AP STATISTICS SUMMATIVE REPORT

What is the correlation/relationship, if any, between sleep and stress levels for university bound students at Central Peel Secondary School?

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Executive Summary:

The issue of humans getting too little sleep and being overly stressed has been present ever since the birth of modern society in the 19th century. If you feel that you are not getting enough sleep, you are not alone. In fact, in a national study of sleep conducted recently, 40% of respondents claimed to be getting less than the recommended hours of sleep. Furthermore, much of the stress experienced in our daily lives has the potential to ruin sleep quality and length of sleep.

Suddenly, an ideas popped into me and my partner, Harsh's brains. We mutually agreed to see if there is a correlation/relationship between sleep and stress for university bound students in high school. Central Peel Secondary School is a school in which university acceptance rates have reported to be one of the highest in the Peel District School Board, and coincidentally, it is the secondary school that we attend.

To find the relationship between sleep and stress levels for university bound students at Central Peel Secondary School, a survey was conducted. Classes that lead to university were asked a multitude of questions pertaining to stress levels such as their happiness, anxiousness, etc, and most importantly, the number of hours they sleep. All of these questions were backed up by an American Psychological Association article which gives hard data on the specifics between hours of sleep and factors related to stress.

Several chi - squared tests for independence were conducted in order to find an association, if any, between stress and sleep levels for students at Central Peel Secondary School. After looking at the results of all the tests conducted, a conclusion was made that there is weak to moderate association between sleep and stress levels for students at Central Peel Secondary School.

Introduction, Problem, Purpose

As a current advanced placement students pondering about what external factors influence secondary school students sleep, that is what was decided as a topic for the AP statistics final summative. The question pretty much stated how hours of sleep is related to the stress levels of university bound students. This is an interesting conundrum that me and my summative parter, Harsh, through about as our personal anecdotes of how many hours of sleep we get and our stress levels were very different, so a decision was made to test out if there is an association between hours of sleep and stress levels. It is interesting as some students state that high stress and little sleep allows them to study and perform well on tests, whereas other students claim that low stress and a lot of sleep allow them to succeed at school. Therefore, the **null hypothesis** , H_0, is that there is no association between hours of sleep and stress levels for university bound students at Central Peel Secondary School.Consequently, the **alternative hypothesis** ,H_a, is that there is an association between hours of sleep and stress levels for university bound students at Central Peel Secondary School.

Research

After deciding the hypotheses that were to be tested, extensive background research was done to determine if sources were reporting there to be an association between hours of sleep and stress levels. Since the term stress levels is vague, factors such as hours worked per week, overall happiness, etc. An article by the Huffington Post states that when students are sleep deprived, students are much more likely to be depressed and experience higher stress levels. Furthermore, a 2003 article published by The Globe states that students lose hours of sleep when they work part time jobs, so we are interested in the correlation between hours of sleep students get and how their stress levels are affected as result. All of these article claims are related to the hypotheses as all the factors mentioned are all commonly associated with stress, and so if there is an association between hours of sleep and a factor associated with stress, a possible conclusion can be made regarding if there is an association between hours of sleep and stress.

Moving on, a 2013 article by APA resulted in the basis of the study. In the report, the study found that stress does have an impact on their sleep and vice versa. Teens report sleeping far less than the minimum age-based recommendation of 8.5 to 9.25 hours. On average, teens say they sleep 7.4 hours a night on a school night and 8.1 hours a night on a non-school night.Also, about one-quarter of teens (24 percent) also report that their sleep quality is fair or poor.

More than one-third of teens (35 percent) report that stress resulted in them staying awake at night in the past month. Furthermore, for teens who sleep fewer than eight hours per school night, a lot of them say their stress level has increased over the past year (42 percent), compared with 23 percent of teens who sleep at least eight hours per school night. In addition, 18 percent of teens say that when they do not get enough sleep, they are more stressed and 36 percent of teens report feeling tired because of stress in the past month. Thirty-nine percent of teens with higher reported stress levels (eight, nine or 10 on a 10-point scale) during the past school year feel even more stressed if they do not get enough sleep, while only 3 percent of teens with lower reported stress levels (one, two or three on a 10-point scale) during the past school year say the same.

