12-2016

Investigating the Relationship Among Sleep, Stress, and Body Mass Index in At-risk First-year College Students

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INVESTIGATING THE RELATIONSHIP AMONG SLEEP, STRESS, AND BODY MASS INDEX IN AT-RISK FIRST-YEAR COLLEGE STUDENTS

By

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B.S. University of Maine, 2015

A THESIS

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Master of Science

(in Food Science and Human Nutrition)

The Graduate School

The University of Maine

December 2016

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INVESTIGATING THE RELATIONSHIP AMONG

SLEEP, STRESS, AND BODY MASS INDEX

IN AT-RISK FIRST-YEAR COLLEGE STUDENTS

By Grace A. Violette

Thesis Advisor: Dr. Adrienne A. White

An Abstract of the Thesis Presented
in Partial Fulfillment of the Requirements for the
Degree of Master of Science
(in Food Science and Human Nutrition)
December 2016

The study objective was to investigate relationships among body mass index (BMI), sleep quality/duration, and perceived stress in 1,176 first semester college students who enrolled in Get Fruved, an 8-state social marketing intervention to prevent unwanted weight gain. Research was limited to first-year college students at-risk for unwanted weight gain. Eligibility was based on self-report of inadequate fruit and vegetable intake and subjects meeting one or more health-risk criteria (e.g., high BMI). Students (mean age=18$\pm$1 years; 65% white) completed physical measurements and an online survey, including the Pittsburgh Sleep Quality Index (PSQI) (score range 0-21; >5=disordered sleep) and the Cohen Perceived Stress Scale (score range= 0 low to 56 high stress). Mean scores were 24.41$\pm$4.88 kg/m^2 (BMI), 5.94$\pm$2.68 (sleep quality), 7.05$\pm$1.29 hr sleep/night, and 26.35$\pm$6.10 (stress).

Three multiple regression models were utilized to investigate relationships among variables. The first model with BMI as the response and PSQI, gender, and

their interaction as predictors was found to be significant over the null model ($F(3,1046) = 5.27$, $p=0.001$). There was a significant interaction ($\beta=0.345$, $t(1046)=3.49$, $p=0.001$) which was in males, as PSQI increased by 1.0 point, mean BMI decreased by 0.19 kg/m^2, and in females, as PSQI increased 1.0 point, mean BMI increased by 0.21 kg/m^2. Cohen's f^2 for this model was 0.013, indicating very weak effect on BMI.

A second model using BMI as the response and stress, sex, and their interaction as predictors was not found to be significant over the null model ($F(3,1045)=0.402$, $p=0.751$). Further investigation using the additive model (with no interaction) was also not significant ($F(2,1046)=0.402$, $p=0.573$).

The third model using stress as the response and duration, sex, and their interaction was found to be significant over the null model ($F(3, 1064)=22.4$, $p<0.001$), but there was no significant interaction ($\beta = -0.268$, $t(1064)= -0.827$, $p=0.408$). The additive model (with no interaction) was still found to be significant (($F(2,1065)=33.2$, $p<0.001$)). After controlling for sex, for every hour of increased sleep duration, perceived stress decreased by 0.61 on average ($t(1065)=-4.04$, $p<0.001$). For a given sleep duration, females were about 3 points higher ($\beta=2.85$, $t(1065)=7.40$, $p<0.001$) on perceived stress compared to males; Cohen's $f^2=0.062$, indicating a weak to moderate effect on stress.

Factors with small effects on weight gain may work synergistically, helping to explain triggers for obesity. Further investigation of these sex differences is needed to explore negative college lifestyle behavior. Sex-specific campus environmental

changes may be warranted to support healthful sleep and reduce stress for students, especially for those considered at-risk for unwanted weight gain.

ACKNOWLEDGEMENTS

Reflecting on the creation of this thesis, I realize that many wonderful people have supported this process: family, friends, colleagues, and the members of my thesis committee. First and foremost, I would like to specifically thank Dr. Adrienne White, who has been my advisor for many years and guided me through the completion of this project with the utmost patience and dedication. I am also grateful for the insight provided by my thesis committee, Mrs. Kate Yerxa, Dr. Susan Sullivan and Dr. Mona Therrien. Thank you all for being amazing professors and inspiring me in the classroom. I would like to acknowledge the researchers from the other universities who collected the data, for without them and their hours of hard work, this project would not have been possible.

I deeply appreciate those in Dr. White's Lab and my fellow graduate students, who helped me during both the data collection process, and throughout the writing process. All of your encouragement, cheer, (and snacks) helped me though all those tough times. I would like to offer a special thanks to my parents, siblings, and extended family for offering me encouragement and support. Thank you, Mom and Dad, for being such great role models, and pushing me to be the best person I can be, both in and out of the classroom. Finally, a special thanks goes to Michael, who provided me with constant support, love, and motivation during this undertaking.

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CHAPTER 1: INTRODUCTION

Young adults entering college for the first time, leave a safe environment to join a world full of brand new experiences and decisions. Unfortunately, these young college students may find themselves susceptible to many adverse health consequences. It is during this time of exploration that students are required to decide many important matters independently, such as the formation of individual health behavior patterns.[1] All too often, these choices are not monitored by parents, but are instead self-regulated or influenced by peers, which can lead to negative health consequences, such as unwanted or excessive weight gain. Students who enter college already at-risk for unwanted weight gain are of special concern.

Over the past 35 years, rates of obesity have almost doubled. The average American now weighs 24 pounds more than the average adult in 1960. While rates began to level off during 2011-2012,[2,3] recent reports indicate that 34.9% of adults and 16.9% of children (age 2 – 19) are obese.[4] With high obesity rates, Americans are at-risk for increased health complications. The negative impact of obesity on children is especially concerning. As a young person's body mass index (BMI) increases, health-related quality of life, as well as their overall health functions begins to decline.[5] An increased BMI as a child may lead to increased weight gain in adulthood. Moreover, pre-established behavioral patterns developed at a young age may contribute to the risk of being overweight or obese later in life.[6]

The causes of obesity are multi-factorial, and all contribute to the development of major health concerns.[7] Roles of sleep duration and quality, as well as the negative consequences of stress, are exceptionally noteworthy when

assessing lifestyle choices and BMI. Researchers have recently reported that the lack of sleep, as well as the negative impact of stress, may be risk factors for obesity.[8] Furthermore, a positive correlation between sleep duration and elevated risk factors for obesity has been identified in adults.[8] For example, an increase in sleep disturbances has been found to indirectly impact a person's body weight due to a reduction in the amount of one's physical activity. For each hour of lost sleep per night, American adolescents' likelihood of being obese increases by 80%.[8] Stress has also been found to have a direct, as well as in indirect, negative effect on health.[9] A higher level of stress may lead to an increase in both depression and anxiety in college students.[10]

The goal of this study was to investigate the relationship among sleep duration, sleep quality, perceived stress, and BMI in a sample of first-year college students that were at-risk for unwanted weight gain. This work was part of an 8-state intervention study called Get Fruved.[11] For this study, at-risk was defined as a self-report of not meeting recommended amounts of servings of fruits and vegetables daily, as well as at least one other screening factor such as, BMI≥25 kg/m^2, first-generation college student, minority status, lower income background, or an overweight/obese parent.[11] College students are typically considered to be at a distinctive life stage so selecting to study a subset of college students at-risk for unwanted weight gain is particularly unique.[12] The baseline data collected for Get Fruved was used to study BMI, sleep quality and duration, and perceived stress in first-year college students.

CHAPTER 2: LITERATURE REVIEW

Introduction

There are many motives to further investigate the relationship of sleep, stress, and body mass index (BMI) in college students. One of the biggest reasons is that sleep quality, as well as the amount, plays a role in overall development, in addition to cognition, behavior, and alertness.[13] Stress for a college student encompasses rigorous academic workloads, new environments, dormitory roommates, and responsibilities. It has also been found that stress has a direct, as well as in indirect, negative effect on health.[9] In the last few decades, there has been a large demographic shift towards enrolling in postsecondary education and the delay of marriage and childbearing.[12] The time spent at a college of choice leads to the development of long-term health behavior patterns. Literature reviews of the Pittsburg Sleep Quality Index and Cohen's Perceived Stress Scale are typically used when researching sleep and stress, respectively. The following literature review includes an overview of these two instruments and includes findings from research with these instruments. This topic is relevant in that there is a great amount of stress, as well as a large amount of lack of sleep, in college students, especially those considered at-risk for weight gain.

College Students

College students, who are in a period of "emerging adulthood" (aged 18 – 25), are transitioning from adolescence to young adulthood. The term "college" is used to refer to post-secondary education, and includes both undergraduate and graduate students. This time period is when many students lose some of their support system

as they change their environment, shift interpersonal influences and move away from home. This time of exploration includes responsible decision-making, independence and the formation of individual health behavior patterns.[1] Nikolaou and colleagues found three thematic barriers to, or facilitators of, healthy lifestyles and weight: peer influence, time management and budget.[14] These themes carry through the entire college experience, and may be a substantial source of stress.

Young adults are entering a new phase where their decisions are not monitored by close family members or parents, and where they are more apt to be influenced by their peers and the social media. This environment is one where some thrive, and others struggle. According to Nelson and colleagues, the transition from adolescence to adulthood is a period where unhealthy diet and negative physical activity practices may develop; this is a time where weight gain may be excessive, physical activity may decrease and overall-diet quality may shift unfavorably.[1] Known risk factors for unhealthy weight gain include diet, stress, sleep, alcohol consumption, physical activity and sedentary behaviors.[15]

Nearly one-third of college students are considered overweight or obese.[16] Nelson and colleagues state that, on average, during the first three to four months of college, undergraduate students gain 1.5 – 6.8 pounds. This doubles the proportion of overweight or obese students by the end of the first semester. Bennett and colleagues found that, on average, students gain 11 pounds throughout their college career, with a sustained annual increase in weight.[17] This weight gain may be linked to the perceived barriers and enablers of college students trying to achieve or manage a healthful weight. Greaney and colleagues investigated college students'

barriers and enablers to managing a healthful weight, and cited intrapersonal (e.g., temptation); interpersonal (social); and environmental (e.g., time), as barriers.[18] The same theme carried for enablers such as intrapersonal (e.g., regulating food intake); interpersonal (social support); and environmental (e.g., university's environment). College students reported being more sensitive to the barriers, rather than the enablers, for weight management.

Food consumption is influenced by many factors; the stress of wanting to fit in with peers may lead to disordered eating for both males and females. Stress leads to a different response between sex: females increase food intake, while males are likely to reduce food intake.[16] The availability of buffet-style dining halls promotes frequent snacking and social pressures to eat even if not hungry. Arnold and colleagues explain eating in the absence of hunger, which is directly related to emotional eating.[16] Quick and colleagues also mention emotional eating, finding an association with both overweight/obesity and gender interaction.[19] Females who were found to be more likely to be overweight/obese may display a greater emotional eating pattern than males.

In 2010, Racette and colleagues studied weight changes, exercise and dietary patterns in both freshman and sophomore college students.[6] The study consisted of 764 student participants (53% female, 47% male), whose mean age was 19.1 ±0.3 years old. At post-test, 290 of the baseline 764 participants returned to college and were available for follow-up. In one year, body weight for these 290 participants increased for 70% (mean increase ~9 pounds), decreased for 26%, and remained the same for 3% ($p<0.001$). BMI increased among 69% of students. An inverse

correlation was found between fruit and vegetable consumption with both fried food intake and high-fat fast food intake ($p<0.001$). Aerobic exercise behavior declined as well as fruit and vegetable intake, which highlighted the inactivity of students in their early college years.

At-Risk Students

The at-risk student population is an important part of the college student population. In 2006, Bulger and Watson broadened the definition of "at-risk" students, to include not only race and class, but also background characteristics (e.g., age, socioeconomic status, disability status), environmental factors (e.g., access to support and resources) and internal characteristics (self-concept).[20] Prior to this definition, these at-risk students were only provided aid in the K-12 education system. Chen and Kaufman identified five risk factors for being at-risk which included: low socio-economic status; from a single parent family; an older sibling dropped out of school; the students themselves changed schools two or more times; had average grades of "C" or lower from sixth to eighth grade; and/or repeated a grade.[21] Though these risk factors are focused on the K-12 education system, it has been found that those identified as at-risk in high school remain at-risk in college. The Wabash National Study researched at-risk student populations in the first year of postsecondary education.[22] Results from the study investigating the effects of first-generation students indicate that these students were at a significant disadvantage, especially in terms of their psychological well-being during the first year of college.

These at-risk students are more at-risk for unwanted weight gain than the general college student population.[11] The college years are vital to developing healthy lifestyles that will continue on into adulthood. Late adolescent and young adult weight gain and having a higher BMI have been linked to overweight and obesity later in adulthood.[23] Obesity is a multifactorial disease.[24] One factor that indicates at-risk for unwanted weight gain is the inadequate intake of fruits and vegetables. Bertoia and colleagues looked at US men's and women's association between intake of specific fruits and vegetables and weight loss or gain.[25] They found that over time, an increased consumption of fruits and non-starchy vegetables had an inverse association with weight change.

The Pittsburgh Sleep Quality Index

Buysse and colleagues developed the Pittsburgh Sleep Quality Index (PSQI) in 1988, in order to provide a reliable and standardized measure of sleep quality and the factors that influence quality.[26] The objectives of the researchers when developing the PSQI were to provide a reliable, valid and standardized measure of sleep quality; to create a tool easy for subjects to use and interpret; a brief, clinically useful assessment of a variety of sleep disturbances; and to quantifiably differentiate between "good" and "poor" sleepers. This tool included nineteen self-rated questions about the individual's own sleep quality, with an additional five questions rated by the bed partner or roommate if applicable.

