PROJECT REPORT

Spring 2022 BSTAT 5325-001 Advanced Methods for Analytics

IMPACT OF SLEEP PATTERN ON STRESS LEVELS

GROUP 9

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CONTENTS

1 INTRODUCTION

1.1 Importance of Sleep

Someone rightly said, early to rise, and early to bed, make a man healthy and wealthy! This also means that sleep is one of the most important factors when it comes to health and a good happy life! This made us think that on how can we work on this very important topic under which our output will be useful for general public use.

Coming towards sleep we are very much aware of the fact that stress is the topmost affecting catalyst that makes us sleep-deprived. When stress exposure disrupts sleep it is called sleeping reactivity. Which is also called insomnia in the modern world. High insomnia is linked to the risk of shift-work disorder, depression, and anxiety. Importantly, stress-related worry may exploit sensitive sleep systems, which will initiate the pathogenicity of sleep reactivity. There are multiple biological and physiological factors that we have considered while finalizing this topic of the project which is “Impact of Sleep Pattern on Stress Levels”.

1.2 Why this topic is important?

What happens if we don’t get enough sleep? And we reached the following conclusions, that less sleep can cause anxiety, and depression and it can also affect our mental health. Also, we found that some of us suffer weird mood swings and unwanted irregularities in metabolism. Also, we understand that less sleep will eventually make us gain weight, neurological issues such as migraine, and it may also lead to poor vision issues in humans. Summing up the above there

points we understood that the topic which we have chosen for studying is very important and has great potential for studying statistical analysis on it.

2 What makes you Sleep Deprived?

The possible causes of sleep deprivation include sleeping disorders like Narcolepsy, Insomnia, Delayed sleep syndrome, obstructive sleep syndrome. Apart from these other possible causes could be, work demands, rotational work shifts, demanding home life, improper sleep cycle.

Narcolepsy: Excessive daytime drowsiness and sudden sleep attacks.

Insomnia: Trouble in falling asleep.

Delayed sleep syndrome: Sleep is delayed by two hours or more than their regular bedtime.

Obstructive sleep syndrome: Occurs when the muscles that support the soft tissues in throat, such as your tongue and soft palate, temporarily relax.

2.1 Important factors that affect sleeping pattern

Important factors which affect sleep pattern, that we choose as independent variables in our project are, Blood oxygen level, Heart Rate, Rapid eye movement, Snoring, Hours of sleep, Body temperature and Limb movement.

3 Blood Oxygen Level

The amount of oxygen present in blood or the amount of oxygen circulating in blood. Also known as Blood oxygen saturation (SpO2). The process of reduction in blood oxygen level is

called oxygen desaturation. A normal level of oxygen for a healthy adult is 95% or higher. If the oxygen level falls between 91% to 95%, it is concerning, and close monitoring should be done. If it goes below 90% it is threatening and consulting a doctor is advisable. Constant fluctuation in blood oxygen level during sleep can be a major cause of sleep apnea, which eventually disturbs human sleep cycle.

3.1 Blood Oxygen Level vs Stress

Blood oxygen level and stress is inversely proportional, which means if the blood oxygen level is more, then the stress is less, and if the blood oxygen level is low, then the stress is high.

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4 Heart Rate

During sleep, your nervous system's stimulation is reduced, and most of your body processes slow down Within about five minutes of falling asleep, your heart rate gradually slows to its resting rate as you enter light sleep. The temperature of your body drops, and your muscles relax. People typically sleep for about half of the night. However, during the next stage, deep sleep, your blood pressure drops and your heart rate slows to about 20% to 30% of your resting heart rate. If you run or engage in other moderate to vigorous physical activity on a regular basis, you can reduce your risk of heart disease. Because exercise strengthens the heart muscle, it can pump a greater volume of blood with each heartbeat. As a result, more oxygen is delivered to the muscles, reducing the need for the heart to beat as frequently as it would in someone who is less fit. Unless they are taking medicines that slow heart rate, such as beta blockers or calcium channel blockers, people's resting heart rate stays about the same as they age.

It is usual for a person's heart rate to drop below that of a regular resting heart rate while sleeping. Adults' sleeping heart rates are usually between 40 and 50 beats per minute (bpm),

though this might vary depending on a variety of circumstances.

4.1 Heart Rate vs Stress

When your mind is still engaged from everyday responsibilities, getting the necessary 7 to 9 hours of sleep can be challenging. Sleep deprivation can cause the body to react as if it is in distress, releasing more cortisol, the stress hormone. Cortisol controls your fight-or-flight response to danger, raising your heart rate in preparation for a fight. However, too much cortisol can cause weight gain and cardiovascular problems over time. This happens when the body is unable to regulate its hormone levels overnight due to poor sleeping patterns. Cortisol-related concerns, such as elevated blood pressure, have been linked to receiving less than five hours of sleep per night. Cortisol levels can be greatly reduced by getting more rest and restoring balance to the body's systems. To avoid the rise in hormone levels and lessen existing tension and anxiety, acquire between seven and nine hours of sleep per night as a preventative measure

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5 Rapid Eye Movement

While you sleep, a lot happens in your body. You alternate between REM and non-REM sleep when you sleep. Rapid eye movement is abbreviated as REM. Your eyes move around fast in a variety of directions during REM sleep, but no visual information is sent to your brain. During non-REM sleep, this does not happen. Non-REM sleep happens first, followed by a brief period of REM sleep, and then the cycle repeats. Dreams are most common during REM sleep. REM sleep usually occurs 90 minutes after you fall asleep. The initial REM cycle usually lasts 10 minutes. Each subsequent REM stag becomes longer, with the ultimate one lasting up to an hour

5.1 Rapid Eye Movement vs Stress

The most basic consequence of daily mild stress is increase in rapid-eye-movement sleep, The research also demonstrated that this increase is associated with genes involved in cell death and survival. REM sleep disturbances are common in mood disorders, such as depression and hyper stress syndrome.

