THE RELATIONSHIP BETWEEN SLEEP AND BMI IN CAL POLY FRESHMAN

A Senior Project submitted in partial fulfillment of the requirements for the Bachelor of Science Degree in Psychology

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I would like to acknowledge Dr. Freberg, Dr. Nazmi, and Dr. Selby for all of their help with my senior project. You help and guidance was invaluable, and this project has been a wonderful learning experience.

Sincerely,

JR

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Abstract

To understand the relationship between BMI and sleep patterns in Cal Poly Freshman (First years) over the course of their first year at Cal Poly. First year students were recruited via campus email to fill out a survey regarding various health aspects. The survey was filled out at the beginning of the year (Fall 2009), and again in June (Spring 2010). The questions used in this study only pertained to height, weight, sleep quantity, and sleep quantity satisfaction rating. The results were not significant for the cross sectional analysis of the Fall 2009 sample and the Spring 2010 sample. The longitudinal results were also not significant. There was no association between BMI and hours slept per night in Cal Poly first year students. There was a 4% increase in students that were overweight or obese from Fall to Spring, however, indicating that there may be other factors indicating to the students weight gain.

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CHAPTER ONE: INTRODUCTION

In contemporary America, 70 percent of adults are overweight and more than a third are obese (Center for Disease Control [CDC], 2009). The most common way to assess overweight/obesity is to calculate body mass index (BMI), which is equal to weight divided by height squared. BMI, a measure of proportionality, provides a reliable indicator of body fatness for most people and is used to screen for weight categories that may lead to health problems (CDC). The ideal BMI in adults is 18.5-24.9 kg/m². A BMI over 25 kg/m² is considered overweight, and a BMI over 30 kg/m² is considered obese. There has been a significant amount of research done on the distribution of BMI in the United States, but here has not been significant research on specific groups of the population. In particular, there is not a great deal of research on post-adolescent groups college age groups (18- 24 years old) and obesity. If there was research on post- adolescent obesity, it would make it easier for researchers to understand the determinates of obesity later in life (Hedley & Ogden, 2004). In particular, the transition to college can affect a young adult's weight significantly-- the "freshman fifteen" is more of a reality than urban myth. During a student's first year in college, studies have found that on average female students gain 7.6 pounds, and males gain 8.0 pounds (Economos, Hildebrant & Hyatt, 2008). This significant weight gain can arise from a variety of reasons: lack of exercise, excess calorie intake, increased alcohol consumption, elevated stress levels, and irregular sleeping patterns (Economos et al., 2008).

Adolescents who do not get enough sleep report being more tired during the day, have difficulty paying attention, receive lower grades, experience increases in stress,

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and have difficulty getting along with others (Noland, Price, Dake, & Telljohann, 2009). Students are getting significantly less sleep now than they did in previous decades. In 1966, college students were getting on average 7.75 hours a night, but in 2001 college students reported 6.65 hours (Hicks, Fernandez, & Pellegrini, 2001). Most adolescents need nine or more hours of sleep each night; while adults need seven to eight hours per night for optimum daytime functioning (Wolfson & Carskadon, 1998). This decrease is alarming because students are not getting nearly as much sleep as they need to properly function during the day.

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Many studies have found a relationship between sleep patterns and weight, but there is not a consensus on whether or not sleep is causally related to increased BMI. Poor sleepers were also shown to have significantly more problems with uncontrolled eating patterns as compared to their 'normal sleeper' counterparts (Shoff, Nuss, Horacek, Boyle, Lohse, Patterson, Krall, White, Matthews, Schembre, & Greene, 2009). However, a cross sectional and longitudinal analysis that measured sleep patterns and BMI did not find an increase in BMI over a five-year period in poor sleepers (Lauderdale, Knutson, Rathouz, Linjing, Hulley, Liu, 2009). The subjects were getting 6.1 hours per night on average, which is below the recommended daily amount. More research within the college and post- adolescent population needs to be conducted looking into a potential relationship between sleep and BMI in order to understand how sleep habits effect BMI and overall health. This literature review aims to discuss BMI, sleep, and the potential causal relationship between sleep and BMI in college students.

