THE IMPACT OF SLEEP QUALITY ON ENERGY INTAKE,
EATING BEHAVIOR, AND PHYSICAL ACTIVITY

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THE IMPACT OF SLEEP QUALITY ON ENERGY INTAKE,
EATING BEHAVIOR, AND PHYSICAL ACTIVITY

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ABSTRACT

Obesity is associated with numerous health risks and is prevalent across all stages of the lifespan, although it tends to increase with age. As such, the college years are an important time for the development of obesity. Sleep behavior is a possible factor that may contribute to obesity; however, most studies that have examined this relationship have focused on sleep duration and not on sleep quality. Because the restorative nature of sleep depends on its quality in addition to quantity, it is important to measure sleep quality. The purpose of this study was to examine the impact of sleep quality on energy intake, eating behavior, and physical activity in a college sample. Participants completed self-report questionnaires measuring their sleep quality, dietary intake, eating behaviors, and physical activity. It was hypothesized that poor-quality sleepers would consume less protein and more carbohydrates, fat, and total calories compared to good-quality sleepers. It was also predicted that poor-quality sleepers would demonstrate increased hunger, disinhibition, and dietary restraint compared to good-quality sleepers. Finally, it was hypothesized that poor-quality sleepers would demonstrate lower frequencies of moderate, hard, and very hard physical activity compared to good-quality sleepers. These findings will contribute to the existing literature on sleep and obesity and will be important in the development of health promotion programs for college students.
The faculty listed below, appointed by the Dean of the College of Arts and Sciences, have examined a thesis titled “The Impact of Sleep Quality on Energy Intake, Eating Behavior, and Physical Activity,” presented by Ashleigh A. Pona, candidate for the Master of Arts degree, and certify that in their opinion it is worthy of acceptance.

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CHAPTER 1

INTRODUCTION

Obesity is associated with numerous health risks and is prevalent across all stages of the lifespan, although it tends to increase with age. As such, the college years in particular are an important time for the development of obesity. During the college years, students often move away from home for the first time, and their diet quality, physical activity, and sleeping habits can change due to school, work, and social schedules. Indeed, factors such as excess energy intake and decreased energy expenditure are the most common reasons thought to contribute to weight gain in college students. However, sleep has also been found to play an important role in the development of obesity and research has repeatedly found an association between reduced sleep and increased weight. There are various pathways through which sleep loss might adversely affect energy balance and lead to weight gain, including factors such as alterations in appetite and glucose regulation, increased food intake, and reduced energy expenditure. In order to work towards the prevention and treatment of obesity, it is important to study the relationship between sleep and obesity especially within the college population. The majority of previous studies have focused on the role of sleep duration in this relationship, and relatively few have investigated the role of sleep quality. Because the restorative nature of sleep depends on its quality in addition to quantity, sleep quality is an important variable to study and may have unique effects on eating behavior. Thus, the collection of sleep quality data will contribute to the existing literature on sleep and obesity and will be important in the development of health promotion programs for college students.
CHAPTER 2
REVIEW OF THE LITERATURE

Obesity

Overweight is defined as a body mass index (BMI) of 25 to 29.9 kg/m$^2$, and obesity as a BMI of greater than or equal to 30 kg/m$^2$ (National Institutes of Health, 1998). Overweight and obesity are associated with numerous health risks and are among the most significant contributors to ill health (Kopelman, 2007). For example, increasing BMI raises the risk of morbidity from health risks such as hypertension, type 2 diabetes, coronary artery disease, stroke, metabolic syndrome, and liver and gall bladder disease, to name a few (Kopelman, 2007). The prevalence of overweight and obesity is also extremely high across stages of the lifespan, and tends to increase with age. Data from the National Health and Nutrition Examination Survey in 2011-2012 indicated that 8.1% of infants and toddlers from birth to 2 years, 16.9% of children and adolescents aged 2-19 years, and 34.9% of adults aged 20 years and older were considered obese (Ogden, Carroll, Kit, & Flegal, 2014; Ogden, Carroll, Kit, & Flegal, 2013). Given the numerous risks associated with overweight and obesity, reducing the high prevalence of increasing body weight has become a public health priority (U.S. Department of Health and Human Services, 2010).