The PSQI tool is used to rate sleep during the previous month through individual questions. The 19 questions assess many factors which provide the basis for seven rated components, including subjective sleep quality, sleep latency, sleep

duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Sleep quality is determined by asking how quality of sleep has been over the past month. Sleep latency is determined by identifying the length of time to fall asleep each night. Sleep duration is based on the usual number of hours of actual sleep per night. Habitual sleep efficiency is based on the percent of time asleep versus the time spent in bed. Sleep disturbance is based on a variety of things that may disturb sleep, such as temperature, bad dreams or breathing problems. Use of sleeping medication is determined by asking if prescribed or over the counter medication has been used to help sleep in the past month. Daytime dysfunction is determined by asking questions such as where one has the ability to stay awake while driving, eating meals, or keeping up enough enthusiasm for various activities.

Scoring of the questionnaire takes little time, with each of the individual questions weighted equally on a scale from 0 – 3. The scores from each category are computed from the seven component scores, which are then summed to equal a global PSQI score. This global PSQI score ranges from 0 – 21. Any total score that equals greater than 5 indicates a significant sleeping disorder. The global score has a "cutoff" of 5 or above, while the scores for the seven components do not have a reported "cutoff" score.

Buysse and colleagues first tested the validity of the tool in an 18-month study period.[26] There were three groups of subjects: the control group (n=52) made up of healthy subjects consisted of "good sleepers"; the group of subjects with diagnosed sleep disorders (n=62) consisted of "poor" sleepers; the group with

depression (n=34) who also consisted of "poor" sleepers. Validity was assessed by comparing differences between groups. The control group had a mean score of 2.5 with a range from 0 – 8. The group of subjects with diagnosed sleep disorders had an average score of 9.5 with a range of 2 – 18. The group of subjects with depression had a mean score of 11 with a range from 2 – 20. When comparing the two variable groups, sleep disorders and depression to the control group of healthy subjects, the PSQI test indicated a sensitivity of 89.6% and a specificity of 86.5%. Sensitivity is the probability that someone without the condition will test negative, while the specificity is the probability that someone with the condition will test negative. The cutoff score of 5 as an indicator of sleep disorders, was accurate in identifying 88.5% (131/148) of all the subjects.

In 2014, Gelaye and colleagues researched the construct validity and factor structure of the PSQI using a cross-sectional study conducted among undergraduate students in four countries.[27] This study included 8,481 college students from Chile (n=830; mean age=21.9 years), Ethiopia (n=2,230; mean age=21.6 years), Peru (n=2,581; mean age=20.9 years) and Thailand (n=2,840; mean age=20.3 years). Research protocol was common among all sites. The researchers found similar PSQI total score patterns across four countries. The sleep quality coefficient had the largest component-total correlation in Chile (r=0.71). The sleep medication coefficient had the smallest component-total correlation in Peru (0.28). When compared to the diagnostic criteria, the PSQI had a cutoff score of 5, but did not calculate the sensitivity or specificity due to the multidimensionality of these scales across countries.

Sleep – Overall Importance

Humans, as well as almost every other species, require sleep just as much as they require food, water, and oxygen. On average, humans spend one-third of their life asleep.[28] The need for time to be asleep varies across ages, lifestyles and health. For young adults, ranging from 18 – 25 years of age, it is recommended to sleep 7 – 9 hours, with 10 – 11 hours being appropriate as well.[28] When overall quality of sleep is decreased, or the duration is reduced, the human body responds in many ways to initiate sleep. Feelings of "sleepiness" will increase and the ability to concentrate will decrease. The National Institutes of Health (NIH) has reported that sleep deficiency will increase the risk of chronic health problems over time, as well as negatively affecting brain function and emotional well-being.[29] In a longitudinal study done by Hicks and colleagues, there was a large increase in numbers of students who reported dissatisfaction with their sleep.[30] In 1978, (n=1,489), 363 reported that they were dissatisfied with their sleep. In 2000, (n=1,462), 1,031 reported that they were dissatisfied with their sleep. This indicates that the students in 2000 were 2.96 times more likely to report dissatisfaction with their sleep than the students in 1978.

In 2010, Paruthi and Chervin looked at sleep disturbances in children and how this affects their general health later in life.[13] They found that the quality of sleep, as well as the amount, plays a role in overall development, in addition to cognition, behavior and alertness. Additionally, in 2013, Short and colleagues looked at the relationship between sleep duration and quality in 386 adolescents (mean

age=15.6, SD =0.95) in a two-year range. The researchers found a negative impact on grades in school, as well as diminished alertness in school. The students were asked to fill out sleep diary reports, which entailed the total sleep time, as well as self-reporting school grades. Results of the study support the hypothesis that adolescents with poor sleep quality were more likely to report worse grades.

Sleep Patterns and Health Risk

Sleep duration and sleep quality make up a pattern that is being researched to assess the well-being of college students.[8,31,32] In regards to health risk, recent research has focused more on the role of sleep duration and sleep quality in the onset of obesity. Though the idea that caloric intake and physical activity imbalance are the two key factors for the current obesity problem, there is an emerging association between body weight and sleeping pattern disturbances.[8] Troubled sleep is also considered to be not only a predictive sign but also a symptom of many illnesses and is even associated with a decrease in the quality of life.[31] Disordered sleep impacts not only concentration, but also work and the ability to interact with others.[33]

There is often an association with increased psychological morbidity and an overall reduced quality of life.[34] Severe obesity (body mass index [BMI] ≥ 35 kg/m^2) has been found to be positively associated with increased risk of developing co-morbidities; such as cardiovascular disease, diabetes, and a decrease in life expectancy.[34,35] In 2014, Quick and colleagues looked at the association between weight status and health-related behaviors among young adult college students (n=1,252; female=737, male=515, mean age=19.2±1.2 years).[19] The Pittsburgh Sleep

Quality Index (PSQI) was used to assess sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, sleep medication use and daytime dysfunction. The results indicated that a bivariate association between weight status (healthy weight vs. overweight/obese) and sleep were significant ($p<0.05$). Also, both the global PSQI mean score and sleep latency were significantly higher in the overweight/obese group than those who were healthy. Sex and age were also significantly ($p<0.05$) associated with overweight/obese status.

Araghi and colleagues studied sleep problems in older adults (n=270; female=202, male=68, mean age of 43.4±12.4 years) associated with obesity. [34] Sleep quality and disturbances were assessed using the PSQI. The results indicated a mean BMI of ≥46.9 kg/m^2 and a mean PSQI global score of 8.6 with 74.8% of patients being poor sleepers. Higher global PSQI scores revealed a poor sleep quality, with a cutoff score of 5 or above indicating a sleep disturbance. The researchers found that poor sleep was associated with a lower quality of life score (r=-0.26) and more notably with anxiety (r=0.30); they reported that poor sleep quality was linked with mood disturbances and that individuals who were severely obese reported poor sleep quality and less sleep duration.

Ling-Ling and Sheng-Ping focused on sleep patterns in college students (n=237; female=110, male=127; age 18 - 24), and more specifically on gender differences.[32] These researchers found that gender differences begin to develop in terms of sleep disturbances in the 20s. Sleep quality and disturbances were assessed using the PSQI. Higher global PSQI scores reveal a poor sleep quality, with a cutoff score of 5 or above indicating a sleep disturbance. The researchers found that

students had an earlier rise time on weekdays rather than weekends ($p<0.001$), and a fairly consistent time in bed. Thus, they spent less time in bed ($F=123.45$, $df=1.229$,$P<0.001$), had total less sleep ($F=74.40$, $df=1.229$, $p<0.001$), and slept a shorter amount of time on weekdays as compared with weekend days. For gender differences, on weekends, women had a higher percentage of difficulties in sleep latency than in men. Sleep difficulties were also higher in women during the weekdays and weekends, when compared to men. This persistently poor sleep pattern in females, throughout the week and weekend, is linked to a reported higher level of stress in female college students.[32] This accumulated sleep debt could lead to other sleep difficulties or other health risks.

In 2013, Chen and colleagues researched the characteristics of sleep in relation to health-related quality of life.[35] There were 2,391 young adult participants aged 20 – 39 years old who were followed for 3 years using the National Health and Nutrition Examination Survey 2005-2008. There were higher percentages of females compared to males who had insomnia (48.6 vs. 35.9%, $p<0.001$), trouble falling asleep (19.8 vs. 12.8%, $p=0.002$) and daytime sleepiness (23.1 vs. 15.8%, $p<0.001$). Participation in physical activity was inversely related to sleep latency. Obesity was significantly related to snoring, sleep apnea and sleep disorders. There was a significant association (OR=1.66; 95% CI 1.19, 2.30) between sleeping <7 h per night and reporting poor general health for young adults.

In 2014, Vargas and colleagues researched the association between sleep disturbances and BMI for US college students (n=515, 73.2% female; mean age $=21.68\pm3.49$ years) who were classified as having a BMI ≥ 25.[8] The PSQI scale was

used to measure sleeping patterns. The researchers reported a global PSQI score of 5.9±2.8, with 51% indicating poor sleep quality (PSQI >5) and 19% indicating extremely poor sleep quality (PSQI >8). The most common sleep disturbance for those students who reported "other" was stress-related. The most noted predictor of overweight/obesity (BMI ≥ 25) was the sleep disturbance component of the PSQI; as sleep disturbances increased, there was 66% probability of being overweight.

Cohen Perceived Stress Scale

Cohen and colleagues first developed the Cohen Perceived Stress Scale (PSS) as an instrument designed to measure a global level of perceived stress.[36] The tool is easy to score and takes very little time. PSS scores are calculated by taking the seven positive items, reversing the scores, then summing across all 14 items. Items 4, 5, 6, 7, 9, 10, and 13 are positive items, in that they are stated positively. Altogether, these 14-items measure the degree to which situations in one's life are classified as stressful. Individual scores range from 0-56, with higher scores indicating higher perceived stress levels. Central components of stress are described as when respondents found their lives uncontrollable, unpredictable and overloading. The population group was split into three samples all of whom attended the University of Oregon. The first sample included 332 (121 male, 209 female, 2 with sex not specified) freshman college students who lived on campus. The mean age of the sample was 19.01 years old. The second sample included 114 (60 male, 53 female, one with sex not specified) members of a psychology class. The mean age of the sample was 20.75 years. The third sample included 64 (27 male, 37 female) who participated in a smoking-cessation program. The mean age of the sample was 38.4

years. The coefficient alpha reliability for the PSS was 0.84 (factor 1), 0.85 (factor 2), and 0.86 (factor 3). In general, the relationship between PSS and the validity criteria was unaffected by sex or age. The researchers found that PSS has adequate internal and test-retest reliability, and is a better predictor of health and health-related outcomes than a life-event score.

In 1988, Cohen and Williamson worked together to provide psychometric data on the three different versions created of the PSS in order to compare the usefulness of each scale.[37] These versions differ by the amount of questions on each scale. The original scale contained 14 items (PSS-14). The four-item (PSS-4) and 10-item (PSS-10) versions of the scale are also validated. The sample consisted of 960 males and 1,427 females, with a mean age of 42.8 years old. Two factors were assessed in the PSS-14: the first factor included those negatively worded (25.9% variance); the second factor reflected positively phrased statements (15.7% variance). The researchers reported the Cronbach's alpha coefficient for the internal reliability of the PSS-14 was 0.75. The PSS-10 was derived by deleting four items, which had relatively low factor loadings and includes items 1-3, 6-11, and 14. The somewhat shorter version resulted in a slight improvement in explained variance (34.4% for factor 1, and 14.5% for factor 2). The Cronbach's alpha coefficient = 0.78. The PSS-4 includes items 2, 6, 7, and 14. Only one factor was revealed which accounted for 45.6% of the variance. The Cronbach's alpha coefficient = 0.60. The researchers found that all three scales have an adequate predictive validity and factor structure, though the PSS-4 did demonstrate a slight loss in reliability. This study found that elevated PSS scores were associated with shorter periods of sleep

among other negative health behaviors. For respondents between 18 – 29 years of age, there was a correlation between the numbers of hours in the longest period of sleep ($r = -0.13$, $p<0.001$). This suggests the general tendency for shorter periods of sleep to be associated with stress.

Stress and Health Risk

Stress is an outcome of how an individual perceives their lack of resources to cope with a perceived situation; the perception of a situation may be regarded as stressful by one individual, and not stressful for another.[38] There are many sources of stress for a college-aged student. According to Ansari and colleagues, these stresses include academic workloads, new environments, dormitory roommates, and responsibilities.[9] Stress has a direct, as well as an indirect, negative effect on health, which may also affect the individual's food choices people select.[9,39] Recently, mental health has become an important topic on college campuses, as most lifetime mental disorders are diagnosed by the age of 24 years old.[40] Studies have found that female students are more likely to be diagnosed with major depression and anxiety disorders, while male students are at a higher risk for suicide.