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CHAPTER TWO: LITERATURE REVIEW

Body Mass Index in College Students:

Body Mass Index is a number calculated from a person's weight and height. BMI provides a reliable indicator of body fatness for most people and is used to screen for weight categories that may lead to health problems (CDC). A normal BMI ranges from 18.5- 24.9 kg/m^2 (Melnick, 2010). In the United States, 70 percent of adults are overweight-- BMI over 25 kg/m^2, and more than a third are obese-- BMI over 30 kg/m^2 . BMI in Americans does vary from state to state, by ethnicity, gender, age, and socioeconomic status (National Center for Health Statistics, 2011).

In college populations, the average BMI is lower than the national average for adults in general. Shirley Haberman and Deborah Luffy (1998) explored the nutritional health behaviors of students at a large university. They used a questionnaire to gather data on 302 students. Eight percent of college students surveyed were categorized as being overweight, which is significantly lower than the national average. Marjorie Freedman (2010) investigated how BMI relates to gender, residence, and ethnicity. Her study used an online survey to gather data about the participants, including their height, weight, consumption of fruits and vegetables, dieting, and exercise patterns. Surveys were issued to all Freshman (N= 3260), and N=756 were returned. The results were broken down by race: 70 percent of White students were normal weight, and 22 percent were overweight. In the Asian population, 70 percent were normal weight, 20 percent were overweight, and 10 percent were underweight. In the Hispanic group, 56 percent were normal weight, and 40 percent were overweight. Overall, 19 percent of the student population reported being overweight.

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There is a stereotype in America that when students go to college they gain the "freshman fifteen." In other words, it is urban legend that when someone goes to college, they gain fifteen pounds. Economos et. al. (2008) examined the impact of stress and health related behaviors on freshman weight gain. They surveyed 396 freshmen upon entry at the university, and they conducted a follow up at the end of the year to detect any differences. They reported that after a year the average freshman weight change was 5.04 pounds for males and 5.49 pounds for females. However, they attributed the weight gain to different lifestyle choices in males and females. Male weight gain was related to increased alcohol consumption (P=0.014), and weight gain was associated with increased workload in females (P=<0.001).

In a similar study at Cornell University, researchers monitored the weight gain of freshman during their first twelve weeks of college. A total of sixty students were weighed during their first week of college, and again twelve weeks later. The subjects gained 1.9- 2.4 kilograms (4.19- 5.29 pounds) in the first twelve weeks of school. The authors conducted two multiple regression models to explain the weight gain, and attribute it to a variety of factors. This amount of weight a student gains can be attributed to a number of factors: 58 percent of the total variance can be attributed to access to healthy food in dining halls, but the other 42 percent can be attributed to other factors, such as, initial weight (2 percent), recent dieting (9 percent), and lastly, sleep (4 percent) (Levitsky, 2006).

Sleep in College Students:

Sleep is an integral part of life, and everyone needs a certain amount of hours of sleep per night. Most adolescents need nine or more hours of sleep each night, while adults only need seven to nine hours per night. The differences in amount of hours sleeping has to do with where a person is developmentally, and how many minutes of REM sleep they need each night. College students are in a period called "emerging adulthood." They are not adolescents, nor are they adults. Thus, they need about seven to nine hours of sleep per night dependent upon year in school and where they are developmentally (Wolfson & Carskadon, 1998).

However, most college students do not get enough sleep. A longitudinal study by Hicks et al. (2001) tracked the changing sleep habits of university students. The researchers surveyed 9, 543 students over the course of three decades. Students are getting significantly less sleep now than in previous decades. In 1969, the average student got 7.75 hours of sleep per night, which is within the recommended daily amount. However, in 2001, students reported getting 6.65 hours of sleep per night, which is below the recommended amount. Sleep behaviors and patterns have been more extensively studied in adolescent populations. Three separate samples from high schools in the Midwest (Noland et al., 2009), with 384 high school students completing a sleep survey. The students who reported an additional hour of sleep each night also reported higher attendance rates, less sleeping in class, and less student reported depression.

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Not only does the amount of sleep affect a student's ability to function properly, but their sleeping patterns can also have an effect. The hallmark signals of a typical sleeping pattern is the ability to fall asleep easily, not waking up more than once in the middle of the night, and not being tired during the day (Pertucci, 2007). Lund, Reider, Whiting, and Prichard (2009) attempted to predict and characterize the sleep patterns in a large population of college students. They surveyed 1125 students (aged 17-24 years old) with an online survey. Overall, the students reported restricted sleep, irregular sleeping patterns, and irregular sleep/ wake patterns. Both irregular sleep patterns and sleep/wake patterns occur at alarming levels in the college population—much high than adolescent or adult patterns. Sixty percent were characterized as "poor quality sleepers". (The participants were characterized as poor quality sleepers by their score on the Pittsburgh Sleep Quality Index (PSQI Score >8)). Poor quality sleepers are more likely to express emotional and academic stress, which leads to negatively affected sleep. The stress-negative sleep pattern is circular, with one feeding the other.

