Key Terms

Pearson Correlation - tests the linear relationship between two variables on a scale of -1 to 1. The closer the correlation value is to -1 or 1, the greater the trend between the two variables.

Sleep Variability Number – A calculation used to determine the individual’s variability from his or her average sleep time.
The Effect of Activity Regularity Upon Sleep Variability in Emory Freshman

Hannah Chen, Irene Makapugay, Rahul Patel

ABSTRACT
Background: Sleep deprivation and irregular sleep result in negative effects on health and performance both physically and mentally. The purpose of this study is to determine if schedule regularity increases sleep regularity in Emory University undergraduate freshmen. We hypothesize that Emory University freshmen undergraduates with regularly scheduled activities have a regular sleep schedule. Methods: Twenty-four Emory University freshmen (13 athletes, 11 non-athletes) completed a survey regarding lifestyle and their daily activities. Participants also documented their activity, sleep, and meal times as well as other factors that may influence sleep for one week. Results: Although there was a slight negative correlation, the correlation between average hours of regular activities per day and total sleep variability was not significant for Emory University freshmen (p=.264). Factors such as study times, number of naps, caffeine intake, gender, and ethnicity did not significantly influence sleep variability. The variable that showed strongest significance of correlation with sleep variability was exercise amongst the non-athlete group (correlation = .699, p = .00835) and activity categorization amongst only males (p= .00992). Conclusions: There was no significant correlation observed between schedule regularity and sleep regularity. We therefore reject our hypothesis.

INTRODUCTION
It has been found that 74% of adults experience a sleep deficiency at least once a week and that 39% receive less than 7 hours of sleep each weeknight (Schenck, 2010). Sleep is a time of physical and mental restoration when the body repairs itself and prepares for the next day. Previous research has shown a positive correlation between sleep quantity at night and GPA for college students (Lowry et al, 2010). The effects of inadequate sleep are both immediate and long lasting. While in the short run sufferers might have increased daytime sleepiness and an inability to pay attention, long-term effects include cardiovascular disease with increased hypertension, heart rate, and endothelial dysfunction (Sauvet et al., 2010), drug and substance usage (Dahl and Lewin, 2002), and an increase in accidents due to an impaired cognitive and motor functionality (Williamson and Feyer, 2000).

Not only can sleep deprivation have ill effects, but sleep irregularity may also be detrimental to health and function. It has been found that night shift workers have increased risk of heart problems, digestive disturbances, and emotional and mental problems. Night-shift medical interns are twice as likely to misinterpret medical records (U.S. NIH, 2007). Overall, irregular sleep negatively affects health and increases the risk of errors.

An experiment by Cheri Mah, a graduate researcher at Stanford, compared the sleeping schedules of normal undergraduates against six skillful basketball players on the varsity team who got 10 hours of sleep regularly, which led to better academic performance (Thai, 2007). This experiment showed that there is a correlation between regularity of activities such as varsity sports, clubs, orchestra, and regularity of sleep. They argued that students with regular activities were obligated to regulate their sleeping schedules in order to be well rested and perform exceptionally at these activities.

How does schedule regularity of Emory University freshmen affect their sleep regularity? We sought to determine the sleeping habits of college freshman at Emory University. It was hypothesized that Emory freshmen with more regularly scheduled activities have decreased
sleep variability. Factors such as exercise, naps, number of meals, caffeinated beverage intake, use of sleeping aids, study hours, and activity times were predicted to cause fluctuations in sleep regularity.

**METHODOLOGY**

**Participants**

The participants in the survey lived in the First Year Experience (FYE) communities at Emory University. There were 24 participants with each being grouped into “athlete” and “non-athlete” groups based on athletics and club participation. They were not recruited based on demographic patterns or any other interests and were instead chosen randomly by the survey conductors. Thirteen participants were engaged in regular activities, while eleven participants were not engaged in any regular activities.

**Survey and Consent Form**

When approached, the participants were given a consent form that had brief information about the purpose of the survey, freedom of not participating, and notice of confidentiality (Figure 1a). The survey page contained questions regarding previous conditions and experiences that the participants had encountered. The purpose of this section was to screen for variables about campus involvement and international student status. Refer to Figure 1b for the survey questions.