Ling-Ling and Sheng-Ping also state that emotional responses to stress are related to several sleep aspects, such as sleep latency or sleep quality.[32] Ansari and colleagues worked together to find an association between mental health indicators and nutritional habits in undergraduate students (n=3,706; mean age=24.9±8.6 years) who were enrolled in seven different universities in the United Kingdom (UK).[9] Perceived stress was measured using Cohen's Perceived Stress Scale (PSS-4).[37] The scale measured to what extent the respondents felt life situations were

stressful, to the extent of feeling unpredictable, uncontrollable, and overloaded. The researchers found that among only females, consuming "unhealthy" foods (sweet, cookies) was positively associated with perceived stress; whereas among only males, consuming fish or seafood was positively associated with perceived stress. The researchers reported a Cronbach's alpha of 0.88 for the whole sample. It was also found that strategies to reduce stress would result in a healthier student body, by consuming healthier foods. In the study by Oliver and Wardle, similar gender results were found in regards to the intake of specific foods while under stress.[39]

Lu and colleagues researched the prevalence of anxiety and depression among Chinese college freshmen (n=1,048, 695 male, 353 female; mean age =18.63$\pm$0.84 years) in 2010, investigating mental health problems and their predictors.[10] Many scales were used to screen for symptoms of anxiety and depression, with the PSS-10 being used to assess stress levels. The average PSS score for the sample was 21.13$\pm$5.83, with a minimum of 10 and a maximum of 40. Higher scores indicate higher levels of stress. When comparing stress levels in depression and non-depression groups, the researchers found that the depression group had a higher score (depression=18.49$\pm$4.91 vs. non-depression=11.63$\pm$4.69). The anxiety versus non-anxiety group followed this same pattern (19.83$\pm$4.57 vs. 12.87$\pm$4.79). No gender differences in stress were found.

Summary

There is significant weight gain that occurs in almost three-quarters of first-year students throughout the first two years of their college career.[6] This increase in BMI has negative effects on the development of healthy lifestyles. Young adults of

both genders have a delayed bedtime, decreased total sleep time and an increase of sleep problems.[31,32] In regard to gender, differences begin to develop in terms of sleep disturbances around the age of 20.[32] Lund and colleagues found that perceived stress was the most explanatory power for poor sleep in a college population.[31]

Based on this literature review, my research is important due to the lack of current research that encompasses all the three topics of sleep, stress and BMI. Exploring characteristics of at-risk college students further justifies the need for this study. There have been no studies thus far where the primary focus has been on the at-risk college population. The relationship between the three variables, especially in college students, is often an overlooked opportunity for weight-related behavior change. Furthermore, the very high rate of college student dissatisfaction with their sleep is cause for concern.[32] The specific objectives of this study are to assess young adult college students, at-risk for unwanted weight gain, for sleep quality, perception of stress and relationships among body mass indices, sleep quality and stress perception with a specific focus on gender differences.

CHAPTER 3: METHODOLOGY

Goal and Objectives

The goal of this study was to characterize at-risk young adults based on their sleep quality and perceived stress and to explore the relationship among these lifestyle factors and body mass index (BMI). The study was part of a larger multistate study, Get Fruved, related to weight management factors in college students. The specific objectives were to assess young adult first-year college students:

a. Sleep quality
b. Perception of stress
c. Relationships among body mass indices, sleep quality and stress perception

Study Design

The research design was a cross-sectional study of young adult college students, split into treatment and control states. The Get Fruved study included both physical measurements and an online survey collected in the fall of 2015 across the eight campuses of Auburn University (AU), Kansas State University (KSU), South Dakota State University (SDSU), Syracuse University (SU), and the Universities of Florida (UFL), Maine (UMaine), Tennessee (UT), and West Virginia (WVU). The researcher was part of the multistate research project and used selected anthropometrics and survey data collected at baseline for the two-year study. The multistate study was a control/treatment design. Data collected for the current study represented four control schools (AU, KSU, ME, SU) and four treatment

schools (UFL, SDSU, UT, WVU). Global approval for this study was granted for each state by the Institutional Review Board for the Protection of Human Subjects at the University of Tennessee.

Participants

All participants were to be first-year college students with at least two conditions that could put them at-risk for unhealthy weight gain. The recruitment goal for each state was 225 participants. To be included in the Get Fruved study, participants needed to first meet eligibility requirements for the multistate study, including being over 18 years of age and first-year standing in college. Participants also had to consume less than two servings of fruits and three-servings of vegetables daily on average and meet one of the following additional screening conditions including: BMI≥25 kg/m^2; self-identification as a as first generation college student; identify as having an overweight or obese parent; low-income background (measured via an affluence scale); and/or self-identification as a racial minority. The eligibility screening tool was used to determine participant eligibility (Appendix A).

Recruitment

The recruitment goal was to reach every first-year student with the information about the study prior to the start of school or within the first few days of school. This was essential as assessments were planned to start within the first two weeks of the incoming first-year students arriving to campuses. A prototype flyer was provided from the lead institution (UT), which was personalized at the state level. See the flyer used at UMaine in Appendix B. Information was provided about the study length of two years, including physical assessments and an online

survey that would take about two hours at each assessment. Assessments would be done twice in the first-year and once in the second year. The flyer included the link to the eligibility screener. Flyers were distributed to students in large entry-level classes, at tabling events, through email systems and also by word of mouth. Incentives provided at recruitment events to encourage participation included items such as water bottles, stickers, sticky notes, and Frisbees. While the ability to reach all students differed across campuses, in Maine, a list of all first-year students was provided to the researcher, who then mailed the recruitment flyer (Appendix B) to the students' home address in August prior to school starting. Residence directors also placed flyers in the mailboxes of all first-year students at the beginning of the semester.

The eligibility screener was analyzed by researchers at UT to determine eligibility status based on the previously stated criteria. Lists of names and emails of those who were eligible were generated and provided to state researchers every other day during the five-week assessment period. The researchers sent a link to eligible students to set up assessment appointments via Google forms. Those who did not respond within one week were sent reminder emails to schedule an appointment. Numerous reminder emails to set up an appointment were sent to try to recruit those who were eligible for the study until the last week of scheduled assessment times. The baseline sample was composed of 1,176 at-risk college students (male=365, female=705, gender not given=9).

Study Protocol

Students were asked to attend the assessment appointment in light clothes and having eaten only a light meal. At most sites they were asked to bring their personal laptops for the survey assessment. Consent was granted prior to starting any assessments (Appendix C) with the participants being given time to read, sign and date the form. The media release form was also signed and dated by students giving permission for their pictures to be used in study publications, and/or research related to facial images (Appendix D).

Assessments started within the first two weeks after the first-year students arrived on campuses and continued for five-weeks. State researchers had flexibility in the protocols used during the assessment, most providing breaks and food for the participants.

Training

Training for the researchers occurred during the spring and early fall of 2015. This process included reviewing the physical assessment protocols, training videos and Inter-rater Reliability (IRR) training documents; participating in conference calls; and attending the annual multistate research group meeting in Tennessee.

Inter-rater Reliability, the degree of agreement among different researchers taking the same measurements, was determined by each researcher completing assessments on five volunteer students. Physical measurements (height, weight) were tested for homogeneity among the different researchers. Based on Pearson correlation, 0.80 agreement was needed between each student researcher and the

expert. Retraining was needed until the specified agreement was met. IRR was calculated for this researcher and the rest of the assessment research team, with the average for the team being 0.9999.

Participant Incentive

The incentive for participating in the physical assessments and online survey was $30, which students received after completion of the overall assessment. Participants knew that they would receive a total of $175 for participation over the course of the two-year study in increasing increments each assessment period ($30 in the fall of year one, $45 in the spring of year one, $100 in the spring of year two.

Instruments

The following instruments were used in the current study. They were assessed at the pre-test assessment of the 2-year Get Fruved study.

Online Survey

The total Get Fruved survey consisted of 337 total general health questions and took about an hour to complete. Surveys were completed in person on either personal laptops, or laptops provided by the researchers.

Demographic Form

Demographic information was collected with twenty-two questions. Selected questions were used for the current study to describe the young adult sample, such as age, sex assigned at birth, and race (Appendix E).

Pittsburgh Sleep Quality Index (PSQI)

Aspects of sleep including quality, quantity, and disturbances were assessed using the Pittsburgh Sleep Quality Index (Appendix F). The PSQI is a self-rated

questionnaire with 19 items, which are grouped into seven component scores, each weighted equally on a 0-3 scale. These seven components include subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. The score from each category is summed to equal a global PSQI score, which ranges from 0 to 21; higher scores reveal a poor sleep quality with a cutoff score of 5 or above indicating a sleep disturbance. The scoring method is in Appendix G.

Perceived Stress Scale (PSS)

The Cohen Perceived Stress Scale (PSS) instrument is a 14-item scale designed to measure a global level of perceived stress (Appendix H) with stressful situations identified by scores ranging from 0=never to 4=very often. Scores range from 0-56 with a higher score indicating higher perceived stress. The instrument includes both positively and negatively stated items with items 4, 5, 6, 7, 9, and 10 being positive items. PSS scores are calculated by taking the seven positive items, reversing the scores, then summing across all 14 items (scoring method in Appendix H). An example of one of the positive items is: "In the last month, how often have you dealt successfully with irritating life hassles?" By reversing the scores, higher scores equate to higher stress. Altogether, these 14 items are a measure of the degree to which situations in one's life are classified as stressful by the respondent. The instrument is designed to identify stress perceived as uncontrollable, unpredictable and overloading.

Physical Assessments

For this study, physical assessments for height and weight were collected. Anthropometric data were recorded on the Data Collection Form (Appendix I). All scales were calibrated prior to use; each anthropometric measurement was taken at least twice and recorded immediately.

Body Weight

Weight was measured using a calibrated digital scale. Students were asked to have no more than a light meal three hours prior to the assessment, empty their bladder, wear lightweight clothing, and remove shoes and socks prior to being weighed. Each participant was asked to step on the zeroed, level scale facing away from the digital readout. Each participant was weighed twice with each weight being recorded to the nearest 0.1 kg. If the two weights were not within 0.2 kg of each other, a third weight measurement was obtained; the two weights that were within 0.2 kg of each other were used as official measurements. The two official measurements were then averaged and recorded on the data collection form and then transferred to the online data management system.

Height

Height was measured directly after the weight measurement using a stadiometer. The participants kept their shoes and socks off for this measurement, and were asked to remove hair accessories (i.e. barrettes, elastics), hairstyles (i.e. buns, braids) or anything else on top of their head (i.e. hats, sunglasses) that would interfere with the height measurement. Participants were to step completely under the slide of the stadiometer, standing as straight as possible with their feet together

and having four points of contact with the stadiometer: heels, buttock, shoulder blades and back of head. With the participant looking straight ahead, the height slide rested lightly on top of the participant's head and the participant inhaled and exhaled to stabilize their height. Two measurements of height were obtained; the measurements were read at eye level to avoid parallax (angular distortion). If there was more than 0.2 cm difference between measurements, the measurements were to be repeated until two measurements are within 0.2 cm; the two heights that are within 0.2 cm of each other were used as official measurements. The two official measurements were then averaged and recorded on the data collection form and then transferred to the online data management system.

Body Mass Index (BMI)

Using the average height and weight measurements, each participant's BMI was calculated. BMI was automatically determined when the height and weight were entered into the online data management system.

Statistical Analysis

The databases for both anthropometric and survey data were collected at the University of Tennessee. Data were cleaned and prepared for individual researchers by Dr. Wenjun Zhou, statistician for the multistate study. The database was sent to the researcher for statistical analyses. Statistical analyses were conducted by the researcher using SPSS, Version 23 (SPSS Inc., Chicago, IL © 2015). General descriptive statistics were generated, including independent samples *t*-tests for between group differences based on control/treatment groups and sex. With no treatment effects being observed, the total data set was combined for analyses of

study objectives. Scores for individual questionnaires along with BMI were generated and presented descriptively to characterize the sample. A one-way ANOVA and Tukey's post-hoc test were used to determine mean BMI differences between states. Multiple linear regression models were made using PSQI, PSS, BMI, sex, and the interaction using the statistical software program R version 3.2.3. Cohen f^2 is used in multiple linear regression models to determine the effect of the model (0.02 weak; 0.15 moderate; 0.35 strong). Significance for all tests was set at $p<0.05$ level. The consulting statistician was Jon Moyer, Husson University.

CHAPTER 4: RESULTS

During the recruitment period of the Get Fruved project, 5,469 participants were recruited and took the eligibility screener; of those, 2,771 participants were eligible, with 1,176 scheduling and attending the assessment. Of the participants who were assessed, 1,080 (87.5%) completed the Pittsburgh Sleep Quality Index, and 1,079 (87.4%) completed the Perceived Stress Scale.

General Descriptive Characteristics

The participants were predominately white (65.31%), living on campus (78.32%), and between the ages of 18 and 19 years old (87.67%) with a mean age of 18 ± 1.03 years old; participants had to be at least 18 years or older to participate. Participants were all first-year students with a gender distribution of 31.04% male, 59.95% female, and 9.01% choosing not to answer. All eight universities were represented in the participant pool in Table 1 below.

No significant differences were found for sleep, stress, or BMI between treatment and control groups. Therefore, data were combined for presentation.