Forquer, Cambden, Gabriau, and Johnson (2008) studied the sleep patterns of students at a public university. They emailed surveys to students, and had 313 participants. Students reported that they had difficulty sleeping: 33 percent of the students took longer than thirty minutes to fall asleep, 43 percent woke more than once nightly, and more than 33 percent reported being tired during the day. The researchers concluded that students have trouble sleeping, which may interfere with their daily performance, including driving a car and academics. Other factors that could be associated with a lack of sleep include moodiness, trouble interacting with others, stress, and weight gain.

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Many studies show a relationship between amount (too much or too little) of sleep and increased BMI. Obesity as a function of sleep deprivation was the topic of a longitudinal study with data from a follow up exam that the National Health and Nutrition Examination Survey (NHANES) gathered in 1982-1984, 1987, and 1992 (Gangwisch, Malaspina, Borden-Albala, & Heymsfield, 2005). (The original, or baseline, measurements were taken in 1971-1975.) There were 9588 participants in the 1982-1984 data set, 8073 participants in the 1987 data set, and 6981 participants in the 1992 data set. Cross-sectional analyses were conducted using the actual measured body weight obtained from the 1982-1984. Follow-up, and longitudinal analyses were performed using the self-reported body weight obtained from the 1987 and 1992 follow-ups. Change in BMI over the follow-up period was computed by subtracting the subjects' BMI in 1982- 1984 from their BMI at the end of the follow-up period in 1992. BMI was dichotomized between obese (BMI ≥ 30) and nonobese (BMI < 30) for logistical regression analyses and retained as a continuous variable for linear regression analyses. There were several controlled variables: depression, physical activity, education, ethnicity, alcohol consumption, cigarette smoking, sex, waking during the night, daytime sleepiness, and age. "In the 1982-1984, 1987, and 1992 logistic regression models, among those with sleep durations less seven hours, as their sleep durations decreased, their likelihood of being obese progressively increased. Subjects who got two to four hours of sleep per night at baseline gained the most weight over the follow-up period, while subjects who got ten or more hours of sleep gained the least weight" (p. 1295). The results are best expressed in Figure One below. The study showed a relationship between self-reported sleep duration and self-reported BMI. The

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researchers were quick to point out that the data are twenty years old, and that obesity rates were only 19 percent when the data were gathered. In the 1999-2000 NAHANES the obesity rate was 30 percent. The increased rate of obesity in the two decades that the data were collected can be attributed to a number of outside factors, including the changing lifestyles of a typical American. With the advent of technology and societal shifts, the correlation between obesity and sleep duration may even be stronger. Americans may be letting technology interfere with their sleeping and exercise patterns more than ever because of the ease of access to technology. Figure One shows the results of BMI and sleep hours of the participants in this study.

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Figure One. Average BMI and Sleep hours reported (Gangwsich et al., 2005)

In another study the researchers' objective was to "test the hypothesis that short sleep duration is associated with obesity and weight gain during young adulthood" (Hasler, Buysse, Klaghofer, Gamma, Ajdacic, Eich, Rossler & Angst, 2004, p. 661). The sample consisted of 496 participants who were interviewed in 1986, 1988, 1993,

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and 1999. Four interviews were conducted, and 62.5% of subjects participated in all four, 77.4% participated in three, and 90.9% participated in at least two. Data from all interviews was included. The results showed a string association between short sleep duration (>6 hours) and obesity. Figure Two below illustrates this point.

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Figure Two. BMI and Sleep Duration (Hasler et al., 2004)

However, no association between sleep duration and BMI was observed after the age of 34 years. The association between sleep and BMI appeared exclusively in young adults. There is no explanation for why the association only appears in young adults.