When they do not sleep enough, more than half of teens (53 percent) report feeling sluggish or lazy and 42 percent say they feel irritable. Thirty-two percent say they are unable to concentrate and 23 percent report feeling no motivation to take care of responsibilities.Teens with low stress during the past school year report sleeping more hours per night than do teens with high stress (7.8 vs. 6.9 hours).Ninety percent of teens with low reported stress levels during the past school year say they get enough sleep, compared to less than half (48 percent) of teens with high reported stress levels during the past school year.

Teens with lower reported stress levels during the past school year are also more likely than highly stressed teens to say they have excellent or very good-quality sleep (59 vs. 22 percent). Teens with high reported stress levels during the past school year are more likely to report having trouble sleeping well — 43 percent say they do not get enough sleep because their mind races, compared to 9 percent of teens with low stress who say the same. Teens who report experiencing high stress during the past school year are also more

likely than those who report having low stress to say they feel the effects of getting too little sleep.

Sixty-one percent of highly stressed teens say they feel sluggish or lazy versus 42 percent of teens with low stress.Fifty-four percent of highly stressed teens say they are irritable versus 25 percent of teens with low stress.Forty-four percent of highly stressed teens say they have trouble concentrating versus 20 percent of teens with low stress.Thirty-nine percent of highly stressed teens say they are more stressed versus three percent of teens with low stress.Twenty-six percent of highly stressed teens say they feel sad or depressed versus one percent of teens with low stress. When it comes to stress, teens who get fewer than eight hours of sleep on a school night appear to fare worse than teens getting eight hours of sleep on school nights:

Teens who sleep fewer than eight hours per school night report higher stress levels in the past month than teens who sleep at least eight hours per school night (5.2 vs. 4.1 on a 10-point scale).Teens who sleep fewer than eight hours on a school night are more likely than teens who sleep at least eight hours on a school night to report experiencing symptoms of stress, such as feeling irritable or angry (50 percent vs. 32 percent), nervous or anxious (46 percent vs. 28 percent), depressed or sad (43 percent vs. 18 percent) and overwhelmed (42 percent vs. 22 percent).

This article led to the basis of the design of the survey. There will be chi - squared tests for independence run to determine association between hours of sleep and a variable representing a factor related to stress. From there, all tests run will be analyzed to see if there is an association between the two variables or not, and finally a conclusion will be made regarding which hypothesis is correct.

Methods and Procedures

To get an accurate picture if hours of sleep are associated with stress levels of students. To reduce the undercoverage bias that would be present in the sample, an executive decision was made to survey approximately 1 to 2 classes per grade level. This is because me and my partner hypothesized that grade 12 students may experience more stress due to the ongoing pressure of university applications and marks required for their respective university programs. First, a list of all classes running during fourth period was obtained. In order to determine which classes led students to university, only academic, university preparation, and advanced placement were chosen as potential classes to be surveyed. Next, each class was assigned a number from 0 to the number of classes - 1, and a random number generator was used from online. This left us with one grade 9 AP class, two Grade 10 AP classes, one grade 11 University class, one grade 11 AP class, and two grade 12 University classes. A decision was made to randomly select seven university bound class, as after looking at potential class sizes and comparing it with the student population of the school (approximately 1220 people), a maximum of 121 people could be surveyed, and about half of the students in each were expected to answer the survey questions, which would lead to about 110 people responding. A decision was made to conduct a simple random sample, as a simple random sample can be highly representative of the entire population if done properly. Furthermore, a simple random sample is free from classification errors, and the method of conducting a simple random sample is easy to use.

HYPOTHESIS TESTS:

One sample t - test of population mean for hours of sleep students receive:

Population mean of 7.4 hours

We believe that university bound students will get less sleep than normal teenagers.

Defining hypotheses in test:

H_0: μ= 7.4

H_a: μ < 7.4

$α = 0.05$

Checking Conditions:

108 people were surveyed

10% Condition : Minimum of 10(108)= 1080 people needed in population, which is less than student population of school

Random: Survey was a random sample

Normal/Large Sample: 108 is greater than 30, so large sample condition is satisfied.

There are 108 responses, so the degrees of freedom is equal to n-1 which is **107**.