Table 1: Participants (n, %) Across States

	n	Percent
Alabama	106	9.01
Florida	301	25.60
Kansas	111	9.44
Maine	167	13.27
New York	156	12.64
South Dakota	69	5.87
Tennessee	171	14.20
West Virginia	95	8.08
Total	1,176	100%

Table 2: General Descriptive Characteristics of the Sample

Total Sample[1]	**Males**		**Females**		**Total**	
	n	(%)	n	(%)	n	(%)
	365	(31.04)	705	(59.95)	1,176	(100)
Age (years)						
18-19	346	(94.79)	685	(97.16)	1,031	(87.67)
20-21	8	(2.19)	10	(1.42)	18	(1.53)
>22	11	(3.01)	10	(1.42)	21	(1.79)
Race[2]						
White	254	(69.60)	511	(72.48)	768	(65.31)
Non-White	137	(35.40)	248	(64)	387	(32.91)
Residence[3]						
On-Campus	316	(86.58)	605	(85.82)	921	(78.32)
Off-Campus	49	(13.42)	100	(14.18)	149	(12.67)

[1]When n≠1,176 the difference is due to non-responders
[2]Non-white: n=157 African American; 139 Asian; 30 American Indian; 14 Native Hawaiian; 47 Other; 9 chose not to answer
[3]Response based on current life situation

The anthropometric data (mean±SD) by BMI category are in Table 3. Within each category, sex differences were noted for height ($p=0.01$) and weight ($p=0.01$), with males having higher values than females. There were a higher percentage of males (30%) compared to females (24%) in the overweight category, and a higher percentage of females (7%) compared to males (4%) in the underweight category. There were similar percentages of males and females in the normal and obese categories.

Table 3: Anthropometric Characteristics of Sample[1]

Body Mass Index (BMI) Category								
	Underweight (<18.49)		**Normal (18.5-24.99)**		**Overweight (25-29.99)**		**Obese (>30)**	
Males	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
(n=358)[2]	14	4	203	57	107	30	34	10
	Mean±SD		**Mean±SD**		**Mean±SD**		**Mean±SD**	
Weight (kg)	52.09±4.65		69.09±7.86		83.85±8.36		104.65±13.71	
Height (cm)	173.44±6.45		176.41±7.33		175.24±7.36		176.10±6.57	
Females	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
(n=691)	46	7	400	58	168	24	77	11
	Mean±SD		**Mean±SD**		**Mean±SD**		**Mean±SD**	
Weight (kg)	47.02±4.59		58.83±6.62		73.17±7.85		95.80±14.15	
Height (cm)	163.92±7.40		163.87±6.54		164.15±7.37		165.81±6.86	

[1]When n≠1,176 the difference is due to non-responders
[2] Males had higher height and weight than females in each BMI category, based on independent samples *t*-tests, (p=0.01)

Overall, the mean weights were 76.21±14.83 kg for males and 65.65±15.11 kg for females. The mean BMI (24.41±4.88 kg/m^2) fell in the upper range of the normal category, and slightly over half of the sample (57%) had a normal BMI. Individual BMI (mean±SD) for each state are given in Table 4. There were between state differences (≤0.01), with Florida mean BMI (23.273±4.24 kg/m^2) being lower than all other states, except Alabama and New York (table 5). New York (23.432±3.93 kg/m^2) had lower mean BMI than Kansas, Maine, and South Dakota (table 5). Alabama mean BMI was not statistically different from any of the other states.

Table 4: Mean±SD of Body Mass Indices (BMI) of At-Risk First-Year College Students by State

State	n	BMI (Mean±SD)
Alabama	99	24.50±5.59
Florida	300	23.27±4.24
Kansas	111	25.33±4.99
Maine	167	25.24±5.45
New York	153	23.43±3.93
South Dakota	68	25.87±4.88
Tennessee	163	24.80±4.51
West Virginia	95	25.24±5.80
Total	1156[1]	24.41±4.88

[1]When n≠1,176 the difference is due to non-responders

Table 5: Differences in Body Mass Indices (BMI) Among States

(I)State[1]	(J) State	Mean Difference*	Std. Error	P-value
FL	SD	-2.60	.65	.002
	WV	-1.97	.57	.012
	KS	-2.06	.53	.003
	ME	-1.97	.46	0.001
	TN	-1.53	.47	.025
NY	ME	-1.81	.54	.018
	SD	-2.44	.70	.012
	KS	-1.90	.60	0.34

[1]Alabama mean BMI is not statistically significantly different from any other state
*The mean difference computed on FL or NY minus other states, significant based on one-way ANOVA ($p<0.05$)

Sleep Duration and Quality

The sleep duration by state is listed in Table 6. The overall sleep duration for the sample was 7.05±1.29 hours sleep/night. The mean range of hours of sleep was from a low for Alabama of 6.50±1.03 hours sleep/night to a high 7.22±1.61 hours of sleep/night for South Dakota. According to a one-way ANOVA, there were statistically significant differences between states with Tennessee having lower sleep than Florida, West Virginia and Maine (p=0.001).

Table 6: Mean±SD Hours of Reported Sleep Duration/Night by State

State	n	Duration (Mean±SD)	Std. Deviation
Alabama	20	6.50	1.03
Florida	301	7.17*	1.28
Kansas	110	6.97	1.22
Maine	166	7.17*	1.05
New York	155	7.03	1.45
South Dakota	69	7.22	1.61
Tennessee	168	6.70*	1.16
West Virginia	92	7.21*	1.34
Total	1081[1]	7.05	1.29

[1]When n≠1,176 the difference is due to non-responders
*Differences in mean sleep duration were based on one-way ANOVA (p=0.001)

The Pittsburgh Sleep Quality Index (PSQI) (sleep quality) scores are in Table 7. All of the 19 individual questions in the PSQI were weighted equally on a scale from 0 – 3, and were summed to compute the overall global PSQI score. The sample had a mean global PSQI score of 5.94±2.68 (score range=1-21: ≤5=normal; >5=disordered), which is just slightly in the disordered sleepers category. The global PSQI score was categorized into normal sleepers (n=514) and disordered (n=566) sleepers, 53% of females and 51% of males reporting disordered sleeping. The mean score of the disordered sleepers (7.94±2.00) is significantly higher than the normal sleepers (3.74±1.18). The mean global PSQI score differed between sexes ($p \leq 0.01$), with females (n=705) having a score of 6.05±2.72 and males (n=365) having a score of 5.72±2.53. Based on an independent samples *t*-test, females exhibited longer sleep duration in hours per night (7.15±1.25) than males (6.92±1.20)($p < 0.001$).

Table 7: Mean±SD of Sleep Quality and Duration of At-Risk First-Year College Students (n=1,081)

Pittsburgh Sleep Quality Index (α=0.80)[1, 2, 3]	**Males** n=365	**Females** n=705	**Total**[3] n=1,080
	Mean±SD	Mean±SD	Mean±SD
Sleep Quality	5.72±2.53*	6.05±2.72*	5.94±2.68
Normal Sleepers (n=514)	3.66±1.17	3.80±1.16	3.74±1.18*
Disordered Sleepers (n=566)	7.70±1.81	8.04±2.07	7.94±2.00*
Sleep Duration (hours)[3]	6.92±1.20*	7.15±1.25*	7.05±1.29
Short Sleepers (<7 hours) (n=294)	5.50±0.85	5.59±0.80	5.51±0.95
Normal Sleepers (7-9 hours) (n=634)	7.38±0.46	7.44±0.47	7.42±0.47
Long Sleepers (>9 hours) (n=92)	9.45±0.69	9.38±0.73	9.39±0.71

[1]Measures sleep quality score range = 0-21; ≤5=normal sleep quality, >5 = disordered sleep[26]
[2]Significant difference between sexes in the global sleep score, sleep duration, normal/disordered sleep (p=0.01)
[3]When n≠1,176 the difference is due to non-responders
*Difference was found based on independent samples *t*-test (p=0.001)

Table 8 categorizes the global sleep score into normal (PSQI≤5) and disordered (PSQI>5). The BMIs by both sexes and total sample are examined. Males in the normal sleepers category had a higher BMI than males in the disordered sleepers category, whereas females in the disordered sleepers category had a higher BMI than females in the normal sleepers category (p<0.01). In the total sample, while still in the normal range for the mean BMI, disordered sleepers had a statistically higher BMI (24.49±5.04 kg/m^2) when compared to normal sleepers (24.30±4.45 kg/m^2) according to an independent sample *t*-test (p<0.01). When examining sleep duration compared to BMI, males who were long sleepers (>9 hours) had a higher BMI (27.07±5.32 kg/m^2), in contrast to females, who were short sleepers (<7 hours) who exhibited a higher BMI (24.74±5.75 kg/m^2)(p<0.05). Differences within sexes for short and long sleepers were determined used a one-

way ANOVA, with male long sleepers having a higher mean BMI and female long sleepers having a lower BMI ($p<0.05$).

Table 8: Mean±SD Body Mass Indices (BMI) by Sleep Categories and Gender

Pittsburgh Sleep Quality Index[1, 2] (α=0.80)	**Males** n=365	**Females** n=705	**Total**[3] n=1,157
	Mean±SD	Mean±SD	Mean±SD
Sleep Quality			
Normal Sleepers (n=450)	25.03±4.59	23.92±4.41	24.30±4.45
Disordered Sleepers (n=632)	24.15±3.98	24.64±5.53	24.49±5.04*
Sleep Duration (hours)			
Short Sleepers (<7 hours) (n=293)	24.30±3.59	24.74±5.75	24.60±5.09
Normal Sleepers (7-9 hours) (n=634)	24.40±4.48	24.17±4.81	24.25±4.68
Long Sleepers (>9 hours) (n=92)	27.07±5.32**	23.37±3.72***	24.12±4.38

[1]Pittsburgh Sleep Quality Index (PSQI)(Appendix G)
[2]Sleep quality score range = 0-21; ≤5=normal sleep quality, >5 = disordered sleep[26]
[3]When n≠1,176 the difference is due to non-responders
*Based on an independent sample *t*-test ($p<0.01$)
**Significantly higher BMI for long versus short sleepers within males, based on ANOVA ($p<0.05$)
***Significantly lower BMI for long versus short sleepers within females based on ANOVA ($p<0.05$)

A major factor contributing to the measure of sleep quality was the varying sleep disturbances. Sleep disturbances (mean±SD) and frequencies of sleep disturbances that affected the sample are shown in Table 9. There are sex-specific differences in the frequency of reported sleep disturbances ($p\leq0.01$). Females reported all individual questions of the PSQI affect their sleep more often than males, with the exception of "wake up in the middle of the night or early morning". Based on the number of times throughout the last month that these sleep disturbances occurred, the most frequently reported disturbances were "cannot get to sleep within 30 minutes", "wake up in the middle of the night or early morning" and "feel too hot". In regard to the three previously stated sleep disturbances, more

females (15%, 22%, 12%) than males (11%, 13%, 10%) reported experiencing these three disturbances, respectively.

Table 9: Most Frequently Reported Sleep Disturbances (Mean±SD, %) for At-Risk First-Year College Students (n=1,080)[1]

During the past month, how often have you had trouble sleeping because you…[2,3]									
	Mean Score	**Not during the past month**		**Less than once a week**		**Once or twice a week**		**Three of more times a week**	
	Mean±SD	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Cannot get to sleep within 30 minutes	2.16±1.01*	330	*26.74*	339	*32.33*	203	*16.45*	149*	*12.07*
Wake up in the middle of the night or early morning	2.38±1.05*	269	*21.80*	334	*27.07*	277	*24.45*	201*	*16.29*
Feel too hot	2.19±1.00*	339	*27.47*	315	*25.53*	309	*25.04*	118*	*9.56*

[1]Full table of reported sleep disturbances (Appendix J)
[2]Pittsburgh Sleep Quality Index (PSQI)(Appendix G)
[3]Individual questions of PSQI scored on a scale of 0-3; 0=not during the past month, 1=less than once a week, 2=once or twice a week, 3=three or more times a week
*Gender-specific differences in the frequency of reported sleep disturbances based on Chi-Square Test ($p<0.01$)

Reported Stress Levels

The overall perceived stress score (PSS) for the total sample (n=1,079) was 26.35±6.10, falling in the mid-range on a scale ranging from 0 – 56 (table 10). When considering scores by sexes, females reported a mean perceived stress score of 27.28±5.90, which was statistically higher than males, who reported a mean perceived stress score of 24.56±6.13 ($p<0.001$).

Table 10: Reported Stress Values (Mean±SD, %) for At-Risk First-Year College Students (n=1,079)

	Males n=364	**Females** n=705	**Total** n=1,079
	Mean±SD	**Mean±SD**	**Mean±SD**
Perceived Stress Score[1,2] (α=0.78)	24.56±6.13	27.28±5.90*	26.35±6.10

[1]Perceived Stress Scale (PSS)(Appendix H)
[2]PSS scores range from 0-56, with higher scores indicating higher perceived stress levels
*Females reported higher PSS than males based on independent samples *t*-test ($p<0.001$)

There were sex-specific differences in the frequency of reported stress scores ($p \leq 0.01$). Females reported higher means on all individual questions of the PSS when compared to males. The most frequently reported items by the total sample reported as contributing to stress were, "found yourself thinking about things you have to accomplish", "felt that you were unable to control the important things in your life", and "been upset because of something that happened unexpectedly" (table 11). Females (42%, 32%, 19%) more frequently reported experiencing these items "very often" when compared to males (32%, 15%, 16%), respectively.