However, not all studies that researched a link between sleep and BMI found a positive association. The CARDIA Sleep Study (Lauderdale et al., 2009) published an article about the longitudinal and cross-sectional associations between BMI and sleep duration. They criticized other studies that relied on self-reported measures, and their study (which actually measured sleep duration, instead of relying on self reported measures) found associations for cross sectional measures, but not longitudinal measures. In the cross sectional data, there was an association found between long or short sleep duration and increased BMI. This is best shown in the *Figure Three* below.

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Figure Three. BMI and sleep hours categorized by sex and race (Lauderdale, et al. 2009)

The average weight gain over five years was (4.5 kg) 9.92 pounds, with a standard deviation of 38.3 pounds. The researchers found subjects with less education gained more weight. Overall, the association between sleep and BMI was found in cross sectional analyses only, not in the longitudinal data. Furthermore, they found that, "Sleep duration did not significantly predict change in BMI over 8-10 years" (p. 813). It is not clear why there is such a strong cross sectional association, and why there is no association for longitudinal data.

This research is imperative because it highlights one of the main modifiable risk factors for obesity—sleep. In Hasler et. al.'s study (2005), *The Association Between Short Sleep and Obesity in Young Adults: a 13-Year Prospective Study*, the researchers point out that sleep is a potentially modifiable risk factor for obesity. Furthermore, that obesity prevention early in life as a way to prevent later health problems. This research shows the importance of understanding good sleep hygiene.

Noland et al., (2009), describes good sleep hygiene as, "ensuring regular bedtimes and rise times, limiting napping during the day, avoid lying in bed waiting to fall asleep, winding down before bed, being relaxed, restricting caffeine and nicotine throught the day, avoiding alcohol and sleep aids, and providing a favorable sleep environment. A favorable sleep environment is one free of excessive noise or light, extreme temperatures, pets, and even a bed partner. Other disruptions to sleep environment include activities that may take place in bed such as watching television, eating, working on schoolwork, or talking on the phone" (p. 229) Furthermore, good sleep hygiene is effective to avoid obesity. The reduced sleep- stress-weight gain cycle is demonstrated below.

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Figure Four. Chart demonstrating the Sleep-Stress-Weight Gain Cycle (Lauderdale et al. 2009).

The main limitations of the current research is that it completely leaves out the college aged population, and even emerging adulthood. Although the college population is not a representative sample of emerging adulthood or young adults, it would be a convenient sample to start from, and could provide insight into how different lifestyles affect sleep and BMI. This age group is distinct in its sleeping patterns, and BMI patterns, but it is not significantly researched. Without that data, researchers cannot make any implications about how college lifestyle affects the relationship between sleep and BMI.

The implications of the future research in sleep and obesity in college students is that researchers will have more information to refer to when understanding the determinants of obesity. Furthermore, there would be more information about the unique lifestyle of college students. Emerging adulthood is a time in which a lot of habits are formed that carry into adulthood. Without any data from this period, a huge piece of the puzzle on adulthood obesity is missing. There is a possible relationship between sleep and BMI in the American population. This relationship has been heavily researched in adolescent and adult populations, but the emerging adulthood and college populations have been left out of the research. This is interesting because the health habits acquired in college are generally precursors to habits in adulthood. One of the ways an individual can increase or decrease their relative BMI is through getting adequate sleep each night (Lauderdale et al, 2004; Lund et al., 2009; Noland et al., 2009). This study aims to investigate the role sleep plays in the BMI of Cal Poly freshman.

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CHAPTER THREE: METHODS

Participants:

The participants were freshman at California Polytechnic State University in San Luis Obispo, California. The participants received an email in the Fall of 2009 with a link to the FLASH survey. The Cal Poly FLASH Study is a large-scale study, which aims to investigate the behavioral correlates of obesity in a college setting (Nazmi, 2011). Of the 3,908 freshman invited to participate, 1,520 (39 percent) agreed to participate, and 1322 (87 percent of those who agreed to participate) fully completed the survey for an overall completion rate of 33.8 percent. There was a follow up survey in Spring of 2010, and 696 students returned for the follow up.

Measures:

Participants completed a survey of 121 questions that included self-reported height, weight, hours of sleep slept per night, and ratings of their sleep quatity.

The BMI measure was computed with the self reported weight and height. (BMI is calculated by converting the pounds to kilograms, and the height to meters. BMI is kilograms over meters squared.) BMI was treated as a categorical and continuous variable. To create a categorical variable for BMI two groups were made: an overweight and obese group (BMI over 24.9 kg/m²), and a normal weight and underweight group (BMI under 24.9 kg/m²). BMI was treated as a dichotomous categorical variable for certain analyses. The continuous version of the BMI variable was not altered.