**Sleep and Activity Chart**

For a seven-day, seven-night period, the participants were asked to fill out a sleep and activity chart. Figure 1c is a chart that represents one day of the log participants filled out during the testing period. The variables that were measured in the experiment were meal times, exercise times, sleeping aids usage, and caffeinated beverage consumption.

**DATA ANALYSIS**

After the seven-day, seven-night period, the sleep and activity charts were collected and analyzed. Data was analyzed with Microsoft Excel. Incomplete sleep logs were not considered in the data analysis. To conduct the assay of sleep variability, a Sleep Variability Number was calculated for each participant. The first step was to calculate the average start time and average end time of night sleep for each participant. Then, to calculate the sleep variability number for one night, the difference in the start time from the average was added to the difference in the end time from the average. To find the participant’s overall sleep variability number, the numbers for all seven days were cumulated. The survey had a seven-day collection period because it allowed for a time course large enough for detailed sampling while not overwhelming the participants. A sample sleep variability number calculation process is given in Figure 1d.

The data was analyzed with the Pearson Correlation test, which tests the linear relationship between two variables. The closer the correlation coefficient is to -1 or 1, the stronger the negative or positive correlation, respectively. If the corresponding p-value was below 0.05, the relationship between the two values was significant.

**RESULTS**

It was hypothesized that Emory freshmen with more regularly scheduled activities have decreased sleep variability. Our results indicate that while there is a slight negative trend between average activity time and sleep variability, the trend is not significant (Figure 2). A Pearson correlation test yielded a correlation coefficient of $r = -0.13533$, which corresponds with a p-value of $p = 0.264692$.

It was predicted that study time would have a similar effect as activity time. There were some noteworthy trends that could be drawn. As demonstrated in Figure 3, the overall Pearson correlation coefficient of $-0.317$ ($p=0.065$) suggests that an increase in study time leads to less sleep variability, though the data is not significant.

According to a sleep review, the expected effect of exercise is that it will improve sleep because of the traditional belief that sleep conserves energy and restores the body (Driver & Taylor, 2000). In our data analysis, the overall correlation of $-0.014$
(p=.474) suggested no overall trend (Figure 4). However, this lack of correlation could have been the result of a blending between two groups that responded very differently. The athlete group had a trend with a coefficient of -.400 (p=.087), suggesting that an increase in exercise leads to less sleep variability. The non-athlete group had a correlation coefficient of .699 and a p-value of .00835, suggesting that an increase in exercise leads to much more sleep variability. This correlation was statistically significant. While there is no overall correlation that can be drawn between exercise amount and sleep variability, athletes were found to slightly decrease sleep variability with exercise while non-athletes showed a significant correlation of increasing their sleep variability. Overall, the effect of gender on sleep variability between males and females is not statistically significant because the P-value is .692 (Figure 5). In addition, there was no statistical significance between female athletes and female non-athletes because the P-value was .843. However, the difference in sleep variability between male athletes and male non-athletes was statistically significant because the P-value was .00992. Our data analysis indicates that there are no significant differences in sleep variability across gender or between female athletes and non-athletes, but in comparing male athletes and non-athletes, there is a significant suggested effect on sleep variability.

There was no significant difference in sleep variability amongst variables such as number of naps taken (Figure 6), amount of caffeine intake (Figure 7), ethnicity, international status, and number of meals. We were not able to gauge effectively for the effects of sleeping aids on sleep variability because no participants used sleeping aids.

DISCUSSION AND CONCLUSION
The research conducted was exclusive to Emory University first-year students. This population has faced a significant amount of lifestyle adjustment over the past 4 month period because of a new degree in personal freedom not experience before, and one of the components most affected is sleep patterns (Pilcher et al., 1997). We hypothesized that Emory freshman undergraduates with regularly scheduled activities have a regular sleep schedule. We predicted that Emory freshmen that are involved in more activities will have more regular sleep schedules than those who do not have as many commitments. Upon completing our data analysis, it was found that the data does not support our hypothesis. There was no significant relationship between activity times and sleep variability.

