

Effect of 8am Classes on Cognitive Performance

Nathan Yeager (ntyeager)

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Introduction

With the recent introduction of 8am classes by Carnegie Mellon, it is only normal that people in turn wonder about how this affects the student body as a whole. As a result of some faculty and students complaining about the effect of this change on cognitive performance, the registrar's office wants to find out if a lack of sleep is indeed associated with lower grades so that these 8am classes can be reconsidered. The data comes from a study conducted at CMU and two other universities, where the students studied were recruited to wear sleep trackers for a month during their spring semester.

The registrar would specifically like to know 3 things: the association between sleep time and GPA, the average GPA effect we expect to see with 2 hours less sleep, and whether or not we can conclude that the GPA change is caused by less sleep.

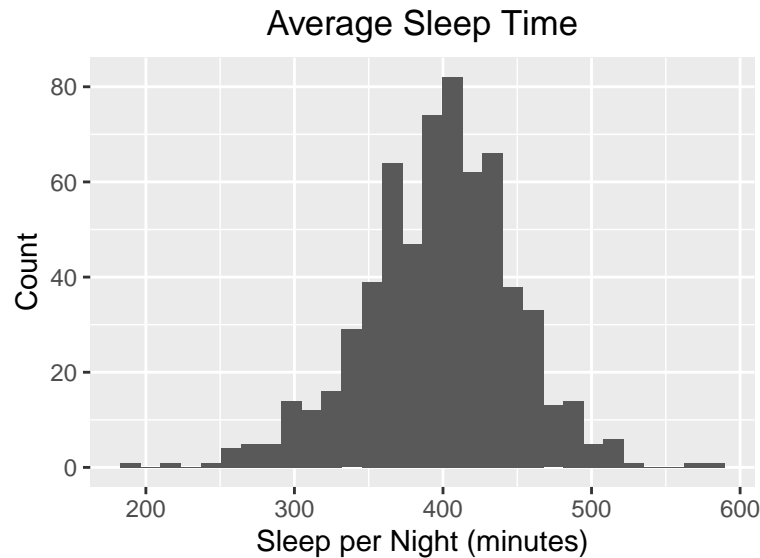
We found that there is indeed an association between sleep time and GPA and that the average GPA effect that we expect to see with 2 hours less sleep is significant enough to recommend for the removal of 8am classes.

Exploratory Data Analysis & Data Summary

The variables of interest from the dataset follow:

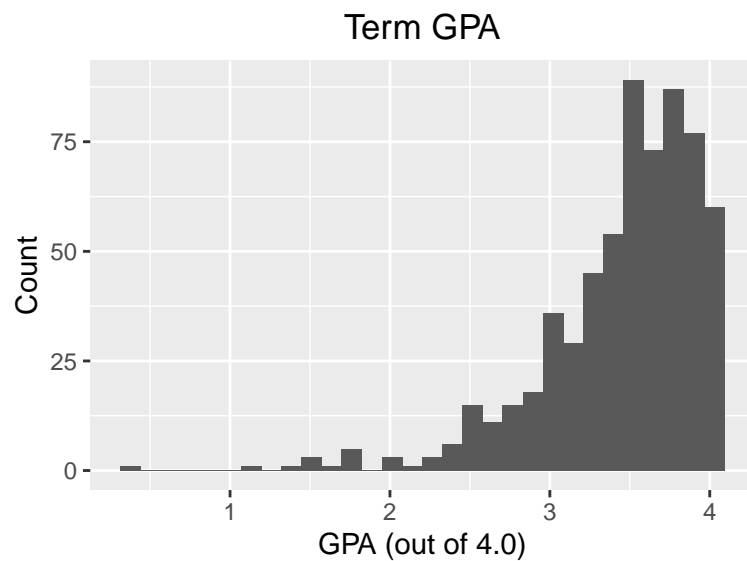
- **TotalSleepTime**: The average time the student spent asleep each night, not counting naps, in minutes
- **term_gpa**: The student's GPA (out of 4.0) for the classes they took in the semester being studied

TotalSleepTime's distribution follows:



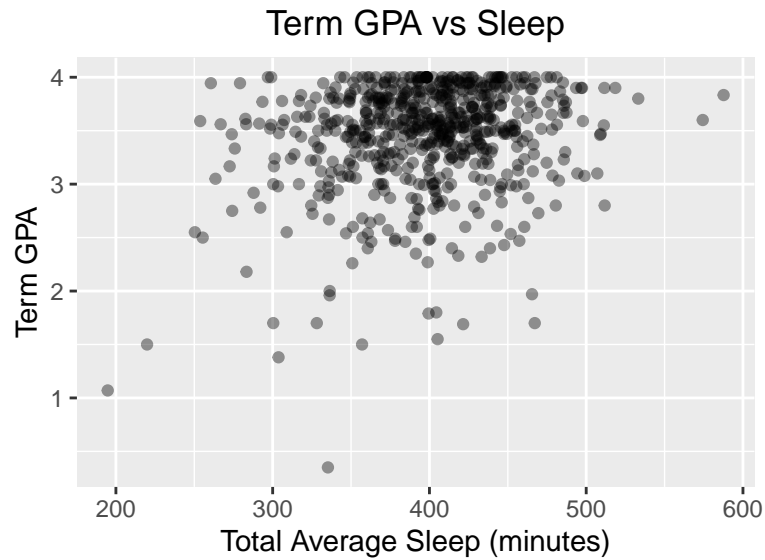
TotalSleepTime has a unimodal and fairly symmetric distribution with a mean of 397.3 minutes and a standard deviation of 50.85.