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Purpose: To understand the relationship between BMI and sleep patterns in Cal Poly Freshman (First years) over the course of their first year at Cal Poly.¶

Method: First year students were recruited via campus email to fill out a survey regarding various health aspects. The survey was filled out at the beginning of the year (Fall 2009), and again in June (Spring 2010). The questions used in this study only pertained to height, weight, sleep quantity, and sleep quantity satisfaction rating.¶

Results: The results were non significant for the cross sectional analysis of the Fall 2009 sample and the Spring 2010 sample. The longitudinal results were also non significant. ¶

Conclusions: There was no association between BMI and hours slept per night in Cal Poly first year students. There was a 4% increase in students that were overweight or obese from Fall to Spring, however, indicating that there may be other factors indicating to the students weight gain. ¶

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The 'sleep hours' variable was combined from two separate questions on the survey. There were two questions that related to number of hours slept: one that asked how many hours were slept on the weekdays, and number of hours slept on the weekends. The two questions were combined through a formula-- weekend hours x 2 + weeknight hours x 5. (The 2 and 5 represent the number of days in that period. The weekend has 2 days, and the weeknight has 5 days.) A continuous sleep hours variable was calculated in this manner. To create a categorical variable, the total hours slept were divided in to even tertiles. The first tertile ranged from 2-6.2 hours, the second tertile ranged from 6.2-7.8 hours, the third teritile ranged from 7.8-13 hours.

The sleep quantity measure was derived from a question that required the participants to rank, on a scale of 1-5, their sleep quantity. A score of '1' indicated very low satisfaction with their sleep quantity, and a score of '5' indicated very high satisfaction with the quantity of hours they slept each night.

Statistical Analysis:

Data were analyzed using SPSS for Windows statistical software. Descriptive statistics (mean, standard deviation (SD)) were used to investigate hours slept, sleep quality, and BMI over the course of the school year. In addition to the descriptive statistics, Analysis of Variance, Cross-Tabulations, and Chi Squares were also conducted to investigate a possible relationship between sleep and BMI in this sample.

The 'sleep hours' and 'BMI' variables were altered to be both continuous and categorical to allow for multiple statistical tests to be completed. Both variables were used in Analysis of Variance, Cross-Tabulation, and Chi-Square analyses. Each analysis was conducted twice: once for the Fall 2009 data, and once for the Spring 2010 data.

Analyses of variance were used to investigate univariate associations betweens hours slept per night, sleep quantity rating, and BMI. The continuous versions of the 'sleep hours' and 'BMI' variables were used to complete the analyses of variance. Cross-tabulations and chi- square analyses were used to examine the potential relationship between sleep and BMI as well.

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Deleted: The categorical variables were created by grouping. The BMI variable was dichotomous: underweight/ normal were grouped into one variable, and overweight/ obese was grouped as another. The sleep variable was divided into even tertiles by number of respondents. The sleep quantity rating was a categorical variable to begin with: a ranking of 1-5 on sleep quantity.

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CHAPTER FOUR: RESULTS

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In the Fall of 2009, the mean BMI for the Cal Poly freshman was 22.17 kg/m² (SD= 3.3331), and 16 percent of the Cal Poly freshman reported a BMI over 24.9 kg/m².

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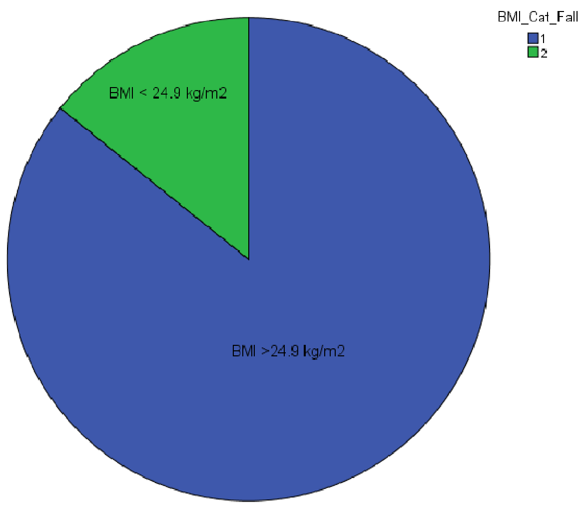

Figure One. Pie Chat demonstrating the percentage of Cal Poly Freshman in the Normal/ Underweight category, and in the Overweight/Obese category.