Because the prevalence of obesity tends to increase with age, the college years in particular are an important time for the development of obesity. In fact, during the past two decades, there has been a significant increase in obesity and obesity-related disorders among individuals in their teens and 20s (U.S. Department of Health and Human Services, 2001; Sparling, 2007). During the college years, students often move away
from home for the first time, and their diet quality and physical activity can change. For example, the “freshman 15” is a widespread belief that college students gain 15 pounds during their freshman year, and this idea has been investigated by several researchers. Butler et al. (2004) found that freshman women who left home to attend college had an average increase in body weight of 1.59 pounds over a 20-week period. During this time, dietary energy intake actually decreased, which suggests that a significant reduction in physical activity could be responsible for the change in body weight (Butler, Black, Blue, & Gretebeck, 2004). However, given that baseline weight measurements were taken at the beginning of the school year, and later measurements were taken 5 months after, the increase in weight could have been due to heavier winter clothes at the time of measurement. Levitsky et al. (2004) also found that freshman students gained an average of 4.2 pounds during their first 12 weeks of college, and that consumption of junk foods explained the most variance in weight gain (explained 24% out of a total of 71% explained variance) after controlling for initial body weight. A third study used a sample of 125 freshman and found that 30% gained 1-5 pounds, 17% gained 6-14 pounds, and 5% gained more than 15 pounds during the first 7 months of college, with an average weight gain of 2.7 pounds (Mihalopoulos, Auinger, & Klein, 2008). Morrow et al. (2006) found a significant body weight increase of 2.4 pounds in a sample of freshman females during their first year of college and reported that subjects who gained weight tended to be less active than those who lost weight. Finally, Racette et al. (2005) found that 70% of students gained approximately 9 pounds during their first two years of college. In sum, although 15 pounds seems to be an overestimate, these studies provide support for the idea that some degree of weight gain is common during the college years.
Research on the “freshman 15” helps to demonstrate why the college years are an important developmental transition period in terms of weight gain and why obesity develops into adulthood. Indeed, many of the effects of students’ eating habits during college continue into adulthood. Although different studies suggest different weight gains, there is a trend for weight gain to occur in college. Thus, in order to work towards the prevention and treatment of obesity, it is important to understand what factors are thought to contribute to obesity in college students. These potential factors are reviewed below.

**Excess Energy Intake**

Overweight and obesity are most commonly caused by excess energy intake relative to energy expenditure. In other words, when a person takes in more calories than they lose via metabolic and physical activity, they are likely to gain weight (Wright & Aronne, 2012). Excess caloric consumption is likely to occur from unhealthy diets high in fat, sugar, and sodium, and low in fiber, fruits, and vegetables (Ludwig et al., 1999). Research has found that such unhealthy diets are especially present amongst college students (Anding, Suminski, & Boss, 2001; Brevard & Ricketts, 1996; Racette, Deusinger, Strube, Highstein, & Deusinger, 2005).

Several studies have demonstrated that college students are likely to adopt diets high in fat, sugar, and sodium. For example, Anding and colleagues (2001) found that two-thirds (66%) of female participants exceeded recommended levels of saturated fat and 20% exceeded recommended levels of cholesterol. In terms of the Dietary Guidelines for Americans, 92% and 65% of the female students consumed a diet high in sugar and sodium, and 83% consumed a high-fat diet (Anding et al., 2001). Brevard et al. (1996)
also found that students consumed higher levels of total fat, saturated fat, and monounsaturated fat than recommended amounts. Racette et al. (2005) studied the dietary pattern changes of students from freshman to sophomore year and found that, during freshman year, almost half consumed three or more fried foods and high-fat fast foods during the previous week (54% and 50%, respectively). During their sophomore year, the students’ consumption of high-fat fast foods stayed the same (47%); however, their consumption of fried foods declined (43%). Moreover, Lazarevich et al. (2013), who evaluated eating behavior among college students in Mexico City, found that 75% reported carbohydrate craving and 41.4% reported constantly feeling hungry and overeating.

Multiple studies have also suggested that college students are not likely to consume the recommended amount of fiber, fruits, and vegetables. For example, Huang et al. (2003) found that students demonstrated an unhealthy diet by not meeting the recommended intake of at least 5 servings of fruits and vegetables per day or a minimum of 20 grams of dietary fiber per day. On average, the students reported consuming only 4.2 servings of fruits and vegetables and only 18 grams of fiber per day (Huang et al., 2003). Racette et al. (2005) also found that 70% of freshman consumed less than 5 fruits and vegetables daily, and Anding et al. (2001) found that 95% of female students did not consume the recommended amount of grains, fruits, and vegetables daily. Finally, Ferrara et al. (2013) found that only 23% of their student sample consumed five or more servings of fruits and vegetables, while 40% consumed only two servings or less.

