The Impact of Lifestyle Factors on Sleep Efficiency and Sleep Quality

Yilin Zhang *

Bathurst Future Agri-Tech Institute, Qingdao Agricultural University, Qingdao, 266000, China

* Corresponding author: 20500066@rau.ac.uk

Abstract. Although previous studies have shown that sleep quality may be related to life factors such as smoking and drinking in a specific potential environment, some evaluations of sleep quality are relatively subjective, and there are few studies on the influence of life factors on sleep efficiency. In this study, sleep quality was quantified by scoring multiple sleep-related variables, and stepwise regression was used to process the data of sleep quality score, sleep efficiency and life factors. Results showed that sleep efficiency was strongly correlated with exercise frequency, alcohol consumption, and smoking status, and sleep quality scores were strongly correlated with caffeine intake, smoking status, and alcohol consumption. Many life factors that may be closely related to sleep have not been focused on their combined effects in previous studies. This study provides suggestions for improving sleep quality and sleep efficiency by changing living habits, and proposes some new perspectives for further research.

Keywords: Sleep efficiency, sleep quality, lifestyle factors, stepwise regression.

1. Introduction

In the modern 24-hour society, sleep deprivation is a global health problem that is prevalent across multiple age groups. Numerous studies have shown a clear relationship between sleep quality and optimal health and function. Insufficient sleep not only causes problems in body systems, it increases the risk of long-term health-related problems such as metabolic and cardiovascular diseases, and increases the incidence of diseases such as diabetes, obesity and cognitive impairment. At the same time, sleep deprivation has potentially dangerous and serious consequences for society, such as increasing the likelihood of traffic accidents and workplace accidents. Lack of sleep is one of the reasons that growing teens have a higher risk of being overweight, depressed and performing poorly on exams. This article selects sleep-related data sets and is committed to studying the impact of living habits on sleep quality and sleep efficiency.

Because sleep deprivation and sleep disturbances occur at high rates in different populations, sleep deprivation can lead to a range of adverse physical and mental dysfunction, so sleep quality is an important indicator of early risk assessment for clinicians and researchers. However, although "sleep quality" is commonly used as a term, it has no clear definition [1]. Some studies define sleep quality as a person's level of contentment with various aspects of their sleep experience [2]. Kline believes that sleep quality has different meanings to different groups of people. Sleep initiation period may be the secret to sleep quality for persons who have sleep onset concerns. Conversely, the number of post-sleep awakenings was the most powerful factor in assessing sleep quality for a person with erratic sleep and frequent awakenings [3]. There is some evidence that impaired sleep quality is also associated with reductions in total sleep time, N3 stage sleep and REM sleep [4]. There are many variables in this data set, such as sleep duration, REM sleep percentage, and Awakenings, which can help quantify sleep quality for analysis. Sleep efficiency, which is determined by dividing the amount of time spent in bed by the amount of time spent sleeping overall, is defined as the percentage of time spent sleeping. Concerning the importance of assessing sleep efficiency, it can be understood that sleep efficiency plays a central role in insomnia research and practice because it captures a core problem that insomniacs spend too much time in bed trying to fall asleep [5]. Some research suggests using another denominator, duration of sleep episodes, to exclude the influence of non-sleep-related activities (e.g., chatting, playing mobile phones, reading, watching dramas in bed) before the onset

of sleep and after eventual waking. However, the variable "sleep efficiency" in the data set used in this article is calculated conventionally.

There are many factors, both internal and external, that affect the quantity and quality of our sleep. Numerous studies reveal factors affecting sleep quality and sleep efficiency. The results of the study showed a strong correlation between sleep quality and both physical and mental health outcomes, with lower socioeconomic position, members of racial or ethnic minorities, and those who had experienced prejudice reporting poorer sleep quality [6]. In the meanwhile, Jackowska investigated whether emotional and psychological factors contributed to variations in subjective and objective measurements of sleep efficiency [7]. Sella assessed whether emotions caused by reading before bedtime affect sleep quality in both young and old persons [8]. Alcohol significantly affects sleep apnea and upper airway resistance, according to studies on the impacts of specific possible environmental and biotoxins on sleep and sleep disorders [9]. Nicotine is a stimulant, and insomnia is a clinically proven nicotine withdrawal symptom. Some studies have considered the potential role of smoking time and concluded that smoking can lead to shortened sleep time and increased insomnia severity to some extent. It is worth mentioning that smoking at night is more likely to interfere with sleep than smoking earlier in the day [10].

After people with sleep problems get used to their lifestyle, they often ignore some relatively simple life factors, but these factors may cause them to maintain lower sleep efficiency and sleep quality. This article will analyze the data of variables such as caffeine intake, smoking status, alcohol consumption, exercise status, sleep efficiency and sleep duration, Awakenings, Deep sleep percentage, etc., and comprehensively consider the relationship between living habits, sleep quality and sleep efficiency.