The mean reported sleep hours was 7.52 (SD= 1.152) hours of sleep per night, and the mean self-reported sleep quality rating was 3.12 (SD=3.12) (1= very bad, 3= 'average', and 5= excellent on the survey).

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In the follow up survey that was taken in the Spring of 2010, the mean BMI was 22.61 (SD=4.316). However, 21% of students had a BMI over 24.9 kg/m2, which is a 4 percent increase in total number of participants with a BMI over 24.0 kg/m2 since the Fall. In the sleep hours variable, there was a slight, but non significant decrease. The average was 7.5 (SD=1.054) hours per night. The sleep quantity rating was 3.12 (SD=.935), which showed a slight, but non significant increase in sleep quantity satisfaction over the course of the school year.

Chi square and Cross Tabulations were conducted to test any possible correlations between sleep and BMI in each sample. In the Fall 2009 sample, there was no association found between hours slept per night and BMI (X^2 = 4.802, d.f. =2, *p*= .091).

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The Sleep variable was broken down into groups. Group one slept the least amount of hours, group two is the middle teritle, and group three slept the most. The three sleep groups are evenly distributed, but the BMI variable is not. Group one is underweight/ normal weight, and group two is the overweight/obese category. The overweight/obese BMI group (group two) had the fewest participants in the ideal sleep group (group two). The majority of the participants were in the Sleep teritle one, which means they received the least amount of sleep. However, the difference between the different groups was not significant.

To test the Spring sample, a Chi-square was also completed. In the analysis from the Spring data, no association was found between hours slept and BMI (X^2 = 2.491, d.f. =2, *p*= .288).

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It is important to note that the total number in the overweight/obese BMI (group two) increased by twenty participants even though the overall sample total decreased by sixteen participants. Furthermore, more participants in the overweight/obese group fell in the lowest sleep category. (Underweight/normal participants fell in the third tertile of sleep—they sleep longer than their overweight/obese counterparts.) However, the results were not statistically significant.

Analyses of Variance were also conducted to further explore the relationship between sleep hours and BMI. The variables used were slightly different for the ANOVA analysis. The continuous versions of each variable were used. A Test of Homogenity of variances was used, and Robust Test of equality of means was conducted. The results showed no significance for the Fall sample (F (4, 722)= .305, p=.874).

To test the follow-up Spring data, Analyses of Variance were conducted to further explore the possibility of a relationship between sleep hours and BMI with that data set. There were no statistically significant results found in the Analyses of Variance for the Spring data (F (2, 690)= .897, p=.408).

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CHAPTER FIVE: DISCUSSION

This study is one of the only to present data on the relationships between sleep and BMI in college students over the course of the school year in a large sample. The findings demonstrated that there was no relationship between sleep hours, rating of sleep quantity and BMI in the Cal Poly freshman population, which is surprising because other research would predict the contrary. Although there was an increase in BMI over the school year (the percentage of overweight and obese students rose 4% from fall to spring), there was no significant decrease in the number of hours slept per night (.02 hours per night average decrease). The sleep quantity satisfaction rating actually increased.

These results were surprising. All the previous studies reported that sleep and BMI are linked, in perhaps a cyclical way: sleep adds to increase food intake, which leads to increased stress, the increased stress leads to less sleep and increased food intake, which all contributes to weight gain.

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Figure Two. Chart demonstrating the Sleep-Stress-Weight Gain Cycle (Lauderdale et al., 2009).

Previous research had shown a cross sectional link between sleep and BMI (Lauderdale et al. 2009), but has failed to establish a longitudinal association, which was one of the aims of this study. There was no cross sectional or longitudinal association in this data.

The lack of significance begs the question: Why is the Cal Poly freshman population immune to this association? There are a few main reasons: they may have lied about their weight, they may be ignorant of their weight change or starting weight (guessing), and other underlying issues contributing to their BMI.

Limitations:

There were some initial issues with the way the data was collected. All data were self reported, which can be a problem when reporting on something that has a social stigma like weight. The participants could have lied about their weight because they are ashamed. They also could have lied about their follow up weight.