We similarly look at the distributions for Term GPA:



Both distributions are skewed left and have means of 3.45 and 3.466, respectively. This left skew might cause problems in analysis later. Term GPA has a slightly higher standard deviation of 0.500 while cumulative GPA has one of 0.438.

We next look at the relationship between GPA and Total Sleep Time:

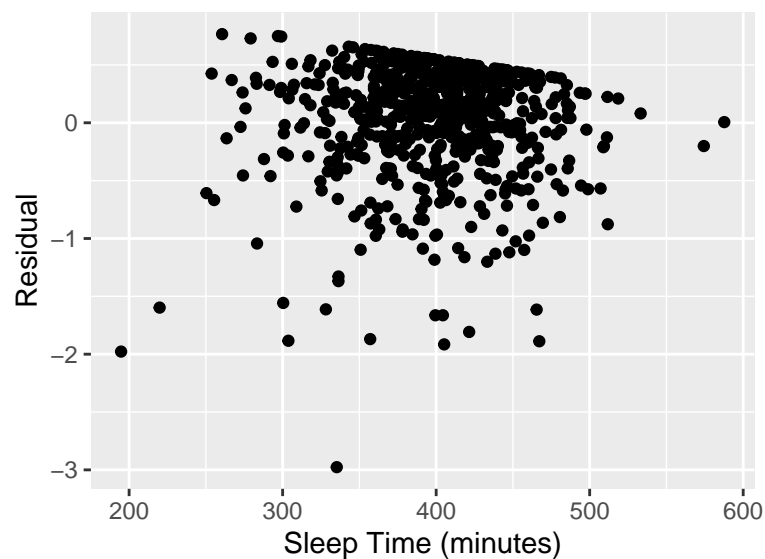


There appears to be a potential positive linear relationship between GPA and sleep from the figure.

Methods

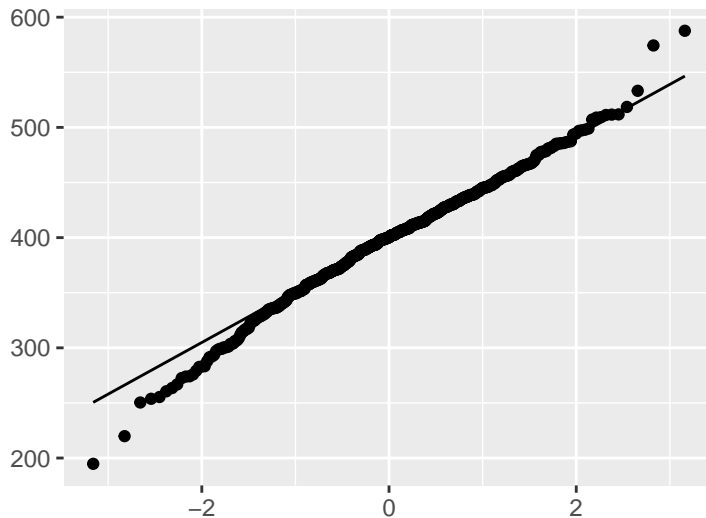
We choose to fit a linear model predicting GPA from sleep time. Since we are looking for an association between sleep time and GPA, our null hypothesis will be that the slope equals 0 and our alternative hypothesis will be that the slope is greater than 0. We will conduct a t test for this B1 coefficient and produce a 95% confidence interval.

To show that this model is appropriate, we will now examine the plot of the residuals:



The apparent main cause of concern is the decrease of the variance of the residuals as sleep time increases. However, this is a result of GPA being capped at 4.0 and of many GPAs being close to this 4.0 maximum. So overall, there might not be any cause for concern but we will note this.

A Q-Q plot shows some cause for concern but this could be due to what we just noted.



Results

Using a t test with linear model with Total Sleep Time being a predictor for term GPA, we reject the null hypothesis that the slope is 0 for the relationship between Total Sleep Time and GPA since the p-value of $3.04e-07$ is less than our alpha value of 0.05. This corresponds to a t value of 5.176. We find that on average, for every extra minute of sleep a student gets per night, their GPA increases by 0.0019846 with a 95% confidence interval of (0.0012331, 0.002736064).

The equation for our linear model follows: $\text{GPA} = 2.661 + \text{TotalSleepTime} \times 0.0019846$ where TotalSleepTime is in minutes.

So using our model, a 2 hour sleep difference would cause a $120 \times 0.0019846 = 0.238$ difference in GPA.

Discussion

In conclusion, we see that there is indeed an association between sleep time and GPA after fitting a linear model between the two and conducting a t-test for B_1 , the slope of the model. We find that with 2 hours less of sleep, a student's GPA is expected to drop by 0.238 on average. So based on this, and the fact that we expect students to get 2 hours less sleep, on average, with the addition of an 8am class, I would recommend the removal of 8am classes. We cannot make a conclusion that GPA change is solely caused by less sleep as we do not know other factors such as whether or not there is an association between class difficulty and class time as some more difficult departments may lean towards earlier classes. To improve analysis, we can try to control for factors such as these. But we have strong evidence that there is an association between sleep time and GPA.