2. Methods

2.1. Data Sources

The data used in this paper was taken from the Kaggle website and was used in a UK research team's study. The research team gathered data over a period of months by utilizing a combination of self-report surveys, actinography, and a sleep tracking method known as polysomnography on subjects they recruited from the local community.

2.2. Variable Selection

The variables used in this paper are as table 1 shows. The data covering people of different age groups from 9 to 69 years old. The data contains 15 variables. Table 1 describes variable's definitions. The data used in this paper count a total of 453 people, including 229 males and 224 females.

Table 1. Variable types and definitions

Variable name	Variable description
age	age of the test subject
Gender	male or female
Bedtime	when each subject goes to bed
Wakeup	when each subject wakes up each day
Sleep Duration	the length of time that an individual sleeps
Sleep Efficiency	the percentage of a sleep episode that is really spent sleeping
REM Sleep Percentage	amount of time each subject spent in that stage of sleep
Deep Sleep Percentage	-
Light Sleep Percentage	-
Awakenings	the number of times each subject wakes up when sleeping
Caffeine Consumption	consumption in the 24 hours before bedtime
Alcohol Consumption	-
Smoking Status	whether or not the subject smokes
Exercise Frequency	the number of times each subject exercises for a week

2.3. Research Protocol

To measure sleep quality in subjects of different ages with sleep-related variables, we need guidelines for a given characteristic. In this paper, the National Sleep Foundation's sleep quality recommendations are used as the standard, and the subjects are divided into five age groups according to age [11]. Table 2 is a measure of high sleep quality in different age groups. When talking about light sleep and deep sleep, the NREM sleep stages are being referred to. Stages 1 and 2 of sleep are marked by light sleep, whereas stage 3 is marked by deep sleep. For the conversion of the proportions of the three sleep stages and the proportion of deep sleep and light sleep, some changes have been made to the original standard.

Table 2. Measurement of high-quality sleep-in different age groups

	school aged	teenager	young adult	adult	older adult
Sleep duration/hours	9-11	8-10	7-9	7-9	7-8
awakening	0-1	0-1	0-1	0-1	0-2
REM sleep percentage	≥10	≥10	21-30	21-30	21-30
Light sleep percentage(N1+N2)	45-55	45-55	45-55	45-55	45-55
deep sleep percentage(N3)	20-25	20-25	16-25	16-25	16-25

For measurements from eligible subjects, score 1 for this item, and 0 otherwise. Scores from all measurements were added to score each person's sleep quality. The scores obtained can reflect the sleep quality of the subjects to a certain extent.

In this paper, a Lasso regression model is used, the dependent variables are total score (Y1) and sleep efficiency (Y2), and the four life factors are the independent variables (X). Next, this paper uses SPSSAU and R studio to analyze the relationship between the impact of X on Y, that is, the relationship of the 4 factors on sleep quality and sleep efficiency.

2.4. Model Principle

The stepwise regression analysis approach automatically selects the most essential variables from a vast number of available variables to create a regression prediction or interpretation model. By gradually inputting independent variables into the model, the system automatically identifies influential variables and incorporates them into the regression model, while removing variables that do not have statistical significance. Finally, an automatically fitted regression model is obtained. It is essentially linear regression.

3. Results and Discussion

The correlation between the Total Score, Sleep Efficiency, Caffeine Intake, Alcohol Intake, Smoking Status, and Exercise Frequency was examined using correlation analysis, and the Spearman correlation coefficient was utilized to show the significance of the correlation.

Figure 1 shows that the correlation coefficient values between Sleep efficiency and Alcohol consumption and Smoking status are -0.370 and -0.235, respectively, and show a significance level of 0.01. Therefore, there is a negative correlation between Sleep efficiency and Alcohol consumption, Smoking status. Similarly, there is a 0.01 level significant positive connection between exercise frequency and sleep efficiency. There is no correlation between sleep quality and caffeine intake, as evidenced by the correlation coefficient between sleep quality and caffeine consumption being close to zero at 0.038 and the P value being 0.429>0.05.

