

Factors affecting sleep quality

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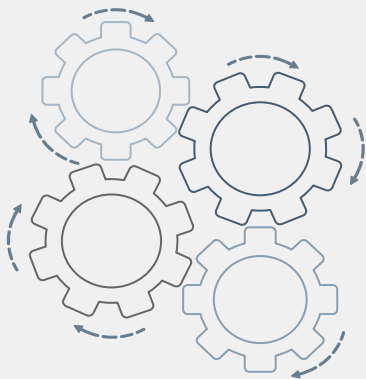
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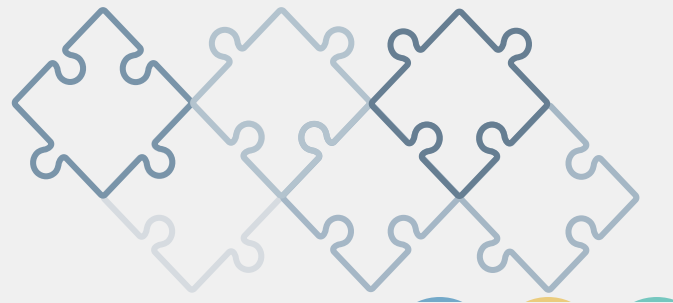
01 Introduction

Sleep is an essential function that allows a human body and mind to recharge, leaving it refreshed when it wakes up. Healthy sleep also helps the body be healthy and stave off diseases. Without it, the brain cannot function properly.

This can impact concentration, clear thinking, and memory processing.

For different age categories, there are different sleep durations needed for proper cognitive and behavioral functions. However, this is not a single reason that can have a significant impact. Besides duration, different factors can impact sleep quality, and it is essential to understand the relationship between sleep and daily life since it can provide insights into a healthy lifestyle.

In this research, I wanted to establish a specific explanation for the impact of particular heart data, triaxial accelerometer data, sleep quality, physical activity, psychological characteristics, and salivary sample factors on sleep quality, using statistical methods. The *project aim* is to investigate the relationship between different factors and sleep quality, measured as PSQI, for further improvement/development of sleep techniques.



02 Data description

Pittsburgh Sleep Quality Index (PSQI): It is a measure of sleep quality. It is a self-report questionnaire that assesses sleep quality. The measure consists of 19 individual items, creating seven components that produce one global score, and takes 5–10 minutes to complete. A score can be ranged from 0 to 21, where lower scores denote a healthier sleep quality



22 adult
people

Pittsburgh Sleep Quality Index (PSQI)

Instructions: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. **Please answer all questions.**

- During the past month, what time have you usually gone to bed at night? _____
- During the past month, how long (in minutes) has it usually taken you to fall asleep each night? _____
- During the past month, what time have you usually gotten up in the morning? _____
- During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.) _____

5. During the past month, how often have you had trouble sleeping because you...	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
a. Cannot get to sleep within 30 minutes				
b. Wake up in the middle of the night or early morning				
c. Have to get up to use the bathroom				
d. Cannot breathe comfortably				
e. Cough or snore loudly				
f. Feel too cold				
g. Feel too hot				
h. Have bad dreams				
i. Have pain				
j. Other reason(s), please describe:				

6. During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?	7. During the past month, how often have you had trouble sleeping awake while driving, eating, meals, or engaging in social activity?	No problem at all	Only a very slight problem	Somewhat of a problem	A lot of problem

8. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?	9. During the past month, how would you rate your sleep quality overall?	Very good	Fairly good	Fairly bad	Very bad

10. Do you have a bed partner or room mate?	No bed partner or room mate	Partner/room mate in other room	Partner in same room but not same bed	Partner in same bed

If you have a room mate or bed partner, ask him/her how often in the past month you have had:

	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
a. Loud snoring				
b. Long pauses between breaths while asleep				
c. Legs twitching or jerking while you sleep				
d. Episodes of disorientation or confusion during sleep				
e. Other restlessness while you sleep, please describe:				

Gauss Markov Assumptions

1.Linear in Parameters

2.Random sampling

3.Zero Conditional Mean

4. No serial errors correlations

5.Homoskedasticity

6.No perfect collinearity

Abbreviation	Observations	Mean	St.Dev.	Min	Max
PSQI	22	5.318182	1.985336	2	9
Age	22	27.272727	4.107853	20	40
Weight	22	75.045455	12.789420	60	115
Height	22	179.909091	8.216760	169	205
BMI	22	23.123541	3.093798	19.409358	33.240837
Cortisol_before	22	0.028053	0.029735	0.012017	0.155777
Cortisol_after	22	0.069860	0.051937	0.015572	0.261252
Melatonin_before	22	8.330234e-09	6.545962e-09	1.629907e-09	2.396239e-08
Melatonin_after	22	7.281474e-09	6.042238e-09	8.283802e-10	2.853905e-08
Latency_Efficiency	22	83.520476	6.498276	73.490000	94.230000
Total_minutes_in_bed	22	382	89.180395	165	630
Total_sleep_time	22	318.571429	80.157328	144	578
RR	22	0.813643	0.072447	0.670949	0.995826
Daily_stress	22	32.181818	16.296761	10	74
Activity_medium	22	20.909091	33.863745	0	129
Activity_heavy	22	93.590909	32.854164	40	180
Activity_small_screen_usage	22	57.363636	54.862204	0	174
Activity_large_screen_usage	22	17.500000	17.065002	0	51
Activity_smoking	22	7.272727	16.292510	0	60
Activity_alcohol_assumption	22	10.318182	11.047027	0	45
Actigraph_X_mean	22	16.434876	16.434876	3.131175	24.693821
Actigraph_Y_mean	22	16.780694	4.245410	10.515468	27.243074
Actigraph_Z_mean	22	19.271554	4.202566	13.269682	29.023668
Steps_mean	22	0.184510	0.047359	0.118963	0.287923

03 Methodology explanation

- This exploration aims to determine what factors have a significant impact on sleeping quality using linear models and tests for statistical significance.
- Multiple Linear Regression models with OLS estimators were chosen.
- The data used in the analysis are cross-sectional and were taken from the MMASH database.
- The independent variables were chosen based on a review of the literature and intuitively. The dependent variable was selected based on researches about sleep quality metrics. All variables were analyzed and checked on Gauss-Markov Assumptions.
- For each variable in the models, the statistical significance of this variable was determined.
- The conclusion was made using the results of the analysis.