6 Snoring

Snoring can be minor, infrequent, and unobtrusive, or it can signal a significant sleep-related respiratory issue. In the United States, snoring is believed to affect 57 percent of men and 40% of women1. It can affect as many as 27% of children2.These figures show that snoring is common, although its severity and health consequences differ. Snoring can be minor, infrequent, and unobtrusive, or it can indicate a significant sleep-related respiratory issue. Knowing the basics about snoring, such as what causes it, when it's hazardous, how to treat it, and how to cope with it, will help you live a healthier life and remove one of the most prevalent causes of sleep problems

6.1 Snoring vs Stress

According to studies sleepapnea where snoring is the major factor is the most common cause of sleep depriviation, which eventually lead to increase in stress.

7 Hours of Sleep

sleep is more than just a time for your body and mind to rest; it is the basis for good health. In truth, your body is still working while you sleep. During this time, your body repairs muscles that have been worn down over the day and removes poisons from your brain that have accumulated while you've been awake. It's also necessary for preserving your memories. Sleep is

also important for controlling your emotions. Even one night of sleep deprivation might boost your emotional response to unfavorable feelings by 60%.In addition, sleep deprivation can impair your body's capacity to manage vital systems such as appetite, immunity, metabolism, and body weight. Finally, sleep is essential for the maintenance of your circadian rhythm, or internal clock.The sleep-wake cycle is controlled by your inner biological clock, which runs on a 24-hour schedule. It could also affect your metabolism, inflammation, and stress response.

7.1 Hours of Sleep vs Stress

According to survey findings, stress may be interfering with good sleep. Adults in the United States sleep an average of 6.7 hours per night, which is less than the minimum recommended of seven to nine hours. 6 Furthermore, 42 percent of adults say their sleep quality is fair or poor, and 43 percent say stress has kept them awake at night in the last month. When the length and quality of their sleep falls, many people report feeling more stressed.Twenty-one percent of adults say they are more stressed when they don't get enough sleep. Adults with greater stress levels (eight, nine, or ten on a 10-point scale) fare even worse, with 45 percent feeling even more agitated if they don't get enough sleep.

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8 Body Temperature

The quality of your sleep is inextricably linked to our body temperature.A healthy adult's body temperature is between 36 and 37.8 degrees Celsius. When your body temperature rises, you'll feel more alert, and when it drops, you'll likely feel weary. You may notice that your body becomes hot when dreaming.This is because your brain's natural temperature regulation system sleeps, and your body temperature is determined by the temperature of your bedroom and the amount of bedding on your bed.

8.1 Body Temperature vs Stress

Stress may create a fever which changes body temperature; here's how to determine if you're suffering from one.Chronic stress can create a low-grade fever of 99 to 100 degrees Fahrenheit (37 to 38 degrees Celsius) in certain persons. When people are subjected to an emotional event, their body temperature can rise to as high as 106 degrees Fahrenheit (41 degrees Celsius).Females are more likely to develop psychogenic fevers.A psychogenic fever is caused by stress.Fever-like symptoms, such as a raised body temperature, body chills or aches, weariness, and flushed skin, can be triggered by both acute and chronic stress

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9 Limb Movement

Limb movement (also known as "periodic limb movement condition").Periodic limb movement disorder (PLMD) is a condition in which the legs cramp or jerk repeatedly while sleeping. It's the sole movement disorder that only happens when you're sleeping, and it's also known as periodic leg (or limb) movements.

9.1 Limb Movement vs Stress

If a subject moves more than 5 times per hour, it is considered a limb movement. Thus, Sleep disruption eventually leads to an increase in stress levels.

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10 Data Collection

Data plays an important role while performing any regression analysis. In order to analyse the relationship between sleep and stress, we had to gather data that could impact the sleep hours. Based on which we could then predict the stress level for a particular person depending on their sleep pattern. Here, SaYo pillow played a crucial role in providing the data (Figure 15).

10.1 SaYoPillow

SaYo Pillow stands for Smart Yoga pillow. It is a real time device that contains various sensors in it including heart rate, body temperature, image processor for body movements etc. (Figure 16). Using IoT (Internet of Things), the data is processed and further using decision algorithm, an app related to the pillow provides the user with certain habits that could help them have a better day after they wake up. We received the data set in the form of a CSV file which contained information on snoring rate, body temperature, heart rate, blood oxygen, rapid eye, hours of sleep, limb movement. There had been certain data inconsistencies which led to improper results. Upon examining, we noticed that there were certain blanks in rows of a values. Using the averages method of Pandas in Python, we corrected the data and executed the regression again.

10.2 Stress Prediction

Perceived Stress Scale (PSS) is a widely used internationally renowned psychological scale for measuring stress level. PSS spans from a scale of 0 to 4, where 0 is the least stress and 4 is the maximum stress. Using the blood pressure, heart rate and other factors, this is calculated. In our experiment of SaYo Pillow, after a person wakes up, using the parameters calculated by the sensors, stress level is then predicted. It has been included for each person in the CSV file. Basing this as our predicted variable, we run the regression model and predict the stress level for each individual.

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11 Methodology

11.1 Regression Model

For our analysis, we used multiple linear regression model. Since we have more than 2 independent variables, we opted for multiple linear regression model. Using snoring rate, body

temperature, heart rate, blood oxygen, rapid eye, hours of sleep, limb movement as our primary independent variables, and stress level as our only dependent variable, we performed our regression analysis on both Excel and SAS for verification purpose. The coefficients that we received from both the tools were almost the same and even the p-values and R-square values matched. This indicated that there is nothing wrong with our data set and we proceeded with the analysis.

11.2 Regression Analysis

Looking at our regression data from SAS (Figure 17), we can see that our p-value is less than 0.001 which indicates that the model rejects null hypothesis and accepts alternative hypothesis. This is one major sign that we can proceed with this model. However, if the p-value is really small it even indicates that there is a high multicollinearity between the independent variables. This we will see in detail in the next section.

