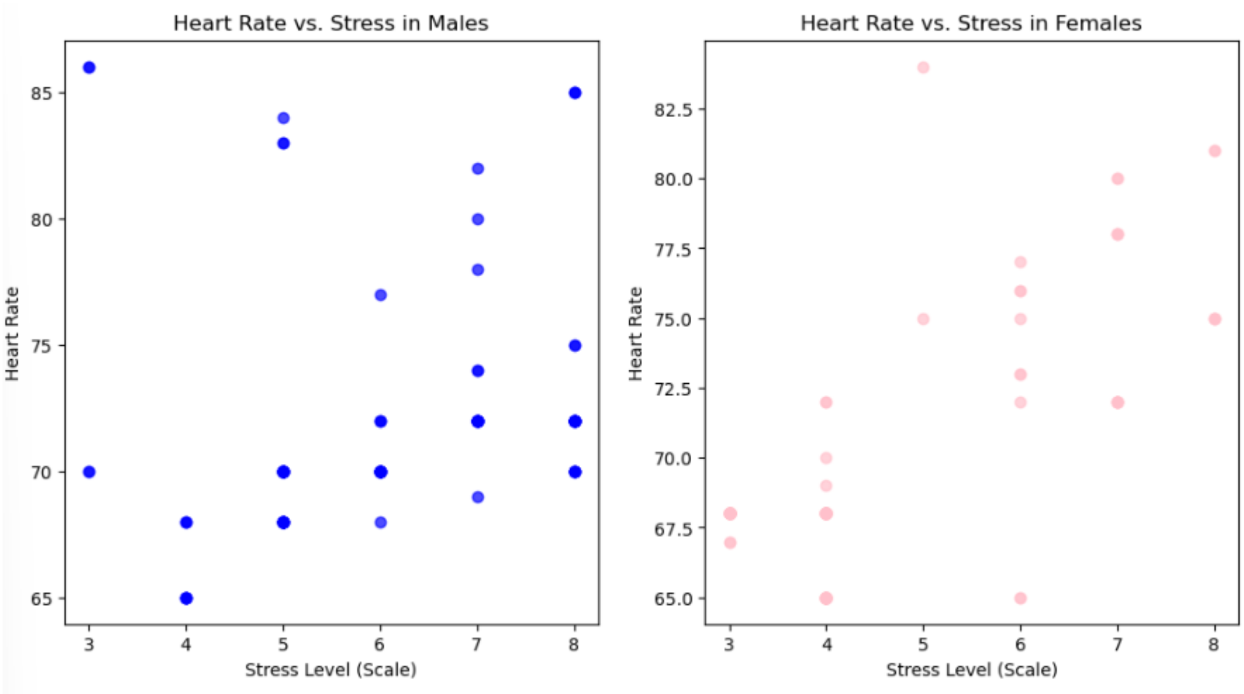
Bar graph for stress level differences between males and females

Stress level differences were assessed between the different job occupations. Firstly, all job titles were grouped into four groups for simplicity with the groups being “Healthcare” for nurses and doctors, “Technical” for engineers, software engineers and scientists, “Business and Sales” for salesperson, sales representatives, managers, accountants, “Education and Law” for teachers and lawyers, and “Other” for anything else. After the categorization, the average stress level per category was calculated. To perform the ANOVA, the assumptions had to be checked (Appendix 1). Given the violation of the equal variances’ assumption, ANOVA could not be conducted. The Walch’s ANOVA is not influenced by group variances, thus it was the test that was performed. Based on the results, the null hypothesis was rejecting, thus at least one group mean differed in their stress levels ($p < .001$). In order to see which categories significantly differ from each other in terms of stress levels, a post-hoc test was conducted and showed that the group of “Business and Sales” was significantly more stressed than “Education and Law” ($M = 5.76$, $p < .05$) and “Healthcare” was significantly more stressed than “Education and Law” ($M = 5.73$, $p < .001$).

Finally, using a correlational analysis the relationship between stress level and heart rate was investigated firstly, for the sample as a whole and then for each gender. The first result showed a positive relationship between stress and heart rate, suggesting that increase in stress level leads to increase in heart rate ($r = 0.54$, $p < .05$). After inspecting the relationship looking at the two genders, the same trend appeared but with some differences among the genders (*Figure 6*). For the males the association was much less strong than for the females ($r_{males} = 0.32$, $p < .05$) which was much stronger ($r_{females} = 0.73$, $p < .05$).

Figure 6

(Left) Scatterplot between stress level and heart rate for males. (Right) Scatterplot between stress level and heart rate for females.



Discussion

The present study investigated the relationships between sleep duration, sleep quality, stress levels, and other lifestyle factors, while also examining gender and occupational differences. The findings revealed a strong positive correlation between sleep duration and physical activity level ($r = 0.86, p < .05$), suggesting that individuals who engage in more physical activity tend to sleep longer. Conversely, stress levels and sleep quality were strongly negatively correlated ($r = -0.87, p < .05$), indicating that higher stress is associated with poorer sleep quality. This negative relationship persisted across genders, with males ($r = -0.89, p < .05$) and females ($r = -0.83, p < .05$) both experiencing declining sleep quality as stress increased.