Sample Mean was found to be : **6.56481** hours

Sample Standard Deviation was found to be: **1.38262** hours

Running Test:

$$t = \frac{\bar{x} - \mu}{\frac{s}{\sqrt{n}}}$$

$$t = \frac{6.56481 - 7.4}{\frac{1.3862}{\sqrt{108}}}$$

$$t = -6.2614$$

Degrees of freedom = 107

Upon finding P value of 0.00000000404832 from the t Cdf on the calculator, we can reject H_0, therefore, we have convincing evidence that the mean average of hours of sleep student receive in our sample is less than 7.4 hours .

One Sample t - test of population mean for hours worked by students on a school day:

We believe that university bound students would work less than 3.4 hours per school day, in order for them to be able to focus on their studies and get the marks required for them to get into university.

Defining hypotheses in test:

H_0: μ= 3.4

H_a: μ < 3.4

$α = 0.05$

Checking Conditions:

108 people were surveyed

10% Condition : Minimum of 10(108)= 1080 people needed in the population, which is less than student population of school

Random: Survey was a random sample

Normal/Large Sample: 108 is greater than 30, so large sample condition is satisfied.

There are 108 responses, so the degrees of freedom is equal to n-1 which is **107**.

Sample Mean was found to be : **0.57407** hours

Sample Standard Deviation was found to be : **1.44819** hours.

Running a one sided t test with the following information:

$\bar{x}$= 0.57407

s_x = 1.44819

μ_0 = 3.4

n = 108

The resulting P-value is less than 0.00001, therefore we can reject the null hypothesis. There is convincing evidence that the students in the sample work less than 3.4 hours a day.

Chi-square test for Independence between Hours of Sleep and Parental Pressure:

Hypotheses:

H_0: There is no association between Hours of Sleep and Parental Pressure for university bound students at Central Peel Secondary School.

H_a: There is an association between Hours of Sleep and Parental Pressure for university bound students at Central Peel Secondary School

$\alpha = 0.05$

Hours of Sleep vs Parental Pressure

Parental Pressure Scale						
		1-2	**3-4**	**5-6**	**7-8**	**9-10**
Hours of Sleep	**3-4**	1	2	0	2	0
	5-6	3	9	12	20	6
	7-8	4	7	11	19	4
	9-10	0	2	0	2	4

(Figure 1.0 : The following figure displays Hours of Sleep vs Parental Pressure organized in a two - way table in the form of frequency)

Checking Conditions:

Random: The data come from a well-designed random sample or randomized experiment.

Minimum of 10(108)= 1080 people needed in the population, which is less than student population of school

Large Counts: As seen in the expected matrix, not all of the expected counts are greater than 5, so the large counts condition for running the test is not satisfied.

Expected Matrix:

Hours of Sleep vs Parental Pressure Expected Counts

Parental Pressure Scale						
		3	4	5	6	10
Hours of Sleep	3-4	0.37037	0.925926	1.06481	1.99074	0.648148
	5-6	3.7037	9.25926	10.6481	19.9074	6.48148
	7-8	3.33333	8.33333	9.58333	17.9167	5.83333
	9-10	0.592593	1.48148	1.7037	3.18519	1.03704

(Figure 2.0 : The following figure displays the expected counts of Hours of Sleep vs Parental Pressure organized in a two - way table)

Test Calculation

$$\chi^2 = \Sigma \frac{(observed - expected)^2}{expected}$$

$$\chi^2 = \frac{(1-0.37037)^2}{0.37037} + \frac{(2-0.925926)^2}{0.925926} \dots + \frac{(4-1.03704)^2}{1.03704}$$

χ^2= **16.9603**

df= (# of Rows -1)(# of Columns -1)
df=(5-1)(4-1)
df= (4)(3)
df= 12

P - Value is found from calculating chi squared cdf with lower bound as 16.9603, upper bound as infinity, and degrees of freedom as 12.

Therefore, P - Value = 0.151098

Since the P - Value is greater than the significance level alpha, we fail to reject the null hypothesis. This means that we do not convincing evidence of an association between Stress Levels and Parental Pressure for university bound students at Central Peel Secondary School.
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Chi-square test for Independence between Hours of Sleep and Mental Fatigueness:

Hypotheses:

H_0: There is no association between Hours of Sleep and Mental Fatigueness for university bound students at Central Peel Secondary School.