Table 11: Perceived Stress Scores of First-Year College Students by Item (Mean±SD, %)[1]

During the past month, how often have you …[2,3]											
	Mean Score	Never		Almost never		Sometimes		Fairly often		Very often	
	Mean±SD	n	*%*	n	*%*	n	*%*	n	*%*	n	*%*
Been upset because of something that happened unexpectedly	2.64±0.96*	36	*2.9*	71	*5.8*	335	*27.1*	443	*35.9*	196	*15.9*
Felt that you were unable to control the important things in your life	2.71±1.03*	32	*2.6*	81	*6.6*	333	*27.0*	354	*28.7*	281	*22.8*
Found yourself thinking about things you have to accomplish	3.13±0.86*	11	*0.9*	31	*2.5*	176	*14.3*	449	*36.4*	414	*33.5*

[1]Full table of reported sleep disturbances (Appendix J)
[2]Perceived Stress Scale (Appendix H)
[3]Individual questions scored on scale of 0-4: 0 being never, 4 very often
*Gender-specific differences in the frequency of reported sleep disturbances based on Chi-Square Test ($p<0.01$)

Relationships Among Body Mass Indices (BMI), Pittsburgh Sleep Quality Index (PSQI) Score, and Perceived Stress Score (PSS)

Mean±SD for BMI, PSQI and PSS are presented in Table 12 by control and treatment groups. Based on independent samples *t*-test, no differences were seen between groups.

Table 12: Mean±SD, Body Mass Indices (BMI), Pittsburgh Sleep Quality Index (PSQI), and Perceived Stress (PSS)

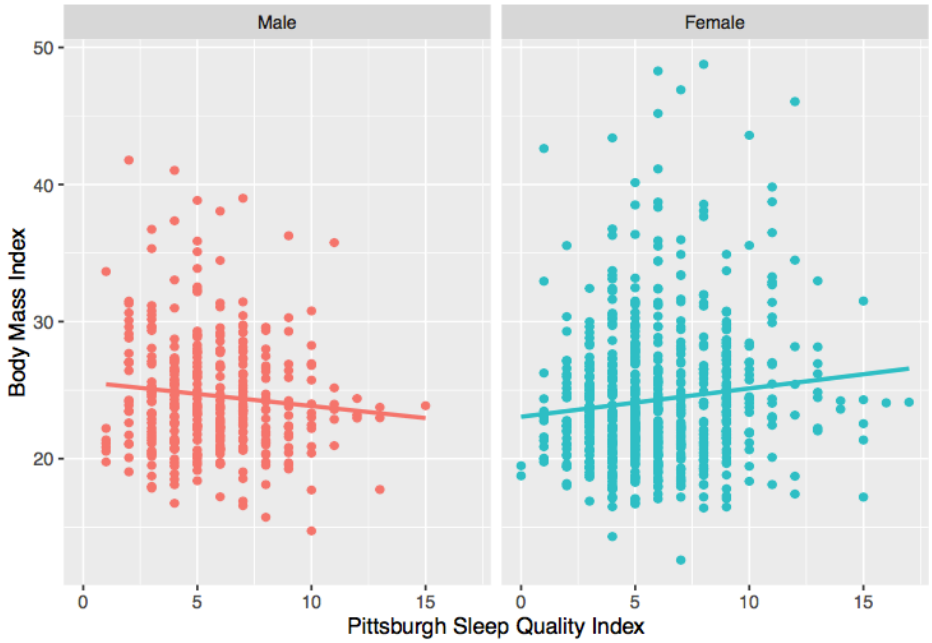
	Group	n[1]	Mean±SD
BMI	Treatment	626	24.25±4.74
	Control	530	24.60±5.04
PSQI Score	Treatment	634	6.01±3.31
	Control	453	6.63±3.40
PSS Score	Treatment	625	26.56±6.03
	Control	453	26.11±6.27

[1]When n≠1,176 the difference is due to non-responders
[2]No difference between groups for BMI, PSQI or PSS scores based on independent samples *t*-test

Results are shown below for the three models run to test the relationship between PSQI, PSS, and BMI. According to an ANOVA 3-way interaction, the relationship of BMI, sleep quality (PSQI), and stress (PSS) in regard to gender was not found to be significant (p=0.94). The residuals did not follow a normal model and were skewed right, suggesting the assumption of normality did not hold. With such a large sample size, regression is resistant to violations to normality. The scatterplots of these model evaluations can be found in Appendix K.

In Figure 1, the first model used to investigate the association between BMI and sleep quality, controlling for sexes, is presented. There was a significant interaction (b=0.40, t(1045)=3.33, p=0.001) between sexes and sleep quality. In males, for a 1-point increase in PSQI, mean BMI decreased by 0.19kg/m^2. In females, for a 1-point increase, mean BMI increased by 0.21kg/m^2; Cohen's f^2=0.01, indicating very weak effect on BMI.

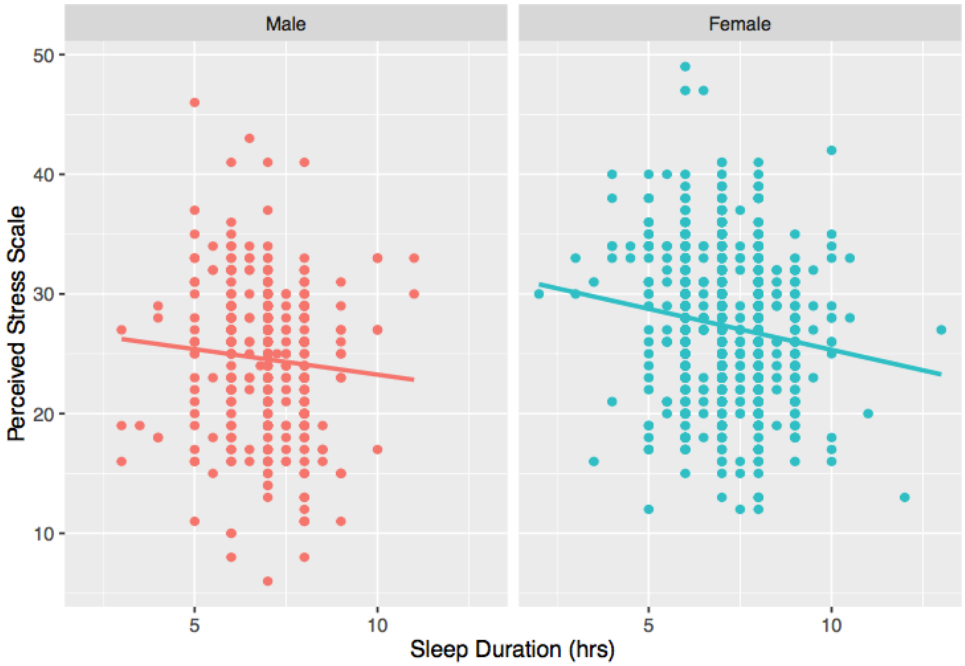
Figure 1: Model of Body Mass Indices (BMI) and Pittsburgh Sleep Quality Index[1] by Sex[2]



[1]Pittsburgh Sleep Quality Index (PSQI) range from 0-21 (Appendix G)
[2]For a 1-point increase in PSQI, mean male BMI decreased by 0.19kg/m^2; mean female BMI increased by 0.21kg/m^2; Cohen's f^2=0.01, indicating very weak effect on BMI

The second model used to investigate the association between sleep duration and stress (PSS), controlling for sexes is in Figure 2. There was no significant interaction between sex and duration of sleep (b=-0.27, t(1064)=-0.83, p=0.41). After removing the interaction between sex and duration, there was a significant association between duration and stress. For a given sleep duration, females tended to be 3 points higher (b=2.85, t(1065)=7.40, p<0.001) on the stress scale compared to males. Controlling for sex, for every hour of increased sleep duration, stress decreased by 0.61 (b=-0.61, t(1065)=-4.04, p<0.001).

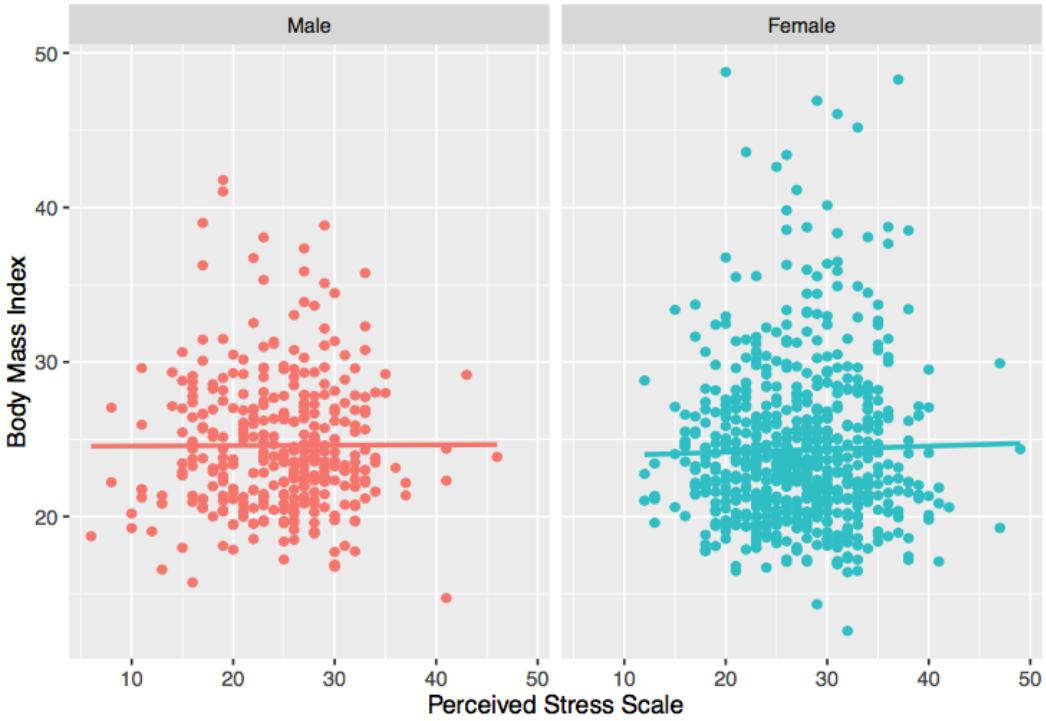
Figure 2: Model of Perceived Stress Scale[1] and Sleep Duration[2] by Sex[4]



[1]Perceived Stress Scale range 0-56 (Appendix H)
[2]Sleep duration = hours sleep/night
[3]For a given sleep duration, females tend to be 3 points higher ($p<0.001$) on the stress scale compared to males
[4]Controlling for sex, for every hour of increased sleep duration, stress decreased by 0.61 ($p<0.001$)

The investigation for the third model was the association between BMI and stress controlling for sex (figure 3). After accounting for sex, there was no significant association between stress and BMI ($b=0.016$, $t(1045)=0.31$, $p=0.76$).

Figure 3: Model of Body Mass Indices (BMI) and Perceived Stress Scale[1] by Sex[2]



[1]Perceived Stress Scale range 0-56 (Appendix H)
[2]No significant association between stress and BMI, accounting for sex (p=0.76)

CHAPTER 5: DISCUSSION

The goal of this study was to assess sleep quality (PSQI), perception of stress (PSS), and body mass indices (BMI) in at-risk first-year college students (n=1,176) at baseline of the 8-state Get Fruved study. They were predetermined to be at-risk for unwanted weight gain based on study screening criteria. Participants were aware of whether they were to be in the control or treatment group, and after finding they were similar demographically, the total sample was combined for statistical analyses for the current study. It was a unique group, not intended to be a representative sample of the general college population.

The participants were predominately white, resided on campus, and were under the age of 19. This population of students was very new to college life, and had not completely adjusted to this change in environment when sampled. While 57% of the sample had BMIs within the normal range, there were 26% who were in the overweight range, 11% who were in the obese range, and only 6% were in the underweight range. The mean BMI from this study was 24.41 ± 4.88 kg/m^2, surprisingly compared favorably to the mean BMI of 28.6 kg/m^2 from a national study of college students collected between 2007-2010.[41] In contrast, when participants in the overweight and obese categories were combined, the total was 37%, which compared unfavorably to earlier national data where only 30% of college students were reported as either overweight or obese.[42,43]

Based on data from the 2014 Behavioral Risk Factor Surveillance System (BRFFS), a total of 65.2% of those who responded reported a sleep duration of ≥7 hours in a 24-hour period.[44] Interestingly, when comparing states, South Dakota had

the highest percentage of BRFFS respondents to report an amount of sleep (71.6%), comparing favorably to the current study, in that South Dakota had the highest mean hours of sleep per night (7.22 ± 1.61) compared to all other states. Females (65.2%) also reported longer sleep durations than males (64.6%), which is consistent with the findings from the current study, with females sleeping longer than males by about 30 minutes/night.

The sleep duration benefit in relation to weight issues has been reported to have a U-shaped effect on obesity-related characteristics.[45] Stamatakis and Brown studied a full range of adults, aged from 20-92 years old and they found that those who slept less than 7 hours (short sleepers) and those who slept more than 9 hours (long sleepers) had common characteristics in regard to obesity. They reported higher BMIs for those groups than participants who slept within the normal range of 7-9 hours.[45] In comparison, Quick and colleagues studied just a college population between the ages of 18-24 and found that as BMI declined, sleep duration increased.[46] In this study, males exhibited higher BMIs when in the long sleepers category, whereas females exhibited a higher BMI when in the short sleepers category. A linear relationship existed between sleep duration and disordered sleep, whereas when disordered sleep increased, sleep duration decreased.