R-square is a measure of how accurate the relationship between the independent variables and the dependent variable is. In our result, we have over 99% efficiency, which explains that the independent variables accurately define the dependent variable.

11.3 Regression Results

If the coefficient of a value is positive, it means that the stress is directly proportional to that independent variable. However, if the coefficient of a value is negative, it means that the stress is indirectly proportional to that independent variable. As per the discussion of all the independent variables we saw earlier, we can say that our results are accurate in accordance to the scientific research. Using the regression equation mentioned in Figure 19, we then apply the variable values and coefficients in the equation and predict the y-value (here stress level) using excel.

12 Results

Multicollinearity generally occurs When there are strong correlations between two or more independent variables. In other words, one predictor variable can be used to predict the other.

12.1 Factors Impacting Multicollinearity

Factors that affect multicollinearity:

1. Dummy Variables: A dummy variable is a variable with values of 0 and 1, with the values indicating whether something is present or not. Data values that reflect categories - data values with a fixed and unordered number of values, such as gender (male/female) - are referred to as categorical data. These values can be described in a regression model by dummy variables, which are variables with values like 1 or 0.

2. Structural Multicollinearity: When a researcher creates a new independent variable from one or more existing variables, this is known as structural multicollinearity.

12.2 Multicollinearity Between Dependent Variables

A correlation heatmap is a graphical representation of a correlation matrix that shows how different variables are related. The correlation coefficient can range from -1 to 1.

For the heat map, we use a random forest algorithm which is a supervised learning algorithm is a random forest. To generate a more accurate and reliable prediction, random forest creates many decision trees and blends them together.

13 Conclusion

13.1 Healthy Sleeping Habits

The suggested SaYoPillow collects and analyzes seven distinct physiological signal data to

forecast stress, as well as educating the user on the benefits of smart sleeping. Physiological and stress data are securely transferred via Wi-Fi and stored on an Ethereum private blockchain.

Some of the Healthy Sleeping habits that promote healthy sleep are:

1. Stick to a fixed time schedule 2. Follow a single diet plan 3. Meditate before sleep

13.2 Future Scope

The work can be further extended in the specific domain of stress monitoring and control as it is an important problem that can have a significant social impact. Stress can lead to depression and that further leads to tendencies that could create a bigger impact on the society. Depression is a leading cause for ill mental health among many people in this generation, be it because of the rapidly growing lifestyle or increasing work load and pressure of competencies. Promoting healthy habits based on our sleep pattern can actually have a bigger impact on the world only towards the betterment.