H_a: There is an association between Hours of Sleep and Mental Fatigueness for university bound students at Central Peel Secondary School.

$\alpha = 0.05$

Hours of Sleep vs Mental Fatigueness

		Mental Fatigueness				
		1-2	3-4	5-6	7-8	9-10
Hours of Sleep	3-4	0	0	0	3	2
	5-6	0	8	10	20	12
	7-8	5	11	11	13	5
	9-10	1	1	4	1	1

(Figure 3.0 : The following figure displays Hours of Sleep vs Mental Fatigueness organized in a two - way table in the form of frequency)

Checking Conditions:

Random: The data come from a well-designed random sample or randomized experiment.

Minimum of 10(108)= 1080 people needed in the population, which is less than student population of school

Large Counts: As seen in the expected matrix, not all of the expected counts are greater than 5, so the large counts condition for running the test is not satisfied.

Expected Matrix:

Hours of Sleep vs Mental Fatigueness Expected Counts

Mental Fatigueness Scale						
		1-2	3-4	5-6	7-8	9-10
Hours of Sleep	**3-4**	0.277778	0.925926	1.15741	1.71296	0.925926
	5-6	2.77778	9.25926	11.5741	17.1296	9.25926
	7-8	2.5	8.33333	10.4167	15.4167	8.33333
	9-10	0.444444	1.48148	1.85185	2.74074	1.48148

(Figure 4.0 : The following figure displays the expected counts of Hours of Sleep vs Mental Fatigueness organized in a two - way table)

Test Calculation:

$$\chi^2 = \Sigma \frac{(observed - expected)^2}{expected}$$

$$\chi^2 = \frac{(0-0.27778)^2}{0.27778} + \frac{(0-0.925926)^2}{0.925926} \dots + \frac{(1-1.48148)^2}{1.48148}$$

χ^2 = **18.7324**

df= (# of Rows -1)(# of Columns -1)
df=(4-1)(5-1)
df= (3)(4)
df= 12

P - Value is found from calculating chi squared cdf with lower bound as 18.7324, upper bound as infinity, and degrees of freedom as 12.

Therefore, P - Value = 0.095193

Since the P - Value is greater than the significance level alpha, we fail to reject the null hypothesis. This means that we do not convincing evidence of an association between Stress Levels and Mental Fatigueness for university bound students at Central Peel Secondary School.

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Chi-square test for Independence between Anxiousness and Happiness

Hypotheses:

H_0: There is no association between anxiousness and happiness for university bound students at Central Peel Secondary School.

H_a: There is an association between anxiousness and happiness for university bound students at Central Peel Secondary School.

$\alpha = 0.05$

Anxiousness vs Happiness

Happiness Scale						
		1-2	3-4	5-6	7-8	9-10
Anxiousness Scale	**1-2**	2	2	3	6	9
	3-4	4	1	9	11	0
	5-6	1	6	11	8	1
	7-8	3	5	11	6	0
	9-10	2	2	4	1	0

(Figure 5.0 : The following figure displays Hours of Sleep vs Mental Fatigueness organized in a two - way table in the form of frequency)

Checking Conditions:

Random: The data come from a well-designed random sample or randomized experiment.

Minimum of 10(108)= 1080 people needed in the population, which is less than student population of school.

Large Counts: As seen in the expected matrix, not all of the expected counts are greater than 5, so the large counts condition for running the test is not satisfied.

Expected Matrix:

Anxiousness vs Happiness Expected Counts

		Happiness Scale				
		1-2	3-4	5-6	7-8	9-10
Anxiousness Scale	1-2	2.44444	3.2596	7.74074	6.51852	2.03704
	3-4	2.77778	3.7037	8.7693	7.40741	2.31481
	5-6	3	4	9.5	8	2.5
	7-8	2.77778	3.7037	8.7963	7.40741	2.31481
	9-10	1	1.33333	3.16667	2.66667	0.833333

(Figure 6.0 : The following figure displays the expected counts of Anxiousness vs Happiness organized in a two - way table)

Test Calculation:

$$\chi^2 = \Sigma \frac{(observed - expected)^2}{expected}$$

$$\chi^2 = \frac{(2-2.44444)^2}{2.44444} + \frac{(2-3.2596)^2}{3.2596} .... + \frac{(0-0.833333)^2}{0.833333}$$

χ^2=44.3897

df= (# of Rows -1)(# of Columns -1)
df= (5-1)(5-1)
df= (4)(4)
df= 16

P - Value is found from calculating chi squared cdf with lower bound as 44.3897, upper bound as infinity, and degrees of freedom as 16.

