A Prediction Study on Sleep Efficiency: Proposal

Group: L2D - 6
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Introduction

In recent years, research has shown that nearly 60% of all university students suffer from poor sleep quality and 7.7% of them meet the criteria for insomnia (Schlarb, A. A., Friedrich, A., & Claßen, M, 2017). Sleeping problems in students have direct consequences such as depression, reduced life satisfaction, irritability and poor academic performance . Past research done in the field also provides evidence for the positive correlation between academic failure and poor sleep quality patterns (Centers for Disease Control and Prevention, 2022).

Considering these negative impacts of poor sleep quality we decided to explore a Kaggle dataset that contains information on a group of test subjects and their sleep patterns to see which variables have a relationship with poor sleep quality. The dataset collected information on 452 subjects' age, gender, waking and bedtimes, proportions of time spent in the various sleep stages, and habits (smoking, alcohol consumption, etc.).

The dataset can be found at the following link:
https://www.kaggle.com/datasets/equilibriumm/sleep-efficiency

Exploring the Research Question

By studying past research, we found that age, alcohol intake, smoking and frequency of exercise are all associated with sleep quality. So, we believe that sleep quality is related to these variables. To predict the sleep efficiency of college students, we decided to explore their relationship with sleep efficiency. In our study, smoking levels were not used because college students had fewer smokers and, in comparison, higher alcohol intake.

When assessing sleep quality, we noticed that age, alcohol, and exercise are often linked to the Rapid Eye Movement (REM) (WebMD Editorial Contributors, 2022) stage of the sleep cycle, and so we wished to explore whether there is a certain relationship between age, exercise frequency, alcohol consumption and percentage of REM sleep. We have thus decided to examine the predictive question: ***How do age, exercise frequency and alcohol consumption predict the percentage of REM sleep?***

To answer our research question, we will be using the following three explanatory variables from our dataset: the age of the test subject in years ('Age'), the number of times the test subject exercises each week ('Exercise.frequency'), and the amount of alcohol consumed within 24 hours before bedtime (in fl oz) ('Alcohol.consumption'); and our response variable is the percentage of total sleep time spent in REM ('REM.sleep.percentage'). We wanted to predict the REM sleep percentage for an *average* college student, and so we decided to predict the REM performance for a 20 year old (the average of 18-22 year olds) exercising 3 times a week (Billitz, 2023) and having 2.4 fl oz of alcohol (equivalent to 4 drinks and this is the average number of drinks for female college student) (Sobering Up, 2021).

The reason we decided to select these variables in particular for exploration is because they seemed to be the most relevant behaviours and factors to the average college student's sleep quality, and we then decided to research and study those assumptions. It is a widely regarded phenomenon that with age, one's sleep quality and the REM proportion of it reduces (Ohayon et al., 2004)(Pótári et al., 2017)(Van Cauter, 2000), and why we thought it would be interesting to explore the variable of age. It would also serve as somewhat of a point of comparison or control in our model since we feel most certain about it having an inverse relationship with REM percentage. Since the maximum REM percentage in the dataset is 30, we hypothesize a 20 year old's best REM sleep percentage would be around 25. With the other variables, exercise and alcohol, we've found research and arguments supporting either side. While there is some debate on the specific effects general exercise can have on sleep (Kripa & Jackson, n.d.), some studies have found that exercising at night or within 4 hours of bedtime can lead to reduced REM activity (Breus, 2022)(Falk, 2022) (Frimpong et al., 2021). Since a lot of college students tend to exercise in the evenings (due to classes during the day), we are assuming for our prediction that the person was exercising within 4 hours of sleeping. Similarly for alcohol, there is much research to support that increased amounts of alcohol consumption lead to spending less time in the REM stage during the sleep cycle (Pacheco, 2023)(Thakkar, Sharma & Sahota, 2015)(Colrain, Nicholas & Baker, 2014). Therefore, we hypothesize that a 20 year old exercising thrice a week (within 4 hours of sleeping) and having 2.4 fl oz of alcohol within 24 hours of sleeping would reduce their REM sleep percentage to around 21.

How we'll be exploring it - Method

To make our prediction, we will fit a multiple linear regression model by using the age, alcohol consumption, and exercise frequency as the explanatory variables and the REM sleep percentage as the response variable.

The first step is to load and tidy the data. We will select the relevant variables - age, Exercise.frequency, Alcohol.consumption, and REM.sleep.percentage - and will remove any missing or invalid values.

We will perform linear regression to fit an additive multilinear model. To evaluate the model's performance, we will examine the summary of the model, which includes information such as coefficient estimates, standard errors, t-values, p-values, and R-squared values. Additionally, we will also fit an interactive multilinear model to compare the two models' predictions. The additive model will work best when the independent variables exist and act independently, while the interactive model will work best when there are complex interactions between the predictor variables.

To compare the performance of the different models, we will use residual plots and QQ plots to evaluate the model's fit and identify potential issues such as outliers or heteroscedasticity. We will also create scatterplots to compare the distributions of the predictor variables and the response variable, which will help us identify any linear relationships between the predictor variables and the response variable. After choosing the optimal model, we can rely on it to make predictions of the percentage of REM sleep based on the chosen variables.

Next Steps

We will be organizing the final report into four major sections, and splitting the work as follows:

Introduction: **- Ece**
- Providing relevant background information
- Specifying variables that are gonna be used
- Stating the research question we will try to answer

Analysis **- Shiyu, Chunyu**
- Fitting the models
- Creating plots for analysis
- Explaining the code used for analysis

Discussion - **Rashi**
- Did the results match our hypothesis?
- What could be done differently, any limitations

Conclusion - **Ece**
- Summarize the findings and the implications of these findings.
- Come up with future questions that this project can lead to.

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