APPENDIX

Table of Illustrations & Figures

Figure 1: Sleep Problems

Figure 2: Relation Between Sleep and Performance

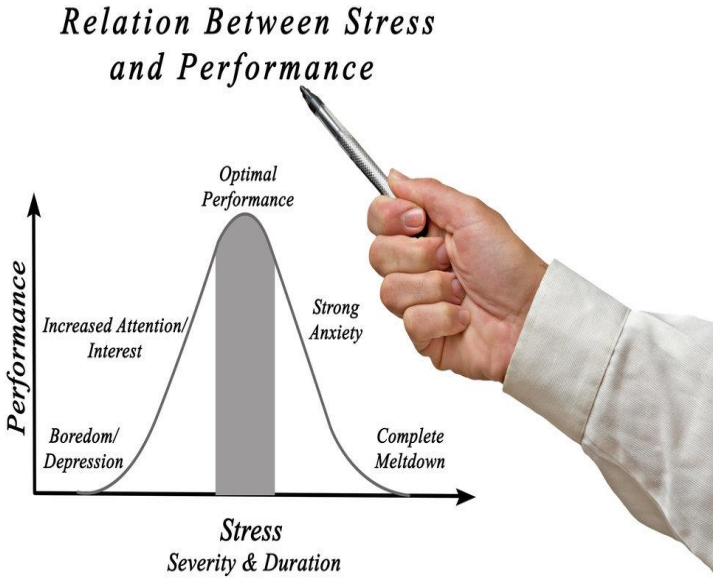


Figure 3: Impact on Human Body

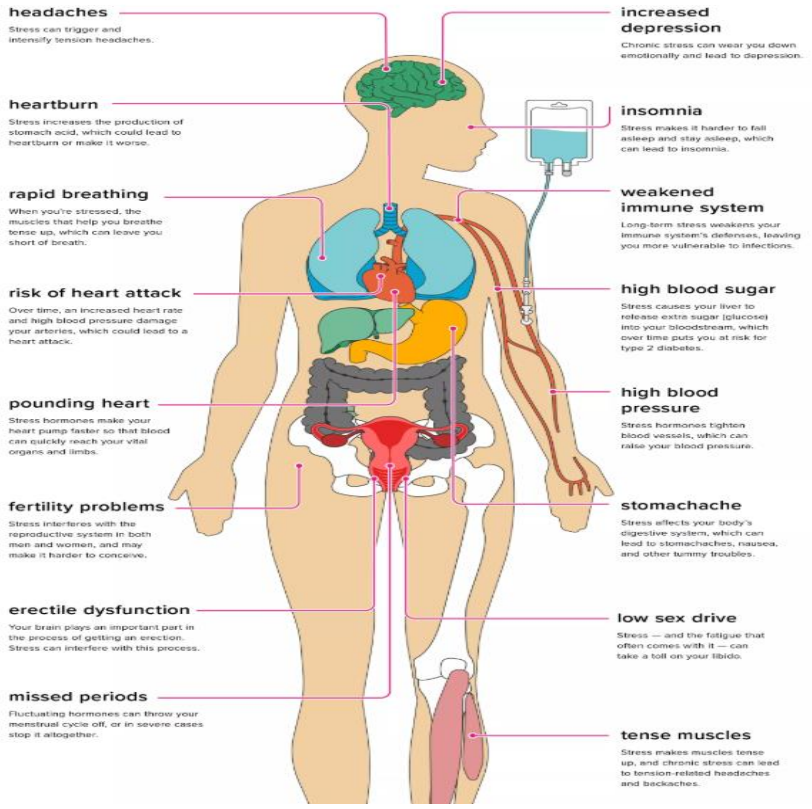


Figure 4: Possible Causes of Sleep Deprivation

Figure 5: Blood Oxygen Saturation

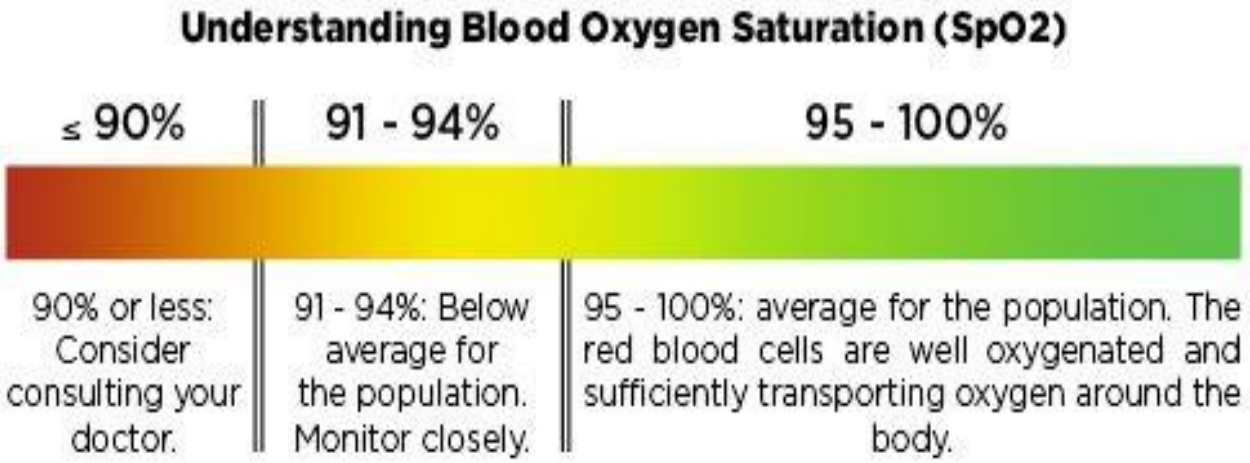


Figure 6: Heart Rate During Sleep

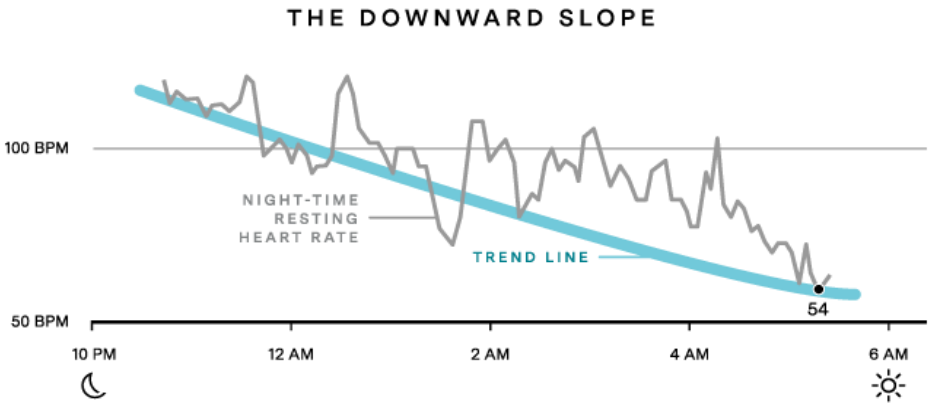


Figure 7: REM VS Sleep Cycle

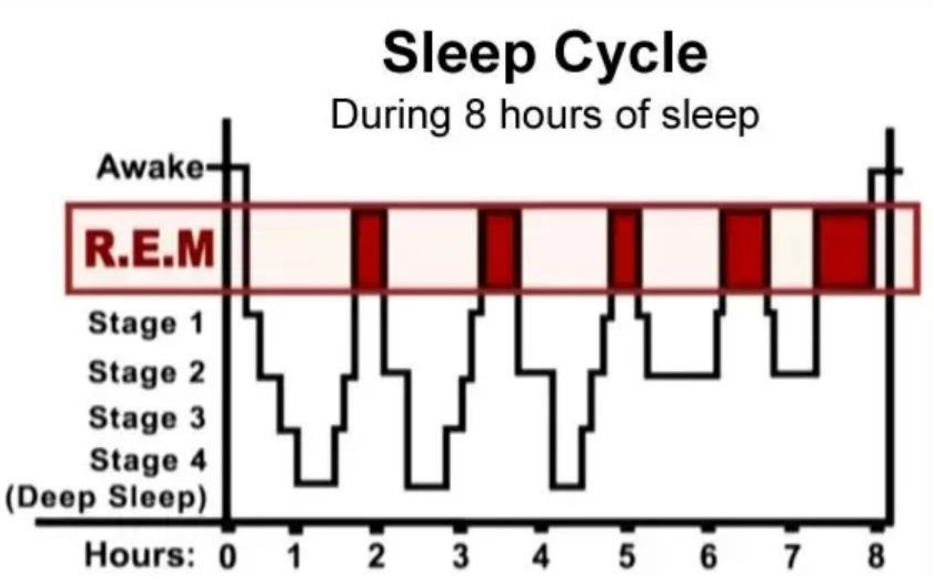


Figure 8: REM VS Wake

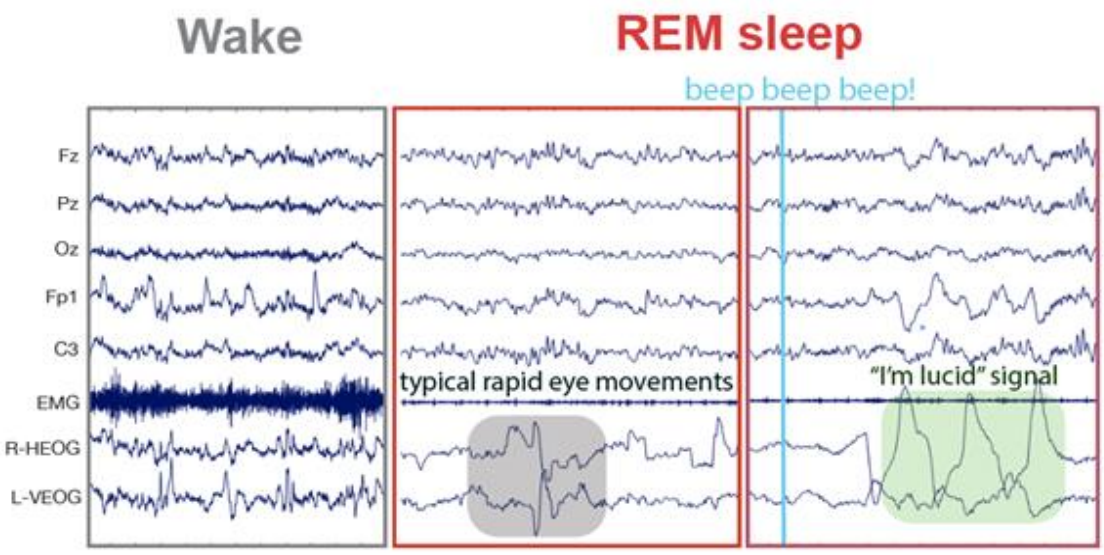


Figure 9: Snore Range