Therefore, P - Value = 0.000172

Since the P - Value is lower than the significance level alpha, we reject the null hypothesis. This means that we have convincing evidence of an association between Anxiousness and Happiness for university bound students at Central Peel Secondary School.

Chi-square test for Independence between Hours of Sleep and Happiness

Hypotheses:

H_0: There is no association between hours of sleep and happiness for university bound students at Central Peel Secondary School.

H_a: There is an association between hours of sleep and happiness for university bound students at Central Peel Secondary School.

$\alpha = 0.05$

Hours of Sleep vs Happiness

		Happiness				
		1-2	3-4	5-6	7-8	9-10
Hours of Sleep	3-4	2	0	1	2	0
	5-6	6	11	21	12	0
	7-8	3	5	12	16	9
	9-10	1	0	4	2	1

(Figure 7.0 : The following figure displays Hours of Sleep vs Mental Fatigueness organized in a two - way table in the form of frequency)

Checking Conditions:

Random: The data come from a well-designed random sample or randomized experiment.

Minimum of 10(108)= 1080 people needed in the population, which is less than student population of school.

Large Counts: As seen in the expected matrix, not all of the expected counts are greater than 5, so the large counts condition for running the test is not satisfied.

Expected Matrix:

Hours of Sleep vs Happiness Expected Counts

Happiness						
		1-2	3-4	5-6	7-8	9-10
Hours of Sleep	3-4	0.555556	0.740741	1.75926	1.48148	0.462963
	5-6	5.55556	7.40741	17.5926	14.8148	4.62963
	7-8	5	6.66667	15.8333	13.3333	4.16667
	9-10	0.888889	1.18519	2.81481	2.37037	0.740741

(Figure 8.0 : The following figure displays the expected counts of Hours of Sleep vs Happiness organized in a two - way table)

Test Calculation:

$$\chi^2 = \Sigma \frac{(observed - expected)^2}{expected}$$

$$\chi^2 = \frac{(2-0.555556)^2}{0.555556} + \frac{(0-0.740741)^2}{0.740741} \ldots. + \frac{(1-0.740741)^2}{0.740741}$$

χ^2=23.2022

df= (# of Rows -1)(# of Columns -1)
df= (5-1)(4-1)
df= (4)(3)

df= 12

P - Value is found from calculating chi squared cdf with lower bound as 23.2022, upper bound as infinity, and degrees of freedom as 12.

Therefore, P - Value = 0.026057

Since the P - Value is lower than the significance level alpha, we reject the null hypothesis. This means that we have convincing evidence of an association between Hours of Sleep and Happiness for university bound students at Central Peel Secondary School.

Problems Encountered

There were a multitude of problems that were encountered when conducting the survey. First and foremost, the cooperation of teachers and students was a major problem encountered. Often times, when we would go to collect data, teachers would refuse us from conducting the survey and tell us to come back another time. A similar problem applies with the students themselves. Some students would refuse to do the survey which we found to be very annoying. A more serious problem would be students deliberately lying , although when instructed to tell the truth at the top of the survey. For example, one student claimed to sleep for 9 hours a day, be involved in 10 extracurriculars, worked 8 hours a day, and did 9 hours of homework a night! That alone gives a total of 26 hours, along with 9 hours, leading us to believe that the data is obviously falsified.

If a reconduction of the survey were to take place, prior appointments with teachers will be taken so the survey can be conducted at a mutually fine time. Also, we would get teachers to demand that students do the survey, as they serve as somewhat of an authoritative figure to the students, and so there authority may cause students to actually do the survey and do it truthfully. The main limitation of the inferences would be the fact that the students did not deliberately lie, which would have led to response bias. A recommendation for next time would be for most teachers to try to establish an authoritative figure before the students conduct the survey, as it will result in an increased likelihood of students completing the survey properly.