Other factors may have affected sleep regularity and influenced our data such as stress, illness, and sleep environment. Sleep environment was not controlled in our study, and noise, light, and temperature could have varied for the different dorms in which Emory freshmen live. A small sample size may not have provided very accurate data. Recruiting more participants would have increased accuracy by representing a larger portion of the Emory undergraduate freshman population. One week of documenting sleep and activity times was also a relatively small sample time. That one week may have not been a typical week for some participants. Some participants may have had tests or other demanding coursework that would have affected activity times, study times, and sleep regularity. Since the data was acquired the week before Thanksgiving, preparations for the holiday may have influenced...
students’ schedules and sleep. In addition, there was no way to enforce accurate responses from participants.

The Emory University first-year student group is representative of transformed sleep dynamics from a privatized high school environment to a more activity-filled, community-based college environment. With the additional freedoms afforded to these freshmen students, it is important to note variations on a regional scale. In future experiments, the transformation of the sleep schedules of undergraduates as they progress during their 4 years of college can be monitored. We suggest that this assessment should start from the high school lifestyle and end with the senior year in college (Wolfson & Carskadon, 1998). An interesting point to note is that freshmen have been observed to rise earlier and have shorter sleep times than other college students during weekdays (Tsai & Li, 2004). This future experiment would provide valuable information as to how involvement in activities, an increase in academic focus, and a period of social change can affect the newest generations of adults.

REFERENCES


Hannah Chen is a freshman from Greenville, South Carolina hoping to major in Chemistry and pursue a career in medicine.

Rahul Patel is a freshman from Sugar Land, TX majoring in NBB. After completing his undergraduate studies, he plans on pursuing an M.D.
APPENDIX

Informed Consent

Title: Schedule regularity and Sleep regularity
Principal Investigators: Hannah Chen, Kyle Lim, Irene Makapugay, and Rahul Patel
Sponsor: ORDER class

Introduction and Purpose: We are asking you to volunteer for a research study that is part of a research methods course. This form is designed to tell you everything you need to think about before you decide to be in the study or not to be in the study. We are asking you to participate in this research because you are 18 years of age or older and you are an undergraduate freshman of the Emory University community. The purpose of the study is to determine how schedule regularity affects sleep regularity.

Procedures: You are being asked to fill out this survey to provide information on your eating habits, sleep times, activity times, study times, and other lifestyle habits and to monitor these factors for a week.

Risks, Discomforts, and Inconveniences: There are no known risks with this type of survey. We are interested in your sleeping and activity patterns but you are free not to answer any questions on the survey.

Benefits: This survey will not benefit you in any immediate way. The information gathered may be used to suggest behaviors or lifestyles that affect sleep regularity.

Confidentiality: This study is confidential. Your name will not be included anywhere in this experiment, associated with your survey or in any other form. Information will be entered into a data file anonymously; there will be no way to link your answers with your name. The surveys that are collected will be kept by the researchers or the teachers of the ORDER class.

Compensation: There is no formal compensation for participating in the study. We are greatly appreciative of your participation in this study.

Contact Persons:
Justine Liepkalns, researcher: Email: jsliepk@emory.edu
Call the Emory University Institutional Review Board if you have any questions about your rights as a participant in this research study or have questions about research conducted as part of classroom learning. You can call toll-free at 1-800-502-9397 or (404) 712-0720; email irb@momy.edu; or write to the office at 1599 Clifton Road, Atlanta GA 30322.

Your Choice: You are free to choose whether or not you want to take part in this study. You can change your mind and stop at any time without penalty. Your decision will not adversely affect your relationship with the researchers or Emory.

Study Findings: If you would like to learn the results of the study, please indicate below and we will e-mail you a summary of the results.

*If you are not comfortable providing answers to any of these questions, please leave the answer or part of the answer blank. Your responses will be anonymous.

Age:

Gender: Male or Female

Ethnicity:

Regular Activities: If you select yes to any question, please list the hours per day and days per week you participate in this activity. Also, if applicable, state which specific activity (i.e., varsity Basketball) you participate in.

1. Are you a member of a varsity sports team?
2. Are you a member of a club sports activity?
3. Are you in an acapella group?
4. Does any single club or organization require a significant amount of your time?
5. How many hours do you study for classes?