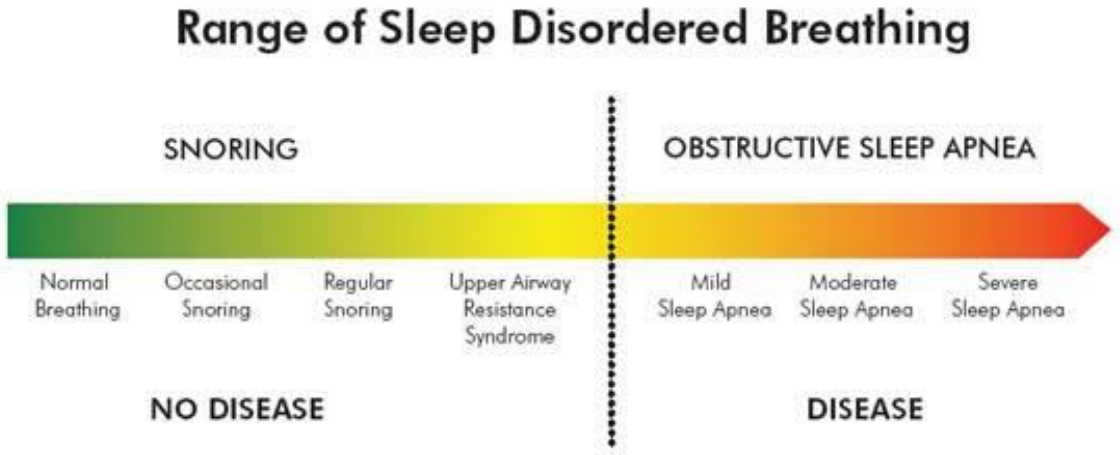


Figure 10: Causes of Snore

Figure 11: Sleep Time Infographic

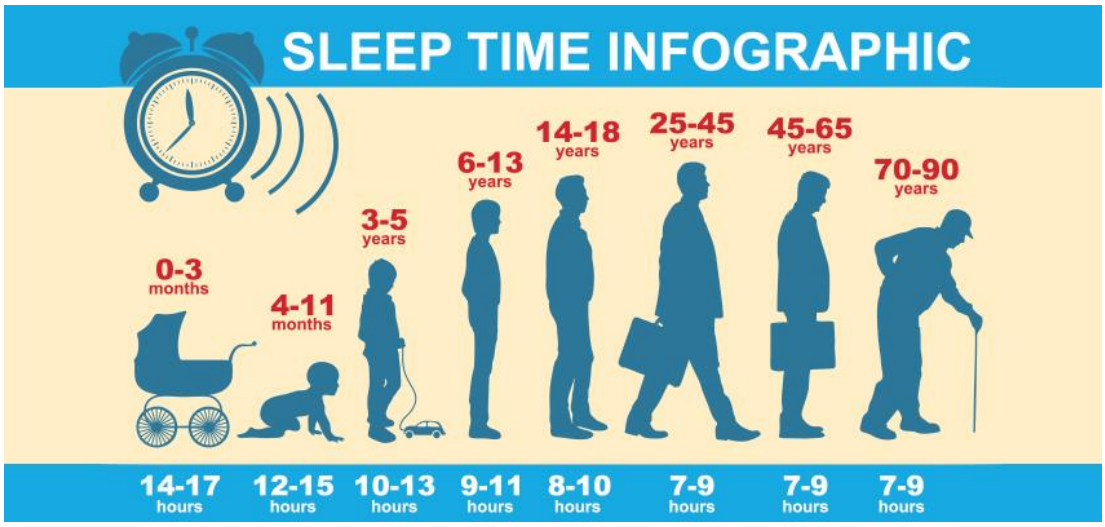


Figure 12: Sleep wake cycle

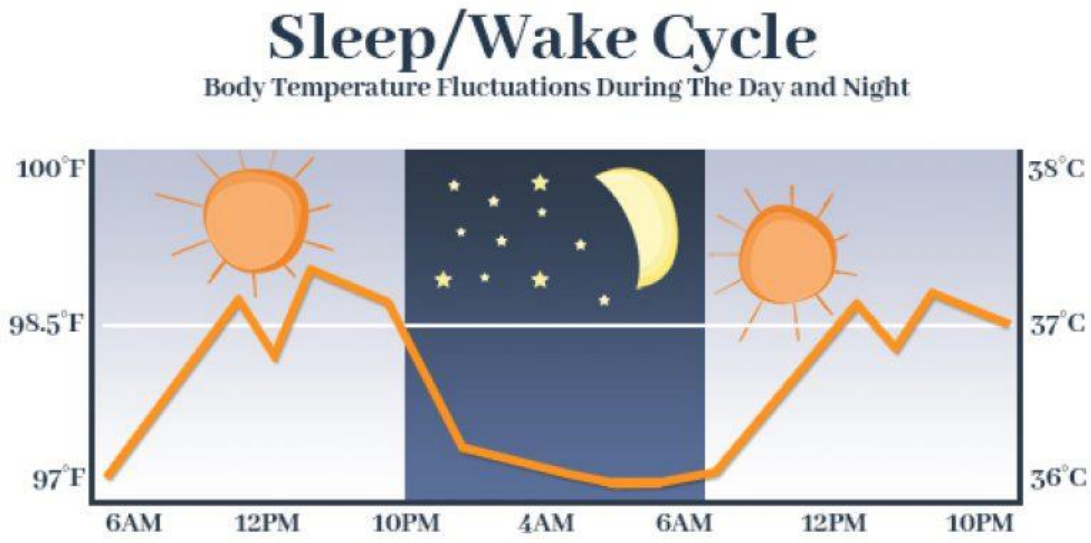


Figure 13: Ideal Sleep Temperature

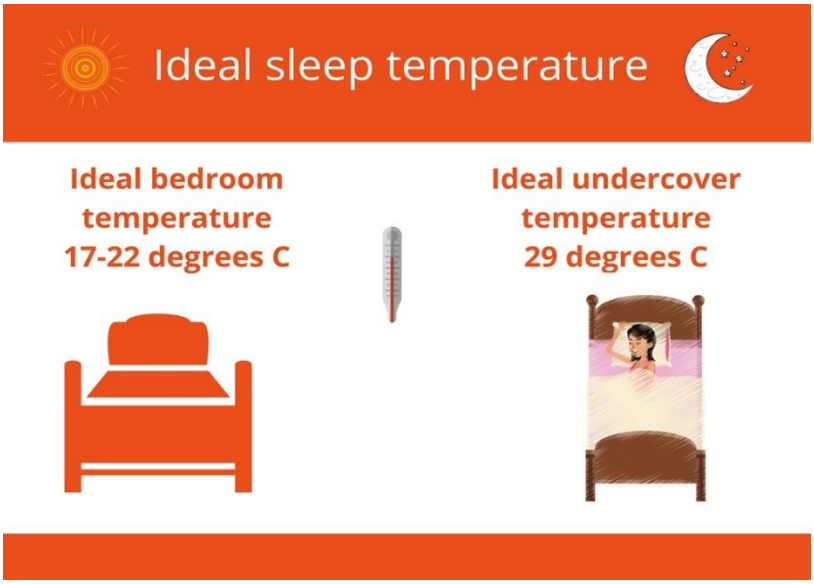


Figure 14: SaYoPillow Methodology

Figure 15: SaYoPillow flow diagram

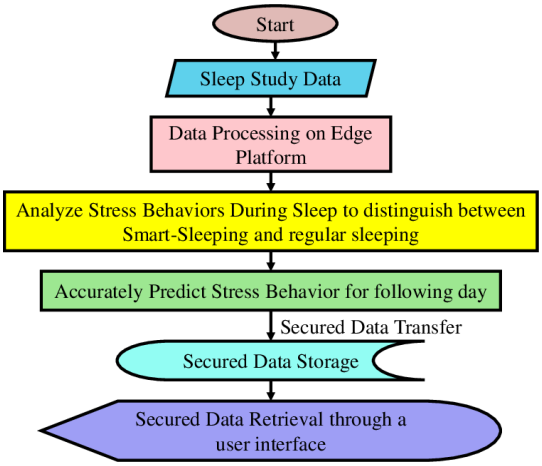


Figure 16: Regression using SAS

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	1259.86242	179.98035	813704	<.0001
Error	622	0.13758	0.00022119		
Corrected Total	629	1260.00000			

Root MSE	0.01487	R-Square	0.9999
Dependent Mean	2.00000	Adj R-Sq	0.9999
Coeff Var	0.74362		

Parameter Estimates

Variable	Label	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	Intercept	1	7.48434	0.07061	106.00	<.0001
Snore_Range	Snore_Range	1	0.00964	0.00017985	53.58	<.0001
Temperature	Temperature	1	-0.16382	0.00315	-51.95	<.0001
Limb_Movement	Limb_Movement	1	-0.07725	0.00204	-37.87	<.0001
REM	REM	1	0.03196	0.00028191	113.38	<.0001
Sleep_Hrs	Sleep_Hrs	1	-0.11159	0.00087236	-127.92	<.0001
Heart_Rate	Heart_Rate	1	0.05041	0.00064137	78.59	<.0001
Blood_Oxygen	Blood_Oxygen	1	0.04692	0.00270	17.37	<.0001