Further, a two-sample t-test revealed a significant difference in sleep quality between males and females ($t = -5.73, p < .05$), with females reporting higher sleep quality on average ($M = 7.68$) than males ($M = 6.67$). The effect size ($d = 0.66$) suggested a moderate to high practical significance. In addition, stress levels were significantly different between genders, with males experiencing higher stress than females (t = 10.76, p < .05, d = -1.25), indicating a strong effect of gender on stress.

Stress levels also varied significantly by occupation. After grouping job titles into four categories (Healthcare, Technical, Business and Sales, and Education and Law), a Welch's ANOVA test found a significant difference in stress levels across the groups (p < .05). Post-hoc comparisons showed that Business and Sales professionals had significantly higher stress than Education and Law professionals (M = 5.76, p = .003), and Healthcare professionals had significantly higher stress than Education and Law professionals (M = 5.73, p = .001).

Finally, an analysis of the relationship between stress levels and heart rate revealed a moderate positive correlation (r = 0.54, p < 0.05), indicating that higher stress is associated with higher heart rate. This relationship was much stronger for females (r = 0.73, p < .05) than for males (r = 0.32, p < .05), suggesting potential gender differences in physiological responses to stress.

Implications of the Results

The results of this study have several implications for public health and workplace wellness programs. First, the strong positive relationship between sleep duration and physical activity suggests that increasing physical activity may be an effective way to improve sleep duration. Encouraging regular exercise could be a valuable intervention for individuals experiencing sleep difficulties.

The negative correlation between stress levels and sleep quality highlights the importance of stress management strategies in improving sleep health. Given that stress levels were higher among males and certain occupational groups (particularly Business and Sales and Healthcare professionals), targeted interventions such as stress reduction programs, mindfulness training, and mental health support in the workplace may be beneficial.

The significant relationship between stress levels and heart rate, particularly among females, suggests that stress may have a greater physiological impact on women. This finding underscores the importance of monitoring cardiovascular health, especially for individuals in high-stress environments. Employers and healthcare providers should consider integrating stress reduction techniques such as relaxation exercises, adequate rest breaks, and flexible work schedules to mitigate the negative effects of stress on heart health.

Limitations

Several limitations can be acknowledged for the present study. Firstly, given the cross-sectional design, the study examines correlations at a single point in time, making it impossible to determine causation (e.g., whether stress causes poor sleep or vice versa). Future research can focus on longitudinal designs to track changes over time. Secondly, there is potential self-report bias such as social desirability bias or inaccurate recall for the data such as stress levels, sleep quality, and physical activity. Other studies can use wearable sleep trackers and heart rate monitors to ensure objective measurements. Thirdly, there were unequal sample sizes in the occupational groups, which may have influenced statistical power, thus in future research the aim should be for larger, more balanced sample sizes. Finally, there was lack of control for confounding variables such as diet, caffeine intake, and medical conditions which could have influenced sleep quality and stress levels. Recommendation for related studies would be to include such variables in the data set in order to control for possible confounding effects.

Conclusion

This study highlights the complex interactions between sleep, stress, physical activity, heart rate, and occupational differences. The findings suggest that higher stress is linked to poorer sleep quality and higher heart rates, while increased physical activity is associated with longer sleep duration. Furthermore, gender and occupational differences in stress and sleep quality indicate a need for tailored interventions in workplace and healthcare settings. Future research should address the study's limitations and explore additional factors influencing stress and sleep to develop more effective public health strategies.

References

Almojali, A. I., Almalki, S. A., Alothman, A. S., Masuadi, E. M., & Alaqeel, M. K. (2017). The prevalence and association of stress with sleep quality among medical students. *Journal of Epidemiology and Global Health*, *7*(3), 169–174. https://doi.org/10.1016/j.jegh.2017.04.005

Burg, M. M., Schwartz, J. E., Kronish, I. M., Diaz, K. M., Alcantara, C., Duer-Hefele, J., & Davidson, K. W. (2017). Does Stress Result in You Exercising Less? Or Does Exercising Result in You Being Less Stressed? Or Is It Both? Testing the Bi-directional Stress-Exercise Association at the Group and Person (N of 1) Level. *Annals of Behavioral Medicine*, *51*(6), 799–809. https://doi.org/10.1007/s12160-017-9902-4

Herawati, K., & Gayatri, D. (2019). The correlation between sleep quality and levels of stress among students in Universitas Indonesia. *Enfermería Clínica*, *29*(2), 357–361. https://doi.org/10.1016/j.enfcli.2019.04.044

THARMALINGAM, L. (2023). *Sleep Health and Lifestyle Dataset*. Www.kaggle.com. https://www.kaggle.com/datasets/uom190346a/sleep-health-and-lifestyle-dataset

Appendix 1

Assumptions of an ANOVA test

Assumption	Check for assumption
Independent observations	The data was collected at a single point in time. There were no repeated measures, thus, no dependent observations. This assumption was met.
Normally distributed errors	Given a potential violation of the assumption, the ANOVA is still robust if the sizes of the group are at least 30. All the occupation categories had a size of above 30, thus ANOVA could be used.
Equal population variances	Tested with the Levene’s test for equality of variances. The test showed rejection of quality of variances. The ANOVA could still be robust against this violation if the smallest group size is no more than 1.5 times smaller than the largest group size. In this case the difference was larger than 1.5, thus ANOVA could not be conducted.