It is intriguing to see the influence of sex on sleep quality and BMI since, in the current study, female BMIs increased as sleep became more disordered and for males, BMIs decreased. In a general college sample of similar size to the current study, Quick and colleagues found that higher disordered sleep was associated with overweight/obesity in females.[46] In both the current study and a study by Vargus

and colleagues,[8] a little over 50% of students reported disordered sleep. Reasons given for disturbed sleep were similar, with the most common reason being "waking up in the middle of the night or early morning." Based on the current study, the association between sleep and BMI is weak, though there does seem to be evidence to suggest that sleep plays a part in being overweight.

College students have also reported that sleep difficulties affect academic performance.[43] We also compared this sample of at-risk fist-year students to the reference group (spring 2014) from the American College Health Association (ACHA), in which 22.4% of general college students reported sleep difficulties affecting their individual academic performance within the last twelve months.[47] It can be concluded that the sample of at-risk college students from this study reports a higher percentage of disordered sleep, when compared to a similar-demographic sample of college students.

In the current study, findings by the researcher indicated that sleep was related to perceived stress level and disordered sleep. This is consistent with Cohen and Williams, who reported that shorter sleep durations are associated with stress and as sleep duration increases, perceived stress levels decrease.[37] In the current study, an effect in regard to sex was seen, since females reported higher perceived stress than males for any given level of sleep duration. These findings are consistent with those of Dusselier and colleagues, who studied a general college population who lived in residence halls on campus.[48] However, based on the current findings and those from other researchers,[49,50] BMI does not appear to be related to perceived stress.

Based on the findings from the current study, the negative effects that disordered sleep has on stress levels should be addressed among students on college campuses. This is especially true for first-year students entering college, since the transition from home to independent living may amplify sleep and stress issues. Based on findings from other researchers, this at-risk group had lower sleep quality and higher perceived stress than their general college student counterparts and there could be implications for school performance and negative health problems. A limitation to this study could be that the data was collected within the first few week of school, and the students were experiencing higher stress and lower quality of sleep. This was also a very targeted sample with specific criteria to be eligible.

The promotion of healthy college lifestyle behaviors targeted for the at-risk students, such as longer sleep duration and decreasing distractions which could interfere with sleep quality, may yield long-term benefits in reducing overweight or obesity levels in college students. Developing methodologies to lessen stressors in the college environment, especially as it relates to high-risk college students, would generate a positive societal impact. Steps to promote healthier lifestyles on campus include many facets. Action plans could include enforcing a mandatory quiet period in the dormitories with the help of resident staff to promote restful sleep, provide healthier food choices in dining halls with a special focus on higher stress times in a college student life (e.g. during exam weeks), and increase education of healthful eating habits, stress-reducing physical activity (i.e., exercise, meditation), and the need for adequate sleep. Based on the findings from the current study, sex-specific

health promotion activities may be desirable. It is through the promotion of a healthy campus environment that overall college student life will become healthier.

CHAPTER 6: CONCLUSION

The majority of the Fruved participants (n=1,176), who were screened at-risk for unwanted weight gain, as they entered college from across 8 different states, had normal sleep duration (62%; 7.1±1.3 hr sleep/night). Their mean body mass index (BMI) was in the normal category (24.4±4.9 kg/m^2) and their perceived stress level fell in the mid-range, with a mean of 26.4±6.2 (scale range=0 low–56 high). They had a mean sleep quality score of 5.94±2.68, slightly above the cut off for normal sleep quality (>5 on the PSQI). Of the total sample, 52% were identified as having disordered sleep, with the total sample reporting "cannot get to sleep within 30 minutes", "wake up in the middle of the night or early morning", and "feel too hot" as the most frequent sleep disturbances. There are sex-specific differences in the frequency of reported sleep disturbances. Females report all individual questions of the PSQI affect their sleep more often than males, with the exception of "wake up in the middle of the night or early morning". Relationships among BMI, sleep quality/duration and perceived stress were determined by multiple regression models. BMI as the response and sleep, sex and their interaction were tested and found significant (p=0.001). In males for a 1.0 point increase in PSQI, mean BMI decreased by 0.19 kg/m^2 and in females for a 1.0 point increase, mean BMI increased by 0.21 kg/m^2; Cohen's f^2 =0.013, indicating very weak effect on BMI. Stress as the response and duration, sex as predictors was tested. Controlling for sex, for every hour of increased sleep duration, perceived stress decreased by 0.61 ($t(1065)=-4.04$, $p<0.001$). For a given sleep duration, females were 3 points higher ($\beta=2.85$, $t(1065)=7.40$, $p<0.001$) on perceived stress compared to males; Cohen's

f^2=0.062, indicating a weak to moderate effect on stress. Establishing healthful sleep and stress management habits during the college years is important for good health, while both in college and for the future. For those at-risk for unwanted weight gain, addressing these health habits as young adults and during a time of life transition may be especially beneficial.

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APPENDIX A: FRESHMEN PARTICIPANT ELIGIBILITY SCREENING TOOL

1. What is your name?
    - First:
    - Last:
2. What is your email address?
3. Please re-enter your email address.
4. Which university will you be attending in the fall of 2015?
    - University of Tennessee
    - University of Florida
    - South Dakota State University
    - West Virginia University
    - Auburn University
    - Syracuse University
    - University of Maine
    - Kansas State University
    - Other university
5. Please specify what university you will be attending in the fall of 2015. (**ONLY DISPLAYED IF "OTHER UNIVERSITY" IS CHOSEN ON QUESTION 4)**
6. Will you be 18 years old or older by September 1, 2015?
    - Yes
    - No
7. Will this fall be the first time you are a college student? (i.e. are you a freshman or first-year student?
    - Yes
    - No
8. Think about what you usually ate last month. Please think about all the fruits and vegetables that you ate last month. Include those that were:
    - Raw and cooked,
    - Eaten as snacks and at meals
    - Eaten at home and away from home (restaurants, friends, take-out), and
    - Eaten alone and mixed with other foods.

    Including snacks, how many cups of fruit and 100% fruit juice do you usually eat each day?
    - Less than ½ cup
    - ½ cup
    - 1 cup
    - 1 ½ cups
    - 2 cups
    - 2 ½ cups
    - 3 cups
    - 3 ½ cups
    - 4 cups

- 4 ½ cups
- 5 cups
- 5 ½ cups
- 6 cups or more
- Choose not to answer

Including snacks, how many cups of vegetables do you usually eat each day?

- Less than ½ cup
- ½ cup
- 1 cup
- 1 ½ cups
- 2 cups
- 2 ½ cups
- 3 cups
- 3 ½ cups
- 4 cups
- 4 ½ cups
- 5 cups
- 5 ½ cups
- 6 cups or more
- Choose not to answer

^^ALL these above must be met in order to be eligible, PLUS ONE (or more) of the following:

9) Are you the first person in your immediate family to attend college?

- Yes
- No
- I don't know/not sure

10) Are either of your parents overweight or obese?

- Yes
- No
- I don't know/not sure

11) Affluence Scale Questionnaire:
Do you have your own bedroom (for just you, or you and your partner/spouse?)

- Yes
- No

How many computers/laptops are in your home?

- Zero
- One
- Two
- Three
- Four
- Five
- Six
- Seven
- Eight
- Nine
- Ten
- More than ten

How many cars, vans, or trucks does your family own?

- Zero
- One
- Two
- Three
- Four
- Five
- Six
- More than six

How many times did you travel away on vacation with your family during the past 12 months?

- Never
- 1 time
- 2 times
- 3 or more times

12) Are you Hispanic or Latino?
- Yes
- No
- I don't know/not sure
- Choose not to answer

Which one or more of the following would you say is your race?
- White
- Black or African American
- Asian
- Native Hawaiian or Other Pacific Islander
- American Indian or Alaska Native
- Other (Please Specify) _____

13) How tall are you? (One foot = 12 inches; 5 feet = 60 inches)
_____ inches
What is your current weight?
_____ pounds

14) What are you
Male
Female

Scoring method for Fruit and Vegetable questions:
- Fruit: Less than 2 cups is required for eligibility (less than 2 servings per day)
- Vegetables: Less than 3 cups is required for eligibility (less than 3 servings per day)
- ONE of these must be met to be eligible

Scoring for Family Affluence questions:
- Points assigned per response:
  - Computers/laptops in house: 0 = 0pts, 1 = 1pt, 2 = 2pts, etc.
  - Own bedroom: no = 0pts, yes = 1pt
  - Family travel: not at all = 0pts, once = 1pt, twice = 2pts, 3 or more times = 3pts
  - Cars in family: 0 = 0pts, 1 = 1pt, 2 = 2pts, more than 2 = 3pts
- Sum all points; corresponding affluence levels:
  - 0-2 = low affluence (eligible)
  - 3-5 = middle affluence (not eligible)
  - 6-9 = high affluence (not eligible)

Height and weight input should be used to calculate BMI
- BMI ≥ 25 kg/m^2 is eligible

APPENDIX B: SAMPLE RECRUITMENT FLYER

APPENDIX C: INFORMED CONSENT

PURPOSE OF STUDY

Thank you for your interest in the College Nutrition Study. **This research study is about college students' health-related behavior and the healthfulness of the campus environment.** There are eight universities that are part of this study: Dr. Adrienne White is the principal investigator here at the University of Maine and the other universities that are part of the study are Auburn University, Syracuse University, Kansas State University, South Dakota State University, University of Florida, University of Tennessee, and West Virginia University.

CAN I PARTICIPATE?

You are eligible to participate if you are:

- ✓ 18 years old or older
- ✓ an incoming freshman who plans to be at the University of Maine through Spring 2017

WHAT WILL I BE ASKED TO DO?

You will be asked to have physical measurements taken and complete online surveys over the next 2 years. There will be one assessment per semester, beginning in fall 2015. Also, there will be one assessment done in year 2 of the study, in the spring of each year.

- Measurements will include your height, weight, waist circumference, hip circumference, neck circumference and blood pressure. The measurements will take about 30 minutes to complete. We ask that you wear light clothing (preferably t-shirt and shorts or non-compression yoga pants). You will be asked to remove your shoes and socks and remove any items from your pockets. You will be measured in a private area by trained researchers. In addition you will be asked to wear a monitor, called an accelerometer, to measure physical activity over a seven-day period.
- A photograph of your face will be taken by a trained researcher for use with facial imagery software. Researchers are using these photographs to mathematically analyze face shape and are comparing face shape to height and weight, and neck, waist and hip circumferences. Researchers hope to determine if facial shape is an accurate indicator of body mass index (BMI).
- The surveys include questions about dietary intake, physical activity, sleep, stress, food security, green eating and demographics and will take about 30 minutes each time to complete. Example questions are the survey include:
    - In the last month, how often have you been upset because of something that happened unexpectedly?
    - I use the university's exercise facilities and equipment
    - I would describe my satisfaction with my family life as…
    - Each time you ate **fruit,** how much did you usually eat?
    - What is your current gender identity?
    - How often did you have a drink containing alcohol in the past year?
    - In the last 12 months, were you ever hungry but didn't eat because there wasn't enough money for food?

- You will be asked to provide your University ID, name and email. The identifying information will be used to match the data you provide and to communication with you over the 2 year study.

BENEFIT

There may be no direct benefit to you, however, you may be benefited by the physical measurements taken each year and looking at your food intake over the 2 year study. Findings from this study may help researchers to understand **health-related behavior of students at the University of Maine and in** the future, lessons learned about what makes a university campus as healthy as possible can be applied within the university system.

COMPENSATION

In fall 2015 you will be compensated $30 for completing the survey ($20) and physical measurements ($10). In the spring 2016, you will receive $45 for completing the survey ($30) and physical measurements ($15) for a total of $75 the first year.

Basic information (your name and address, date of payment, value of payment, my name as researcher) will be given to a University office for tax reasons. For student employee of UMaine this information will be sent to the Human Resources Department. The value of the compensation may be added as wages and subject to taxation.

RISKS

Risks to participation are minimal, primarily related to your time, inconvenience, perhaps feeling uncomfortable during physical assessments or by some of the questions. You may contact the Counseling Center for any concerns (581-1392). The data could be intercepted during the completion and transmission of the online surveys. This risk will be reduced by using an encrypted transmission for online surveys.

VOLUNTARY

Participation is voluntary. If you leave the study for any reason, you will not be eligible for the incentives described above.

CONFIDENTIALITY

All data collected will be held in confidence and stored securely.

- Hard copy data will be housed at each student's own university in researchers locked laboratories and uploaded onto a secure, password protected website maintained at the University of Tennessee. The website you will use for the survey is password protected for both the participants and researchers. The survey will be stored in a database on the secured server maintained by the University of Tennessee.
- When data collection is complete, data will be removed from the server and transferred to disks and maintained at the University of Tennessee. To secure data and maintain confidentiality, an https encrypted website is being used for this study and data are encrypted when transmitted. Your confidentiality will be maintained to the degree permitted by the technology used. Specifically, no guarantees can be made regarding the interception of data sent via the Internet by any third parties.

- The de-identified data will be combined with de-identified data from a variety of university locations and will be available to a variety of researchers, potentially from many different locations, for other analyses on related topics for an indefinite period of time.
- When data are presented for scientific purposes, data will be reported in summary format, and no names or other identifiable information will be used.
- Identifiable information will be kept only by your own university and used for communication with you over the study period and to disperse incentives. It will be destroyed after 4 years.
- Facial photographs are identifiable and measures will be taken to protect your photographs. You will be asked to hold your participant photo ID while the photograph is taken. Your name and identifying data will not be attached to the photograph. The list with participant IDs and participant photo IDs will be associated with your name and will be kept locked in our laboratory at the University of Maine. Photos will be uploaded to a password protected software database (SmugMug), which is only accessible by trained researchers. The photographs will be destroyed within seven years at the end of the study by closing the account and deleting electronic files.