Bias, Errors & Confounding Variables

Despite all attempts to remove biases, errors, and confounding variables in any study or experiment, they will always be present no matter what.

First, there was undercoverage bias present in this observational study. Undercoverage bias is a type of bias in which certain members of the population are left out of the study. Since the survey was conducted online , it only represents the results of people who have a device on which the survey can be done. The results could have been different if everyone, including students who do not have their own devices, were included in the observational study.

Next, response bias is the tendency for the participants to knowingly reply falsely to questions posed in the survey. Students might lie about their anxiousness level, as some students may think that their results are not anonymous, and so their anxiety may cause

other students to shift negative attention towards them. Also, some students might be having a bad and so they unleash their anger by deliberately falsifying answers to the survey.

Furthermore, there was a little bit of voluntary response bias present. Although most teachers were willing to cooperate and establish an authoritative figure in the classroom for their students to do our survey, some were not. Some classes were comprised of volunteers and so this could have the potential to skew the data if the students that did not complete had vastly different answers than the students that did complete the survey.

Next, there is a form of measurement bias present in the survey. Some of the questions were asked on a scale such as happiness. For the same action, such as playing video games, might cause one person to rank their happiness as a 7, whereas one person could rank their happiness as a 9 for the same act. In turn, this will cause some bias in the data, as the surveyors have no idea what each respondent's happiness gauge is. In turn , this may lead to a scatter of data with a weak correlation between act conducted and happiness level stated.

Also, there was undoubtedly the experimenter's effect present when collecting the data. The experimenter's effect is when the researcher unintentionally influences subjects through factors such as facial expression, tone of voice, attitude, etc. This would have been present as me and Harsh were walking around each classroom making sure that the students were completing the survey. In turn this may have caused them to get intimidated and possible submit false information regarding some of the questions.

Lastly, there were a few confounding variables present when collecting the data. Confounding variables are variables that the researcher fails to control or eliminate, which in turn damages the internal validity of an observational study or experiment. First and foremost, the confounding of time was present. Due to time constraints, not all students were surveyed on one day. Factors such as a talent show happening on one day may cause a student to report them reporting less stress levels than what they would normally report. Likewise, a student having a test the same day they were surveyed increases the likelihood of them reporting that they experience more stress. Also, certain aspects such as if the subjects have eaten a good lunch, their performance on a test received back on the same day, a conflict they have gotten into, etc.

Conclusion:

_____Upon performing a variety of hypothesis tests between hours of sleep and a multitude of various factors related to sleep, the study is deemed to be a moderate success. It can be concluded that there is most likely a weak to moderate association between hours of sleep and stress levels for university bound students at Central Peel. This conclusion was reached upon a multitude of reasons. Firstly, the chi - squared test for independence between hours of sleep and parental pressure showed that there is no association between those two variables. Likewise, the chi -squared test between hours of sleep and mental fatigueness also showed no association. However, the chi - squared tests for independence between anxiousness and happiness, and hours of sleep versus happiness, showed that there is an association between the two variables. An important piece of factual evidence that was considered before making the conclusion is that none of the expected counts conditions were met as not all expected counts were greater than 5, so extra caution had to be taken there.Lastly, since this a simple random was conducted, it is hard to question the validity of the survey, Overall, an interesting question regarding university bound students at the school has been solved! Final decision is that a conclusion has been made that there is a weak to moderate association between stress levels and the hours of sleep university bound students at Central Peel receive.

GLOSSARY:

Chi-squared test : A chi-squared test is any statistical test where the sampling distribution of the p - value is a chi-squared distribution when the null hypothesis is true.

Confounding Variables : A confounding variable are variables that the researcher has failed to control, or even eliminate, which can damage the validity and conclusions drawn from an experiment.

Experimenter Effect : Occurs when the researcher/experimenter unintentionally influences subjects through such factors as facial expression, tone of voice, or attitude.

Measurement Bias : Bias that occurs when one type of respondent is overrepresented in the sample.

Response Bias : Bias that results from respondents deliberately replying falsely to questions posed to them in the study.

Sampling Bias : Bias that results when the sample does not represent the population accurately and aries when random sampling techniques are utilized.

Voluntary Response Bias : A bias that results when the people selected in the experiment or study are self - selected volunteers.

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