Figure 17: SAS Plots

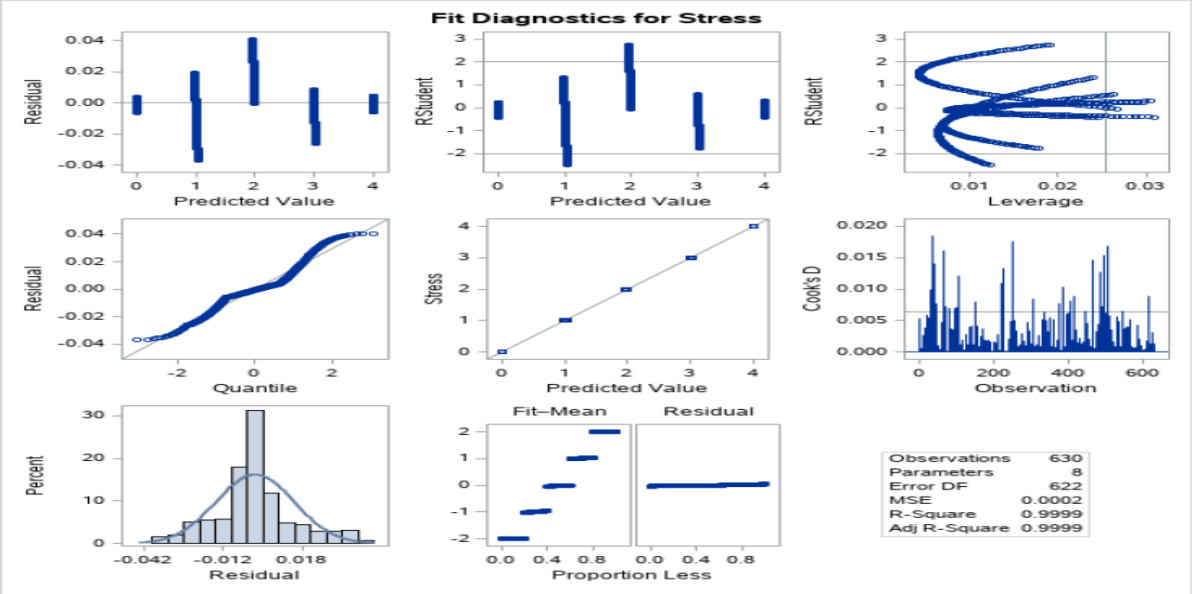


Figure 18: Regression using Excel

$$y = \beta_0 + \beta_1 X_1 + \ldots + \beta_n X_n + \varepsilon$$

Regression Statistics	
Multiple R	0.999945404
R Square	0.999890811
Adjusted R Square	0.999889582
Standard Error	0.01487234
Observations	630

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	7.48433893	0.070606167	106.0012068	0	7.345683582	7.622994279	7.345683582	7.622994279
Snore	0.009637495	0.000179854	53.584991	2.9361E-235	0.0092843	0.00999069	0.0092843	0.00999069
Temperature	-0.163822197	0.003153423	-51.95059922	2.0391E-228	-0.170014842	-0.157629552	-0.170014842	-0.157629552
Limb	0.046920922	0.002700658	17.37388189	2.05517E-55	0.041617408	0.052224435	0.041617408	0.052224435
REM	0.031962856	0.000281908	113.3806447	0	0.03140925	0.032516462	0.03140925	0.032516462
Sleep_Hrs	-0.111592988	0.00087236	-127.9207418	0	-0.113306116	-0.109879859	-0.113306116	-0.109879859
Heart_Rate	0.050407021	0.000641367	78.59311214	0	0.049147514	0.051666528	0.049147514	0.051666528
Blood_Oxygen	-0.07725359	0.002039734	-37.87434755	1.177E-163	-0.081259189	-0.07324799	-0.081259189	-0.07324799

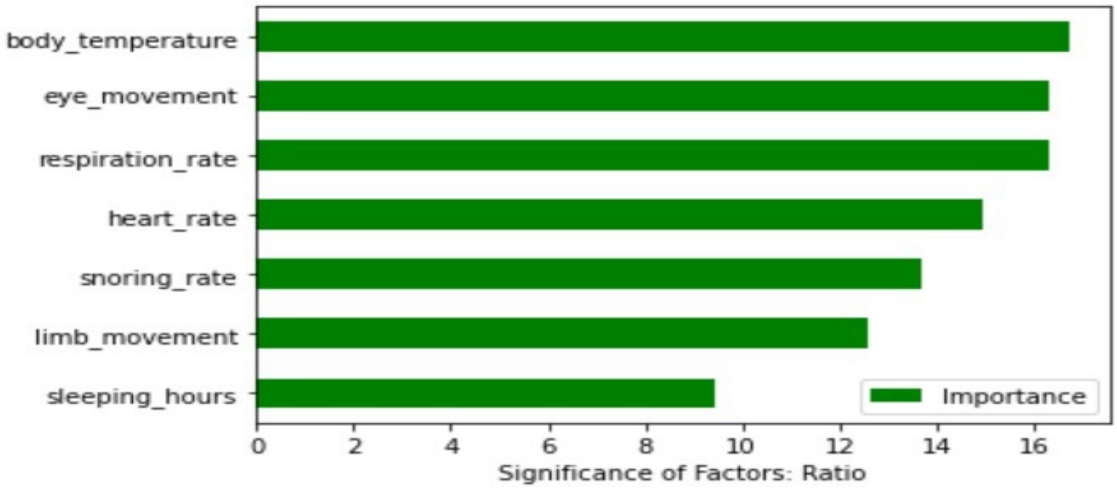
Figure 19: Sample Dataset

Snore_Range	Temperature	Limb_Movement	REM	Sleep_Hrs	Heart_Rate	Blood_Oxygen	Observed_Stress	Predicted_stress
93.8	91.84	16.6	99.6	1.84	74.2	89.84	3	2.994241691
91.64	91.552	15.88	98.88	1.552	72.76	89.552	3	2.999254268
60	96	10	85	7	60	95	1	0.98072246
85.76	90.768	13.92	96.92	0.768	68.84	88.768	3	3.012899616
48.12	97.872	6.496	72.48	8.248	53.12	96.248	0	0.002564447
56.88	95.376	9.376	83.44	6.376	58.44	94.064	1	0.9983038
47	97.2	5.6	68	7.8	52	95.8	0	0.000401814
50	99	8	80	9	55	97	0	0.006194582
45.28	96.168	4.224	61.12	7.112	50.28	95.112	0	-0.002919374
55.52	95.104	9.104	82.76	6.104	57.76	93.656	1	1.005967462
73.44	93.344	11.344	91.72	4.016	63.36	91.344	2	1.987141891
59.28	95.856	9.856	84.64	6.856	59.64	94.784	1	0.984779692
48.6	98.16	6.88	74.4	8.44	53.6	96.44	0	0.00349129
96.288	85.36	17.144	100.36	0	75.72	82.432	4	3.996413015

Intercept	b0	7.48433893
Snore	b1	0.009637495
Temperature	b2	-0.163822197
Limb	b3	0.046920922
REM	b4	0.031962856
Sleep_Hrs	b5	-0.111592988
Heart_Rate	b6	0.050407021
Blood_Oxygen	b7	-0.07725359