QUESTIONS

If you have any questions or concerns about what this study involves, please contact Dr. Adrienne White at awhite@maine.edu. Contact the human subjects' representative, Gayle Jones (gayle.jones@umit.maine.edu) if you have concerns about your rights as a research participant. This study has been approved by the Institutional Review Board (IRB) of the University of Maine.

Your signature below indicates that you have read, understand the above information, and that you agree that you will participate in the College Nutrition Study. You will receive a copy of this form for your records.

_____ _____

Printed Name Signature

_____

Date

University of Maine Institutional Review Board
Approved for Use Through 07/06/2016

APPENDIX D: GET FRUVED MEDIA RELEASE FORM

I hereby grant Dr. Sarah Colby and researchers from partner institutions permission to use my artwork, logo, slogan, or creative ideas submitted to the FRUVED campaign and/or my likeness in a photograph or video in any and all of its publications, including website entries and distribution through technologies including mobile devices, without payment or any other consideration.

I understand and agree that these materials will become the property of Dr. Sarah Colby and will not be returned. I understand that these materials may be analyzed for research purposes but that my name or identifiable information will not be disclosed in any research findings.

I hereby irrevocably authorize Dr. Sarah Colby and researchers from partner institutions to edit, alter, copy, exhibit, publish or distribute this artwork, logo, slogan, creative ideas, photo, or video for purposes of publicizing or inclusion in Dr. Sarah Colby's programs or for any other lawful purpose. In addition, I waive the right to inspect or approve the finished product, including written or electronic copy, wherein my likeness or material contributions appear. Additionally, I waive any right to royalties or other compensation arising or related to the use of these materials.

I hereby hold harmless and release and forever discharge Dr. Sarah Colby and researchers from partner institutions from all claims, demands, and causes of action which I, my heirs, representatives, executors, administrators, or any other persons acting on my behalf or on behalf of my estate have or may have by reason of this authorization.

I am at least 18 years of age and am competent to contract in my own name. I have read this release before signing below and I fully understand the contents, meaning, and impact of this release.

_____ _____

(Printed Name) (Date)

_____ _____

(Signature) (Date)

_____ _____

(Witness Signature) (Date)

APPENDIX E: DEMOGRAPHIC FORM

Q332 What was your home address? (If possible please give the address for where you lived the longest prior to coming to college. If unknown, please provide the name of the town.)

Name of Street (no numbers please) (1)
City (2)
State (3)
Zipcode (4)

Q344.0 Please indicate the highest level of education achieved

Q344 Mother's education level

- ❍ Less than high school (1)
- ❍ High school/GED (2)
- ❍ Some college/vocational training (3)
- ❍ College graduate (4)
- ❍ Advanced/professional degree (5)
- ❍ I don't know (6)

Q345 Father's education level

- ❍ Less than high school (1)
- ❍ High school/GED (2)
- ❍ Some college/vocational training (3)
- ❍ College graduate (4)
- ❍ Advanced/professional degree (5)
- ❍ I don't know (6)

Q346 Do you consider yourself to be:

- ❍ Heterosexual or straight (1)
- ❍ Gay or lesbian (2)
- ❍ Bisexual (3)

Q347 In the past (time period e.g. year) who have you had sex with?

- ❍ Men only (1)
- ❍ Women only (2)
- ❍ Both men and women (3)
- ❍ I have not had sex (4)

Q348 People are different in their sexual attraction to other people. Which best describes your feelings? Are you:

- ❍ Only attracted to females (1)
- ❍ Mostly attracted to females (2)
- ❍ Equally attracted to females and males (3)
- ❍ Mostly attracted to males (4)
- ❍ Only attracted to males (5)

Q349 What sex were you assigned at birth, meaning on your original birth certificate?

- ❍ Male (1)
- ❍ Female (2)

Q350 How old are you?

- ❍ 18 (2)
- ❍ 19 (3)
- ❍ 20 (4)
- ❍ 21 (5)
- ❍ 22 (6)
- ❍ 23 (7)
- ❍ 24 (8)
- ❍ More than 24 years old (9)

Q351 What is your current gender identity?

- ❍ Male (1)
- ❍ Female (2)
- ❍ Trans male/Trans man (3)
- ❍ Trans female/Trans woman (4)
- ❍ Genderqueer/Gender non-conforming (5)
- ❍ Different identity (please state): (6) _____

Q352 Are you Hispanic or Latino?

- ❍ Yes (1)
- ❍ No (2)
- ❍ I don't know/Not sure (3)

Q353 Which one or more of the following would you say is your race?
- ❍ White (1)
- ❍ Black or African American (2)
- ❍ Asian (3)
- ❍ Native Hawaiian or Other Pacific Islander (4)
- ❍ American Indian or Alaska Native (5)
- ❍ Other (please specify) (6) _____

Q354 What is your year in school?
- ❍ Freshman (1)
- ❍ Sophomore (2)
- ❍ Junior (3)
- ❍ Senior (4)
- ❍ Graduate (5)

Q355 Where do you live?
- ❍ Campus residence hall (1)
- ❍ Sorority or fraternity (2)
- ❍ Other university/college housing (3)
- ❍ Off campus housing (4)
- ❍ Parent or guardian's home (5)
- ❍ Other, please specify (6) _____

Q356 Where is the university you attend?
- ❍ Alabama (1)
- ❍ Florida (2)
- ❍ Maine (3)
- ❍ Kansas (4)
- ❍ New York (5)
- ❍ Tennessee (6)
- ❍ South Dakota (7)
- ❍ West Virginia (8)

Q357 How would you define your current relationship status?
- ❍ Single (1)
- ❍ In a committed relationship (2)

Q358 How many hours a week do you work for pay during the school year?
- ❍ I do not work (1)
- ❍ 1 to 9 hours (2)
- ❍ 10 to 19 hours (3)
- ❍ 20 to 29 hours (4)
- ❍ 30 to 39 hours (5)
- ❍ 40 hours (6)
- ❍ More than 40 hours (7)

Q359 My overall GPA is
- ❍ 3.5 - 4.0 (1)
- ❍ 3.0 - 3.49 (2)
- ❍ 2.50 - 2.9 (3)
- ❍ 2.0 - 2.49 (4)
- ❍ Under 2.0 (5)
- ❍ Prefer not to answer (6)

Q360 Are you a student-athlete?
- ❍ Yes (1)
- ❍ No (2)

Q361 Do you have a scholarship?
- ❍ Yes (1)
- ❍ No (2)

Q362 Do you currently receive a Pell Grant?
- ❍ Yes (1)
- ❍ No (2)

Q363 What is your resident status?
- ❍ In-state student (1)
- ❍ Out of state student (2)
- ❍ International student (3)

Q337 Do you consider yourself to be a vegetarian?
- ❍ Yes (1)
- ❍ No (2)
- ❍ Choose not to answer (3)
- ❍ Don't know (4)

APPENDIX F: PITTSBURGH SLEEP QUALITY INDEX

INSTRUCTIONS:
The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month.
Please answer all questions.

1. During the past month, what time have you usually gone to bed at night?
BED TIME _

2. During the past month, how long (in minutes) has it usually taken you to fall asleep each night?
NUMBER OF MINUTES _

3. During the past month, what time have you usually gotten up in the morning?
GETTING UP TIME _

4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spent in bed.)
HOURS OF SLEEP PER NIGHT _

For each of the remaining questions, check the one best response. Please answer all questions.

5. During the past month, how often have you had trouble sleeping because you . . .

a) Cannot get to sleep within 30 minutes

Not during the past month_	Less than once a week_	Once or twice a week_	Three or more times a week_

b) Wake up in the middle of the night or early morning

Not during the past month_	Less than once a week_	Once or twice a week_	Three or more times a week_

c) Have to get up to use the bathroom

Not during the past month_	Less than once a week_	Once or twice a week_	Three or more times a week_

d) Cannot breathe comfortably

Not during the past month_	Less than once a week_	Once or twice a week_	Three or more times a week_

e) Cough or snore loudly

Not during the past month_	Less than once a week_	Once or twice a week_	Three or more times a week_

f) Feel too cold
Not during the past month_ | Less than once a week_ | Once or twice a week_ | Three or more times a week_

g) Feel too hot
Not during the past month_ | Less than once a week_ | Once or twice a week_ | Three or more times a week_

h) Had bad dreams
Not during the past month_ | Less than once a week_ | Once or twice a week_ | Three or more times a week_

i) Have pain
Not during the past month_ | Less than once a week_ | Once or twice a week_ | Three or more times a week_

j) Other reason(s), please describe_
How often during the past month have you had trouble sleeping because of this?
Not during the past month_ | Less than once a week_ | Once or twice a week_ | Three or more times a week_

6. During the past month, how would you rate your sleep quality overall?
Very good _ Fairly good _ Fairly bad _ Very bad _

7. During the past month, how often have you taken medicine to help you sleep (prescribed or "over the counter")?
Not during the past month_ | Less than once a week_ | Once or twice a week_ | Three or more times a week_

8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?
Not during the past month_ | Less than once a week_ | Once or twice a week_ | Three or more times a week_

9. During the past month, how much of a problem has it been for you to keep up enough
enthusiasm to get things done?
No problem at all
Only a very slight problem
Somewhat of a problem
A very big problem

10. Do you have a bed partner or roommate?
No bed partner or room mate
Partner/roommate in other room
Partner in same room, but not same bed
Partner in same bed

If you have a roommate or bed partner, ask him/her how often in the past month you have had . . .

a) Loud snoring

Not during the past month_	Less than once a week_	Once or twice a week_	Three or more times a week_

b) Long pauses between breaths while asleep

Not during the past month_	Less than once a week_	Once or twice a week_	Three or more times a week_

c) Legs twitching or jerking while you sleep

Not during the past month_	Less than once a week_	Once or twice a week_	Three or more times a week_

d) Episodes of disorientation or confusion during sleep

Not during the past month_	Less than once a week_	Once or twice a week_	Three or more times a week_

e) Other restlessness while you sleep; please describe_

Not during the past month_	Less than once a week_	Once or twice a week_	Three or more times a week_

APPENDIX G: PSQI Scoring Method

Name_____ Date_____

Sleep Quality Assessment (PSQI)

What is PSQI, and what is it measuring?

The Pittsburgh Sleep Quality Index (PSQI) is an effective instrument used to measure the quality and patterns of sleep in adults. It differentiates "poor" from "good" sleep quality by measuring seven areas (components): subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction over the last month.

INSTRUCTIONS:

The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

During the past month,

1. When have you usually gone to bed? _____
2. How long (in minutes) has it taken you to fall asleep each night? _____
3. What time have you usually gotten up in the morning? _____
4. A. How many hours of actual sleep did you get at night? _____
   B. How many hours were you in bed? _____

5. During the past month, how often have you had trouble sleeping because you	Not during the past month (0)	Less than once a week (1)	Once or twice a week (2)	Three or more times a week (3)
A. Cannot get to sleep within 30 minutes				
B. Wake up in the middle of the night or early morning				
C. Have to get up to use the bathroom				
D. Cannot breathe comfortably				
E. Cough or snore loudly				
F. Feel too cold				
G. Feel too hot				
H. Have bad dreams				
I. Have pain				
J. Other reason (s), please describe, including how often you have had trouble sleeping because of this reason (s):				
6. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep?				
7. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?				
8. During the past month, how much of a problem has it been for you to keep up enthusiasm to get things done?				
9. During the past month, how would you rate your sleep quality overall?	Very good (0)	Fairly good (1)	Fairly bad (2)	Very bad (3)

Scoring

Component 1	#9 Score	C1 _____
Component 2	#2 Score (<15min (0), 16-30min (1), 31-60 min (2), >60min (3)) + #5a Score (if sum is equal 0=0; 1-2=1; 3-4=2; 5-6=3)	C2 _____
Component 3	#4 Score (>7(0), 6-7 (1), 5-6 (2), <5 (3)	C3 _____
Component 4	(total # of hours asleep) / (total # of hours in bed) x 100 >85%=0, 75%-84%=!, 65%-74%=2, <65%=3	C4 _____
Component 5	# sum of scores 5b to 5j (0=0; 1-9=1; 10-18=2; 19-27=3)	C5 _____
Component 6	#6 Score	C6 _____
Component 7	#7 Score + #8 score (0=0; 1-2=1; 3-4=2; 5-6=3)	C7 _____

Add the seven component scores together _____ ***Global PSQI*** _____

A total score of "5" or greater is indicative of poor sleep quality.
If you scored "5" or more it is suggested that you discuss your sleep habits with a healthcare provider

APPENDIX H: COHEN'S PERCEIVED STRESS SCALE – 14

The next set of questions are about how you perceive stress.
In the last month, how often have you…
1)…been upset because of something that happened unexpectedly?
(0) Never
(1) Almost never
(2) Sometimes
(3) Fairly often
(4) Very often
(5) Choose not to answer

2)…felt that you were unable to control the important things in your life?
(0) Never
(1) Almost never
(2) Sometimes
(3) Fairly often
(4) Very often
(5) Choose not to answer

3)…felt nervous and stressed?
(0) Never
(1) Almost never
(2) Sometimes
(3) Fairly often
(4) Very often
(5) Choose not to answer

4)…dealt successfully with irritating life hassles?
(0) Never
(1) Almost never
(2) Sometimes
(3) Fairly often
(4) Very often
(5) Choose not to answer

5)…felt that you were effectively coping with important changes that were occurring in your life?
(0) Never
(1) Almost never
(2) Sometimes
(3) Fairly often
(4) Very often
(5) Choose not to answer

6)…felt confident about your ability to handle your personal problems?
(0) Never
(1) Almost never
(2) Sometimes
(3) Fairly often
(4) Very often
(5) Choose not to answer

7)…felt that things were going your way?
(0) Never
(1) Almost never
(2) Sometimes
(3) Fairly often
(4) Very often
(5) Choose not to answer

8)…found that you could not cope with all the things that you had to do?
(0) Never
(1) Almost never
(2) Sometimes
(3) Fairly often
(4) Very often
(5) Choose not to answer

9)…been able to control irritations in your life?
(0) Never
(1) Almost never
(2) Sometimes
(3) Fairly often
(4) Very often
(5) Choose not to answer

10)…felt that you were on top of things?
(0) Never
(1) Almost never
(2) Sometimes
(3) Fairly often
(4) Very often
(5) Choose not to answer

11)…been angered because of things that happen that were outside of your control?
(0) Never
(1) Almost never
(2) Sometimes
(3) Fairly often
(4) Very often
(5) Choose not to answer

12)…found yourself thinking about things that you have to accomplish?
(0) Never
(1) Almost never
(2) Sometimes
(3) Fairly often
(4) Very often
(5) Choose not to answer

13)…been able to control the way you spend your time?
(0) Never
(1) Almost never
(2) Sometimes
(3) Fairly often
(4) Very often
(5) Choose not to answer

14)…felt difficulties were piling up so high that you could not overcome them?
(0) Never
(1) Almost never
(2) Sometimes
(3) Fairly often
(4) Very often
(5) Choose not to answer

PSS-14 scores are obtained by reversing the scores on the seven positive items, e.g., 0=4, 1=3, 2=2, etc., and then summing across all 14 items. Items 4, 5, 6, 7, 9, 10, and 13 are the positively stated items.