04 Results

Model 1

$$\text{PSQI} = -3.47 - 1.33 \text{ Weight} + 2.57 \text{ Height} + 1.6 \text{ Melatonin_before} + 6.77 \text{ Melatonin_after} - 9.92 \text{ Latency_Efficiency} - 4 \text{ Activity_medium} - 4.74 \text{ Activity_large_screen_usage} + 2.01 \text{ Actigraph_X_mean} - 1.18 \text{ Actigraph_Z_mean}$$

N = 22

R² = 0.557

Model 2

$$\text{PSQI} = -5.99 + 7.64 \text{ Height} + 1.63 \text{ Melatonin_before} + 1.87 \text{ Total_minutes_in_bed} - 1.99 \text{ RR} - 1.33 \text{ Activity_medium} + 1.990 \text{ Activity_smoking} + 3.26 \text{ Actigraph_X_mean}$$

N = 22

R² = 0.761

For the first model, independent variables were chosen from a model with all independent variables removing ones with the highest p-values.

In the model, only Height, Actigraph-X-mean and Actigraph-Z_mean are statistically significant at 10% confidence interval (or 90% confidence level).

For the second model, independent variables were selected in a next way: firstly, were created all 245157 combinations with 7 from 23 variables, then for every combination was created a regression model and from all models a one with the highest R-squared was chosen.

In the model, Height is are statistically significant at 10% CI, Melatonin_before, RR and ActigraphX_ mean at 5% CI and Total_minutes_in_bed at 1% CI.

Model 3

$$\text{PSQI} = -6.13 + 3.15 \text{ Age} + 1.04 \text{ Weight} + 1.55 \text{ Melatonin_before} + 2.3 \text{ Total_minutes_in_bed} - 2.32 \text{ RR} + 1.83 \text{ Activity_heavy} + 6.1 \text{ Actigraph_X_mean} - 4.27 \text{ Steps_mean}$$

$$N = 22$$

$$R^2 = 0.813$$

For the third model, independent variables were selected in a next way: firstly, were created all 490314 combinations with 8 from 23 variables, then for every combination was created a regression model and from all models a one with the highest R-squared was chosen.

In the model, Age, Actigraph_X_mean and Steps mean are statistically significant at 10% confidence interval, Weight and Melatonin_before at 5% confidence interval and RR and Total_minutes_in_bed at 1% confidence interval.

Model 4

$$\text{PSQI} = -2.97 + 3.67 \text{ Age} + 1.01 \text{ Weight} + 1.49 \text{ Melatonin_before} - 4.96 \text{ Latency_Efficiency} + 2.35 \text{ Total_minutes_in_bed} - 2.4 \text{ RR} + \text{Activity_heavy} + 7.51 \text{ Actigraph_X_mean} - 5.39 \text{ Steps_mean}$$

$$N = 22$$

$$R^2 = 0.83$$

For the fourth model, independent variables were selected in the next way: firstly, were created all 817190 combinations with 9 from 23 variables, then for every combination was created a regression model and from all models a one with the highest R-squared was chosen.

In the model, Age, Actigraph_X_mean and Steps_mean are statistically significant at 10% confidence interval, Weight and Melatonin_before at 5% confidence interval and RR and Total_minutes_in_bed at 1% confidence interval.

05 Conclusions

- This project explores the factors contributing to sleep quality, which is measured as a PSQI. In order to take into different dimensions, I used such variables as age, weight, height, BMI, cortisol and melatonin before sleep, percentage of sleep time on total sleep in bed, total time in bed, total sleep time, heart beat-to-beat interval, Daily Stress Inventory value, Activity: medium, heavy, small screen usage, large screen usage, smoking, alcohol assumption, Actigraph X-, Y-, Z-mean and steps-mean.
- Many models were created, and four of them with the highest R-squares for specific degrees of freedom were included in the paper, although all of them do not explain income inequality exactly.
- Model 1, in which independent variables were chosen from a model with all independent variables removing ones with the highest p-values (12 df), has not the best R-squared (only 0.557).
- Model 4 has the highest R-squared among the other models in this paper (83%). It includes Age, Weight, Melatonin_before, Latency_Efficiency, Total_minutes_in_bed, RR, Activity_heavy, Actigraph_X_mean and Steps_mean variables. In this model, Age, Actigraph_X_mean and Steps_mean are statistically significant at 10% CI, Weight and Melatonin_before at 5% CI and RR and Total_minutes_in_bed at 1% CI. Contrary to my assumption, increasing age correlates with an increase in PSQI; increases in RR and Steps_mean correlated with decreasing PSQI in the model. My hypotheses that increasing in Weight, Melatonin_before, Total_minutes_in_bed and Actigraph_X_mean correspond to increases in PSQI were not rejected.
- In the models above, there are omitted many factors that could have an impact on sleep quality. Reducing the missing factors may make the models more relevant. Additionally, more observations would strengthen the models.

**THANKS FOR
YOUR ATTENTION!**