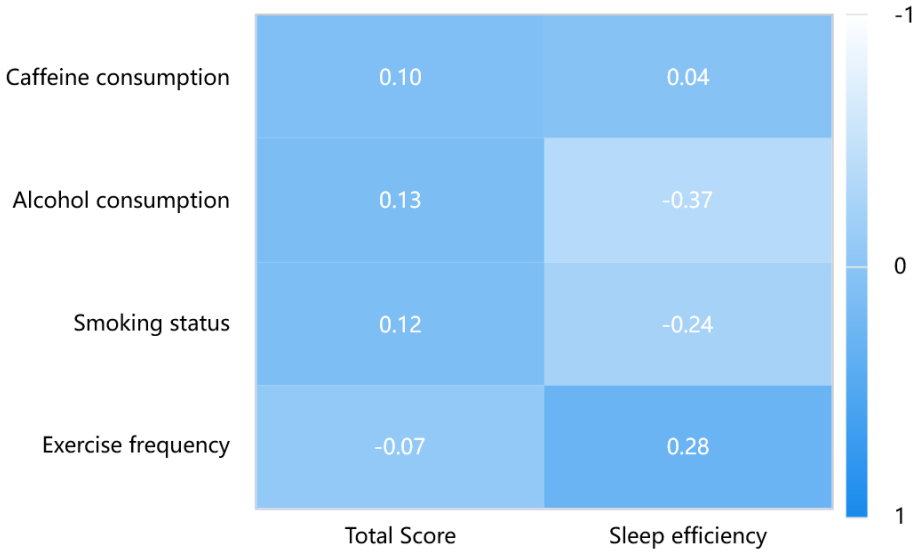


Figure 1. Spearman correlation visualization

The correlation coefficient values between Total Score and Caffeine consumption, Smoking status, and Alcohol consumption are 0.101, 0.119, and 0.128, respectively, which shows that there is a significant positive correlation between Total Score and Caffeine consumption, Smoking status, and Alcohol consumption. There is no correlation between total score and exercise frequency, as seen by the correlation coefficient between total score and exercise frequency.

Table 3. Stepwise regression analysis results (Sleep efficiency)

	regression coefficient	95% CI	VIF
constant	0.807** (75.351)	0.786 ~ 0.828	-
Alcohol consumption	-0.031** (-8.723)	-0.038 ~ -0.024	1.004
Smoking status	-0.072** (-5.986)	-0.096 ~ -0.049	1.006
Exercise frequency	0.024** (6.106)	0.016 ~ 0.032	1.002
sample size	407		

As Table 3 shows, stepwise regression analysis was performed using caffeine consumption(X1), alcohol consumption(X2), smoking status(X3), exercise frequency(X4), and sleep efficiency as independent variables and dependent variables, respectively. After the model is automatically identified, there are finally three remaining items in the model: X2, X3, and X4. The R square value indicating that can explain 28.2% of the change in Sleep efficiency. The model also passed the F test (F=52.692), demonstrating its effectiveness. The model formula is:

$$\text{sleep efficiency} = 0.807 - 0.031X_2 - 0.072X_3 + 0.024X_4 \quad (1)$$

The multicollinearity test of the model also showed that all the VIF values were less than 5, proving that there was no collinearity problem. The D-W value is close to 2, indicating that there is no correlation between the model and the sample data and that the model does not exhibit autocorrelation. In summary, Exercise frequency has a significant positive impact on Sleep efficiency, and Alcohol consumption and Smoking status have a significant negative impact on Sleep efficiency, as Table 4 shows.

Caffeine consumption, alcohol consumption, and smoking status make up the remaining three variables in the stepwise regression analysis model, which uses Total Score as the dependent variable. The model also passed the F test, proving its validity. The model formula is:

$$\text{Total Scors} = 2.273 + 0.04X_1 + 0.085X_2 + 0.249X_3 \quad (2)$$

Table 4. Stepwise regression analysis results (Total Score)

	Regression coefficient	95% CI	VIF
constant	2.273** (30.214)	2.125 ~ 2.420	-
Caffeine consumption	0.004* (2.379)	0.001 ~ 0.007	1.013
Alcohol consumption	0.085** (2.954)	0.029 ~ 0.141	1.016
Smoking status	0.249* (2.575)	0.060 ~ 0.439	1.005
sample size	407		

According to the final specific analysis, smoking status has a 0.249 regression coefficient (t=2.575, p=0.0100.05), alcohol use has a 0.085 regression coefficient (t=2.954, p=0.0030.01), and caffeine usage has a 0.004 regression coefficient (t=2.379, p=0.0180.05). It means that Caffeine consumption, Smoking status, and Alcohol consumption will have a significant positive impact on Total Score.

4. Conclusion

This study selected different data and focused on influencing factors that may be related to sleep quality and sleep efficiency. The results showed that sleep efficiency was affected by exercise frequency, alcohol consumption and smoking status, and sleep quality score was affected by caffeine consumption, smoking status and alcohol consumption, and most of these factors were easily ignored by people in life.

It is undeniable that since the data on life factors come from subjects' self-reports, they are relatively general, which may affect the accuracy of the results. In addition, there are differences in the number of people in all age categories covered by the sample, so that the model may also have errors. However, this study still has great reference value. First, the methodology employed in this study is innovative. On the one hand, the scoring method is used to quantify sleep quality as the sum of scores of eligible sleep-related variables, which can make the results clearer and more intuitive. On the other hand, this experiment did not adopt the single factor analysis method used in many previous experiments, but chose the stepwise regression method to screen variables to make the experiment more comprehensive. Secondly, the research results provide solutions that can be considered for solving sleep disorders, such as proper exercise and reducing alcohol and smoking can help improve sleep efficiency, and so on. It has a certain positive effect on improving sleep quality and sleep efficiency.

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