Primary Reference:

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. Journal of Health and Social Behavior, 24, 385-396.[36]

APPENDIX I: DATA COLLECTION FORM

Participant ID:

Did the Participant Complete-	Consent □ Yes □ No Media Release □ Yes □ No Time of day assessments begun:

	Date			**Date**		
	#1	**#2**	**AVG**	**#1**	**#2**	**AVG**
Height (cm)						
Weight (kg)						
Waist Circumference (cm)						
Hip Circumference (cm)						
Neck Circumference (cm)						
Blood Pressure (mm/Hg)						
Blood Pressure Arm (left or right)						
Photograph Taken?	□ Yes □ No			□ Yes □ No		
Accelerometer Serial Number						
Computer number						
Concerns for Error						
Comments						

*Enter these data on _____ website

**Round off the average of the two official measurements to two decimal places

If applicable: If participant dropped-out, list the date: _____

APPENDIX J: FULL TABLES NOT LISTED IN RESULTS

Table 9: Most Frequently Reported Sleep Disturbances (Mean±SD, %) for At-Risk First-Year College Students (n=1,081)

During the past month, how often have you had trouble sleeping because you …[1,2]									
	Mean Score	**Not during the past month**		**Less than once a week**		**Once or twice a week**		**Three of more times a week**	
	mean±sd	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Cannot get to sleep within 30 minutes	2.16±1.01*	330	*26.74*	339	*32.33*	203	*16.45*	149	*12.07*
Wake up in the middle of the night or early morning	2.38±1.05*	269	*21.80*	334	*27.07*	277	*24.45*	201	*16.29*
Have to get up to use the bathroom	1.85±0.95	502	*40.68*	317	*25.69*	181	*14.67*	81	*6.56*
Cannot breath comfortably	1.23±0.60	904	*73.26*	119	*9.64*	39	*3.16*	19	*1.54*
Cough or snore loudly	1.23±0.58	899	*72.85*	125	*10.13*	42	*3.40*	15	*1.21*
Feel too cold	1.77±0.91	546	*44.25*	297	*24.07*	180	*14.59*	58	*4.70*
Feel too hot	2.19±1.00*	339	*27.47*	315	*25.53*	309	*25.04*	118	*9.56*
Had bad dreams	1.62±0.85	623	*50.49*	290	*23.50*	122	*9.88*	46	*3.73*
Have pain	1.33±0.67	825	*66.86*	182	*14.75*	48	*3.89*	26	*2.11*

[1]Pittsburgh Sleep Quality Index (PSQI)(Appendix G)

[2]Individual questions of PSQI scored on a scale of 0-3; 0=not during the past month, 1=less than once a week, 2=once or twice a week, 3=three or more times a week

*Gender-specific differences in the frequency of reported sleep disturbances based on Chi-Square Test ($p<0.01$)

Table 11: Perceived Stress Scores of First-Year College Students by Item (Mean±SD and percent)

During the past month, how often have you …[1,2]											
	Mean Score	Never		Almost never		Sometimes		Fairly often		Very often	
	Mean±SD	n	*%*	n	*%*	n	*%*	n	*%*	n	*%*
Been upset because of something that happened unexpectedly	2.64±0.96*	36	*2.9*	71	*5.8*	335	*27.1*	443	*35.9*	196	*15.9*
Felt that you were unable to control the important things in your life	2.71±1.03*	32	*2.6*	81	*6.6*	333	*27.0*	354	*28.7*	281	*22.8*
Felt nervous and stressed	1.97±1.11	107	*8.7*	253	*20.5*	396	*32.1*	215	*17.4*	110	*8.9*
Dealt successfully with irritating life hassles	1.91±0.98	94	*7.6*	233	*18.9*	493	*40.0*	201	*16.3*	60	*4.9*
Felt that you were effectively coping with important changes that were occurring in your life?	1.24±0.97	265	*21.5*	415	*33.6*	303	*24.6*	73	*5.9*	25	*2.0*
Felt confident about your ability to handle your personal problems	1.15±0.92	287	*23.3*	431	*34.9*	299	*24.2*	46	*3.7*	18	*1.5*
Felt that things were going your way	1.54±0.90	140	*11.3*	368	*29.8*	442	*35.8*	116	*9.4*	15	*1.2*
Found that you could not cope with all the things that you had to do	1.79±0.99	89	*7.2*	334	*27.1*	442	*35.8*	148	*12.0*	68	*5.5*
Been able to control irritations in your life	1.45±0.86	138	*11.2*	426	*34.5*	419	*34.0*	84	*6.8*	14	*1.1*

Table 11: continued

Felt that you were on top of things	1.43±0.89	166	*13.5*	400	*32.4*	413	*33.5*	89	*7.2*	13	*1.1*
Been angered because of things that happen that were outside of your control	2.15±1.02	64	*5.2*	189	*15.3*	455	*36.9*	265	*21.5*	108	*8.8*
Found yourself thinking about things you have to accomplish	3.13±0.86*	11	*0.9*	31	*2.5*	176	*14.3*	449	*36.4*	414	*33.5*
Been able to control the way you spend your time	1.25±0.82	197	*16.0*	474	*38.4*	352	*28.5*	54	*4.4*	4	*0.3*
Felt difficulties were piling up so high that you could not overcome them	1.86±1.05	86	*7.0*	332	*26.9*	393	*31.8*	183	*14.8*	87	*7.1*

[1]Perceived Stress Scale (Appendix H)
[2]Individual questions scored on scale of 0-4: 0 being never, 4 very often
*Gender-specific differences in the frequency of reported sleep disturbances based on Chi-Square Test ($p<0.01$)

APPENDIX K: MODEL EVALUATION

Figure 4: Model Evaluation - BMI vs PSQI, Sex

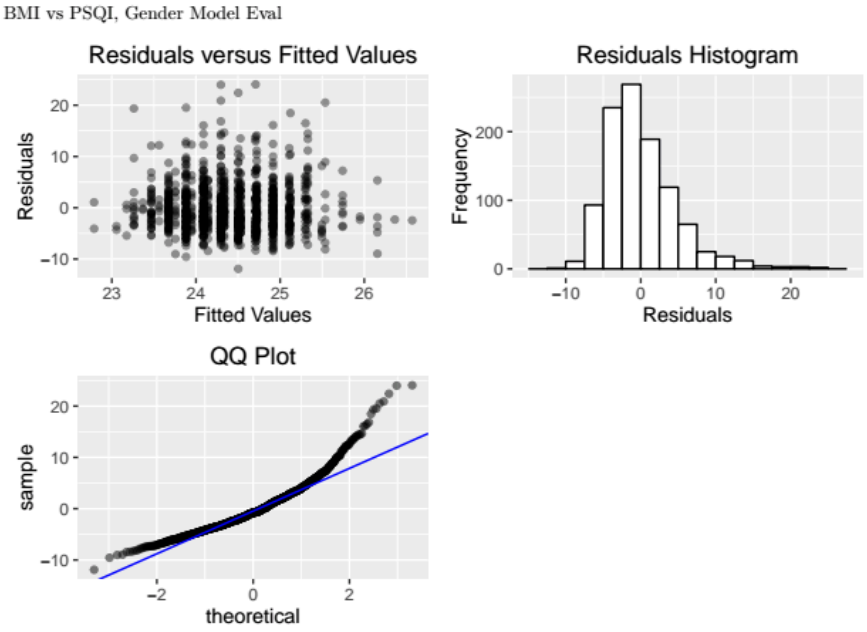


Figure 5: Model Evaluation - Stress vs. Duration, Sex

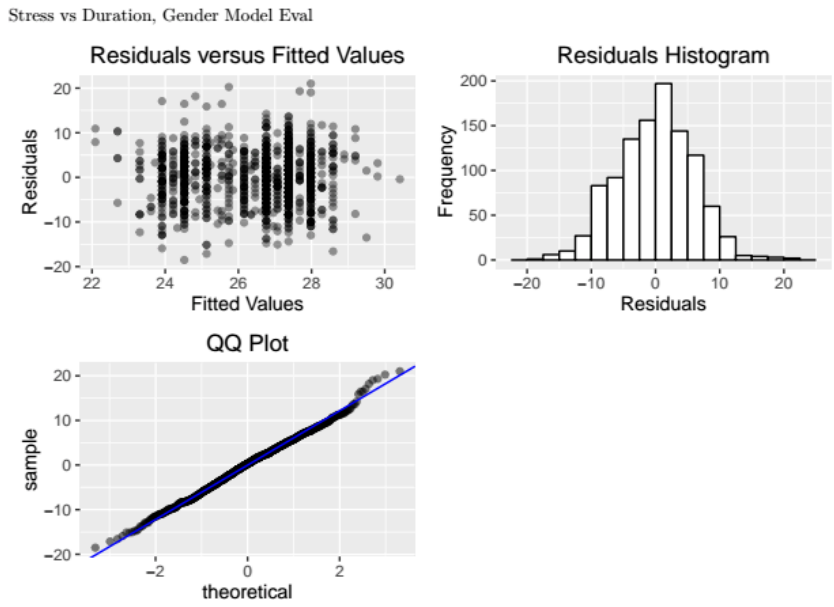
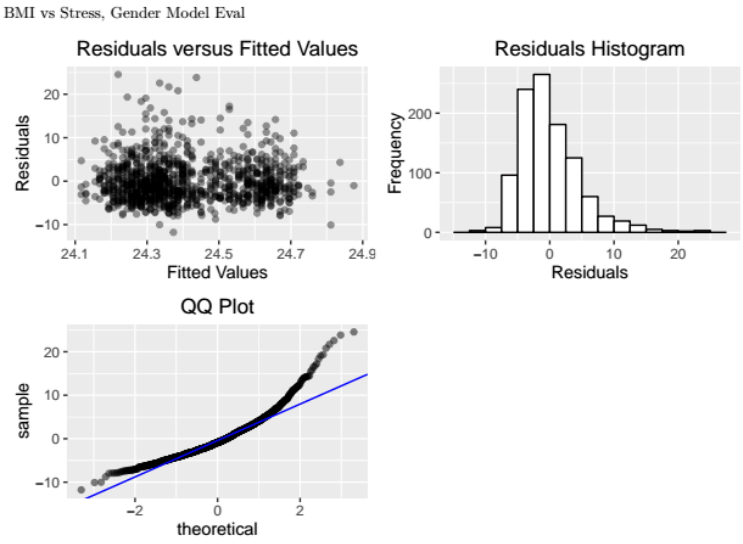


Figure 6: Model Evaluation - BMI vs. Stress, Sex



BIOGRAPHY OF THE AUTHOR

Grace A. Violette was born in Bridgeport, Connecticut on April 19, 1992. She completed her high school education in June of 2010 at Waterville Senior High School in Waterville, Maine. In May of 2015, Grace graduated magna cum laude from the University of Maine with a Bachelor of Science in Food Science and Human Nutrition and minor in Psychology. Before graduating from her undergraduate program in 2015, Grace was accepted into the University of Maine's Graduate Degree program and is participating in the Dietetic Internship program. Grace was appointed to a Research Assistantship for the Fruved research study under Dr. Adrienne White. Grace is a member of Kappa Omicron Nu Honor Society, the Academy of Nutrition and Dietetics, the Maine Academy of Nutrition and Dietetics and the Maine Nutrition Council. Her future plans include sitting for the registered dietitian exam, and working as a clinical or community dietitian. She is a candidate for the Master of Science degree in Food Science and Human Nutrition from the University of Maine in December 2016.