Figure 20: Multicollinearity Heatmap

Figure 21: Variable Importanc



References:

- N. Schneiderman, G. Ironson, and S. Siegel, “Stress and Health: Psychological, Behavioral, and Biological Determinants.” Annu Rev Clin Psychol, vol. 1, p. 607628, 2005.
- K. S. Han, L. Kim, and I. Shim, “Stress and Sleep Disorder,” Exp. Neu., vol. 21, no. 4, pp. 141–150, 2012.
- R. K. Nath, H. Thapliyal, A. Caban-Holt, and S. P. Mohanty, “Machine Learning based Solutions for Real-Time Stress Monitoring,” IEEE Consum. Electron. Mag., pp. 1–1, 2020.
- V. C. Magaa and M. Muoz-Organero, “Reducing Stress on Habitual Journeys,” in Proc. 5th IEEE Int. Conf. Consum. Electron. - Berlin (ICCE-Berlin), 2015, pp. 153–157.
- H. R. Colten and B. M. Altevogt, Sleep Disorders and Sleep Deprivation: An Unmet Public Health Problem. Institute of Medicine (US) Committee on Sleep Medicine and Research, 2006.
- R. J. Raymann, D. F. Swaab, and E. J. Van Someren, “Skin Deep: Enhanced Sleep Depth by Cutaneous Temperature Manipulation.” Brain : A J. of Neu., vol. 131, no. 2, p. 500513, 2008.
- H. Scofield, T. Roth, and C. Drake, “Periodic Limb Movements during Sleep: Population Prevalence, Clinical Correlates, and Racial Differences.,” Sleep., vol. 31, no. 9, p. 12211227, 2008.
- J. Peever and P. M. Fuller., “Neuroscience: A Distributed Neural Network Controls REM Sleep.” Curr. Biol., vol. 26, no. 1, pp. R34–R35, 2016.
- S. KP, “Overview of obstructive sleep apnea in adults.” webpage, Nov.2015. [Online]. Available: http://www.uptodate.com/home
- S. F. Quan, B. V. Howard, C. Iber, J. P. Kiley, F. J. Nieto, G. T.O’Connor, D. M. Rapoport, S. Redline, J. Robbins, J. M. Samet, andP. W. Wahl, “The Sleep Heart Health Study: Design, Rationale, and Methods.” Sleep., vol. 20, no. 12, pp. 1077–1085, Dec. 1997.
- G. Q. Zhang, L. Cui, R. Mueller, S. Tao, M. Kim, M. Rueschman,S. Mariani, D. Mobley, and S. Redline, “The National Sleep ResearchResource: Towards a Sleep Data Commons.” J Am Med Inform Assoc.,vol. 25, no. (10, pp. 1351–1358., Oct. 2018.
- L. Rachakonda, A. K. Bapatla, S. P. Mohanty, and E. Kougianos,

"SaYoPillow:Blockchain-Enabled Privacy-Assured Framework for Stress Detection, Prediction and Control Considering Sleeping Habits in the IoMT," arXiv Computer Science, no. arXiv:2007.07377, July 2020.

- J. H. Beinke, C. Fitte, and F. Teuteberg, "Towards a Stakeholder-Oriented Blockchain-based Architecture for Electronic Health Records:Design Science Research Study," J Med Internet Res, vol. 21, no. 10,p. e13585, Oct 2019. [Online]. Available: https://www.jmir.org/2019/10/e13585
- web3j, "web3j," GitHub, Jun. 2020. [Online]. Available: https://github.com/web3j/web3j
- MetaMask, "MetaMask," GitHub, Jun. 2020. [Online]. Available: https://github.com/MetaMask/metamask-extension [40] W. Wu, S. Pirbhulal, H. Zhang, and S. C. Mukhopadhyay, "Quantitative Assessment for Self-Tracking of Acute Stress Based on Triangulation Principle in a Wearable Sensor System," IEEE J Trans. Eng. Hea. Med.,vol. 23, no. 2, pp. 703–713, 2019.
- L. Rachakonda, S. Mohanty, E. Kouginos, K. Karunakaran, and M. Ganapathiraju, "Smart-Pillow: An IoT based Device for Stress Detection Considering Sleeping Habits," in Proc. IEEE Int. Symp. On Smart Electron. Sys. (IEEE-iSES), pp. 161–166, 2018.
- https://www.healthline.com/health/deep-sleep#benefits
- https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0125752
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5846126/
- https://www.sciencedirect.com/science/article/pii/S0960982217313295
- https://www.quora.com/Can-someone-break-down-an-8-hour-usual-sleep-or-break-down-a-usual-sleep-such-as-what-certain-periods-of-sleep-can-do-to-our-body
- https://www.verywellhealth.com/the-four-stages-of-sleep-2795920
- https://statisticsbyjim.com/regression/multicollinearity-in-regression-analysis/
- https://statisticsbyjim.com/regression/interpret-f-test-overall-significance-regression/
- https://www.excel-easy.com/examples/regression.html
- https://www.sprc.org/system/files/private/event-training/Penn%20College%20-%20Perceived%20Stress%20Scale.pdf
- https://www.analystforum.com/t/significance-of-f-is-0/123248
- https://blog.minitab.com/en/adventures-in-statistics-2/regression-analysis-how-do-i-interpret-r-squared-and-assess-the-goodness-of-fit

- https://statisticsbyjim.com/regression/multicollinearity-in-regression-analysis/
- https://www.healthline.com/health/deep-sleep#requirements
- https://theconversation.com/are-sleep-trackers-accurate-heres-what-researchers-currently-know-152500
- https://www.usa.philips.com/c-e/hs/better-sleep-breathing-blog/better-sleep/how-do-sleep-trackers-actually-work.html#:~:text=Heart%20Rate%20and%20Respiration,stages%20by%20measuring%2heart%20rate.