Another issue with the self-reporting of the sample was that students may not have had access to a scale to weigh themselves throughout the course of the school year. The Cal Poly Recreation Center and Gym is one of the only places for students living on campus to weigh themselves (unless they brought their own scale). The location of the scale in the gym poses a paradox for collecting the correct weight for students at the end of the year—the students who go to the gym regularly probably have not gained as much weight as the students who do not go to the gym frequently. Furthermore, the Recreation Center and Gym was (and still is) experiencing ongoing renovations which make a scale even harder to access. In past years, the scale was in the locker room, but at the time of the study, the only scale was on the gym floor. Embarrassment of initial weight or potential weight gain could potentially hinder a participant from weighing themselves on the gym floor. The participants at the follow up survey may have not had the opportunity to weigh themselves over the year, and thus relied on the last time that they weighed themselves.

Another potential reason for the insignificant results are other contributing factors to weight stabilization. The majority of students surveyed reported getting the recommended amount of sleep (seven to eight hours per night), and there are lower incidences of obesity in the Cal Poly population than there is nationally. Previous studies had cited different reasons for weight gain in males and females. In females, weight gain was attributed to increased stress, and in males weight gain was attributed to increased alcohol consumption (Economos et al., 2009). Both of those factors were not examined in this study, but they could potentially have contributed to the 4% increase in percentage of overweight and obesity over the school year.

Lastly, the demographics of Cal Poly are slightly unique. There is a higher percentage of White and Asian students (80.1% of first year students) than compared to other CSU's, and lower percentages of Blacks and Latinos (14.2%). This is significant because generally incidence of overweight and obesity is much lower in White and Asian populations than in Black and Latino groups (Freedman, 2010). In addition to the lack of racial diversity, Cal Poly also has a higher than average socioeconomic status, as compared to other college campuses. Incidence of overweight and obesity is also sensitive to socioeconomic status, and since there is not a lot of variability in this sample, it could have affected the results. The lack of diversity within the sample could have contributed to the lack of association between sleep and BMI.

Directions for Future Research:

One of the possible directions for future research would be to use a college freshman sample that was measured, rather than self reported for weight, height, and hours slept per night. Furthermore, a longitudinal analysis of participants BMI and sleep habits over the course of college would be beneficial to understand how those habits change throughout emerging adulthood.

Another aspect that should be researched is the other possible factors that contribute to a student's BMI during their college years. Economos et al., researched the differences in weight change by gender, and sleep was not a factor for either sex. Race, socioeconomic status, housing status (dorm, apartment, house, fraternity/sorority house, etc), major, stress, caffeine consumption, jobs, exercise, nicotine usage, club involvement, alcohol consumption, use of hormonal birth control (in females), and campus food choices should also be considered in future research, in addition to sleep.

References

Carskadon, M. A., & Wolfson, A. R. (1998). Adolescent sleep patterns, circadian timing, and sleepiness at a transition to early school days. *Journal of Sleep, 15(5),* 881-887.

Center for Disease Control and Prevention (2011). About BMI for adults. Retrieved on [2011] from http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html

Economos, C. D. (2008). College freshman stress and weight change: differences by gender. *American Journal or Health Behavior, 32(1),* 16-25.

Forquer, L. M., Camden, A. E., Gabriau, K. M., & Johnson, C. M. (2008). Sleep patterns of college students at a public university. *Journal of American College Health, 56*(5), 563-565.

Freedman, M. R. (2010). Gender, residence and ethnicity affect freshman bmi and dietary habits. *American Journal of Health Behavior, 34*(5), 513-524.

Gangwisch, JE, Malaspina, D, & Boden-Albala, B. (2005). Inadequate sleep as a risk factor for obesity: analyses of the nhanes i. *Journal of Sleep, 28(10),* 1289-1296.

Habberman, S, & Luffey, D. (1998). Weighing in college students diet and exercise behaviors. *Journal of American College Health, 46(4),* 189-192.

Hasler, G, Buysse, DJ, Klaghofer, R, Gamma, A, & Ajdacic, V. (2004). The association between short sleep duration and obesity in young adults: a 13-year prospective study. *Sleep Journal, 27(4),* 661-666.

Hicks, R, Fernandez, C, & Pellegrini, R. (2001). The changing sleep

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habits of university students: an update. *Perceptual and Motor Skills, 93,* 648-649.