International/Boarding Status:

1. Before you enrolled at Emory, did you live in an international country? If so, please list the country and how long you lived there.
2. If you answered affirmatively to the preceding question, what were the starting and ending times for your high school/junior college? (example: 7am to 3pm)
3. Did you attend a boarding school or pre-college institution in which you lived away from your house for an extended time period?

Social Behavior/ Stress:
Please respond to the following questions by filling in the corresponding charts. Please fill in time averages.

Question
Emory
High School

1. How many meals do you consume a day?
2. Do you keep and consume food in your room?
3. What are the main exercise activities you engages in (cardio, weightlifting, basketball)

Average stress level (1-5 scale with 5 being the most stressed)

Figure 1a- Consent form

Figure 1b Survey Questions. The survey was distributed to Emory University undergraduate freshmen. Survey questions were broad to encompass a wide range of factors that may affect sleep regularity.
Figure 1c: One day of the seven day log that participants had to fill out regarding their sleep schedules in the sleep and activity chart.

| Day     | Total Sleep Time (Cumulative Hours) | First Nap Time (ex. 12:00-2:30) | Second Nap Time (ex. 7:00-8:30) | Night Sleep Time (ex. 12:00-5:00) | Breakfast Time (ex. 5:00) | Lunch Time | Dinner Time | Additional Meal Times | Caffeinated Beverages Consumed | Sleeping Aids and times used | Total Study Hours (ex. 3) | Activity Times (Ex: 5pm-8pm) | Exercise Times (Ex: 12:00-1:15) |
|---------|-------------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------|-------------|-------------|----------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|-------------------------------|-------------------------------|
|         |                                     |                                 |                                 |                                 |                           |             |             |                      |                             |                             |                             |                               |                               |                               |
| Wednesday |                                     |                                 |                                 |                                 |                           |             |             |                      |                             |                             |                             |                               |                               |                               |

Figure 1d: Sample sleep variability number calculation. Night sleep start and end times are converted to their distance from midnight which are averaged. The sleep variability number is the straying of each individual day’s night start and end sleep times from their respective averages.

<table>
<thead>
<tr>
<th>Day</th>
<th>Night Sleep Start Time</th>
<th>Night Sleep End Time</th>
<th>Night Sleep Start Time (Distance from Midnight)</th>
<th>Night Sleep End Time (Distance from Midnight)</th>
<th>Sleep Variability (Compared to Average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday</td>
<td>10:00</td>
<td>7:00</td>
<td>-2</td>
<td>7</td>
<td>4 (2+2)</td>
</tr>
<tr>
<td>Tuesday</td>
<td>11:00</td>
<td>8:00</td>
<td>-1</td>
<td>8</td>
<td>2 (1+1)</td>
</tr>
<tr>
<td>Wednesday</td>
<td>12:00</td>
<td>9:00</td>
<td>0</td>
<td>9</td>
<td>0 (0+0)</td>
</tr>
<tr>
<td>Thursday</td>
<td>1:00</td>
<td>10:00</td>
<td>1</td>
<td>10</td>
<td>2 (1+1)</td>
</tr>
<tr>
<td>Friday</td>
<td>2:00</td>
<td>11:00</td>
<td>2</td>
<td>11</td>
<td>4 (2+2)</td>
</tr>
</tbody>
</table>

Average: 0
Total: 9

Figure 2: Average Activity vs. Total Sleep Variability. The red dots and line represent the correlation for non-athletes and the blue dots and line represent the non-athlete group. Correlation coefficients were .011 for athletes, -.193 for non-athletes, and -.135 overall.
Figure 3: Average Study Time vs. Total Sleep Variability. Correlation coefficients of -.329 for athletes (p=.136), -.459 for non-athletes (p=.0778), and -.317 overall (p=.065).

Figure 4: Average Exercise Time vs. Total Sleep Variability. The overall correlation coefficient was -.014, the correlation coefficient for athletes was -.400, and the correlation coefficient for non-athletes was .699.

Figure 5: Gender and Activities vs. Total Sleep Variability. The P-value between males and females was .692, the P-value between females athletes and non-athletes was .843, and the P-value between male athletes and non-athletes was .00992.