Hedley, AA, Ogden, CL, & Johnson, CL. (2004). Prevalence of overweight and obesity among u.s. children, adolescents, and adults, 1999–2002. *JAMA, 291(23),* 2847-2850

Lauderdale, DS, Knutson, KL, Rathouz, PJ, & Hulley, SB. (2009). Cross-sectional and longitudinal associations between objectively measured sleep duration and body mass index . *American Journal of Epidemiology, 170(7),* 805-813.

Levitsky, DA, Garay, J, Nausbaum, M, & Neighbors, L. (2006). Monitoring weight daily blocks the freshman weight gain: a model for combating the epidemic of obesity. *International Journal of Obesity, 30,* 1003-1010.

Lund, HG, Reider, BD, Whiting, AB, & Prichard, JR. (2009). Sleep patterns and predictors of disturbed sleep in a large population of college students. *Journal of Adolescent Health*, 1-9.

Lytle, LA, Pasch, KE, & Farbakhsh, K. (2011). The relationship between sleep and weight in a sample of adolescents. *Behavior and Psychology*, 19(2), 324-331.

Melnick, MA. (2010, December 3). What's the ideal bmi for longevity?. *Time Magazine*, Retrieved on [2011] from http://healthland.time.com/2010/12/03/whats-the-ideal-bmi-for-longevity/

Nazmi, A. (2011, April 5). Personal communication.

Noland, H, Price, JH, Dake, J, & Telljohann, SK. (2009). Adolescents sleep behaviors and perceptions of sleep . *Journal of School Health, 79(5),* 224-230.

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Petrucci, GL. (2007). Sleep loss as a risk factor for obesity. *Bariatric Nursing and Surgical Patient Care, 2(3)*, 185-188.

Schoff, S, & Noss, E. (2009). Sleep quality is associated with eating behavior in 18-24 year old college students. *Journal of Nutrition Education and Behavior, 41(4S)*, 333-335

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Table One is the SPSS output from the Chi-square analysis:

Table One

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.802[a]	2	.091
Likelihood Ratio	4.733	2	.094
Linear-by-Linear Association	1.710	1	.191
N of Valid Cases	712		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 31.25.

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Table Two

Sleep_Cat_Fall * BMI_Cat_Fall Crosstabulation

Count

		BMI_Cat_Fall		Total
		1	2	
Sleep_Cat_Fall	1	176	40	216
	2	218	28	246
	3	215	35	250
Total		609	103	712

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Table Three

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.491[a]	2	.288
Likelihood Ratio	2.503	2	.286
Linear-by-Linear Association	.619	1	.432
N of Valid Cases	696		

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 39.41.

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Table Four

Sleep_Cat_Spring * BMI_Cat_Spring Crosstabulation

Count

BMI_Cat_Spring

		1	2	
Sleep_Cat_Spring	1	187	48	235
	2	190	33	223
	3	196	42	238
Total		573	123	696

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Table Five is the descriptive statistics of the Fall sample BMI.

Table Five

BMI_Fall

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	95% Confidence Interval for Mean Upper Bound	Minimum	Maximum
1	26	21.58	2.221	.436	20.69	22.48	17	27
2	182	22.10	3.713	.275	21.55	22.64	2	38
3	291	22.16	3.046	.179	21.81	22.51	16	38
4	168	22.29	3.257	.251	21.80	22.79	16	33
5	56	22.24	2.660	.355	21.52	22.95	17	33
Total	723	22.16	3.219	.120	21.92	22.39	2	38

A Test of Homogenity of variances was used, and and ANOVA and Robust Test of equality of means was conducted. The following tables (*Table Six, Seven, and Eight*) are the outputs from those various tests.

Table Six

Test of Homogeneity of Variances

BMI_Fall

Levene Statistic	df1	df2	Sig.
2.277	4	718	.060

Table Seven

ANOVA

BMI_Fall

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12.705	4	3.176	.305	.874

Within Groups	7469.491	718	10.403		
Total	7482.196	722			

Table Eight
Robust Tests of Equality of Means

BMI_Fall

	Statistic[a]	df1	df2	Sig.
Welch	.521	4	139.130	.721

a. Asymptotically F distributed.

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Table Nine
ANOVA

BMI_Spring

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	30.535	2	15.267	.897	.408
Within Groups	11711.646	688	17.023		
Total	11742.181	690			