Decreased Energy Expenditure

In addition to excess energy intake, decreased energy expenditure resulting from
physical inactivity also plays an important role in the development of obesity. During the past several decades, physical activity levels have dramatically decreased among U.S. adults, primarily due to sedentary lifestyles (Racette et al., 2005). For example, more time is now spent watching television, surfing the internet, and playing video games (Wright & Aronne, 2012). Furthermore, college students are known to have busy lifestyles filled with school, work, and social responsibilities; thus, students may be too tired or too busy to engage in the recommended amount of exercise. Indeed, research has shown that lack of regular exercise appears to be common amongst college students.

In a study conducted by Haberman et al. (1998), 39% of students reported that they exercised 3 or more times per week, and 12.3% reported not exercising at all. In addition, Anding et al. (2001) found that 75% of female participants did not comply with the Dietary Guidelines for Americans guideline of obtaining regular physical exercise and maintaining a healthy weight. Huang et al. (2003) also surveyed students and found that a high percentage engaged in low physical activity, in which students reported engaging in exercise on only 2.8 days in the previous 7 days. Racette et al. (2005) found that only about half (59%) of their student participants engaged in regular aerobic exercise, and 30% did not engage in any exercise. Ferrara et al. (2013) also found a lack of physical activity in their student sample, where only 18% reported engaging in vigorous to moderate aerobic exercise for at least 20 to 30 minutes on five or more days, 36% reported exercising on three or four days, and 46% reported exercising on two or less days during the past week.

Similar findings have also been observed among ethnically diverse college students. For example, Suminski et al. (2002) examined physical activity levels among
ethnically diverse college students and found that 47% of the total sample did not engage in vigorous physical activity, and 17% were inactive during the month before the study. In addition, Kelley et al. (1994) inquired about the activity levels of African-American freshman and found that approximately 42% of males and 65% of females were considered low or very low with regard to their level of physical activity.

Sleep

In addition to energy intake and expenditure, sleep has also been found to play an important role in the development of obesity. Specifically, research has shown that sleep restriction may cause increases in hunger and appetite (Spiegel, Tasali, Penev, & van Cauter, 2004). Indeed, as the prevalence of obesity has risen, there has been a parallel increase in work hours and sleep deprivation (Gupta, Mueller, Chan, & Meininger, 2002; Lerger, 2000).

Although sleep plays an especially fundamental role in college—a time when good health, productivity, and performance are imperative—research suggests that sleep problems are of concern in this population. For example, school, work, and social schedules are common to the lifestyle of college students and may potentially interfere with sleep needs (Wolfson & Carskadon, 1996; Wolfson & Carskadon, 1998). Moreover, the prevalence rates of sleep problems (i.e., poor sleep quality) among college students have ranged from 9.7% to 54.7% across studies (Fernández-Mendoza et al., 2009; Cheng et al., 2012). According to the national data of the spring 2008 American College Health Association—National College Health Assessment, 25.6% of student participants experienced sleep difficulties. In addition, 30.3% of students reported having at least 5
days of feeling fully rested in a week, and only 6.9% reported feeling fully rested every day of the week (American College Health Association, 2008).

Sleep can be defined as an active and reversible state of perceptual disengagement from and unresponsiveness to external stimuli. (Carskadon & Dement, 2005). There are two domains that are commonly used to describe sleep: sleep quality and sleep duration. Sleep duration is an objective sleep domain and refers to the actual time during which an individual is asleep. Sleep quality, on the other hand, refers to the subjective indices of how sleep is experienced, including feeling rested when waking up and satisfaction with sleep (Pilcher, Ginter, & Sadowsky, 1997). Furthermore, it is well known among health professionals that sufficient, restorative sleep has a fundamental and important role in the maintenance of physical and mental health (Lund, Reider, Whiting, & Prichard, 2010).

Although adequate sleep is crucial for good health, productivity, and performance, recent statistics have shown that sleep debt is becoming prevalent in industrialized countries (Ohayon & Partinen, 2002). The National Sleep Foundation suggests that most adults need 7 to 9 hours of sleep per night; however, this is not always the case. For example, in 2009 a sleep module was added to the Behavioral Risk Factor Surveillance System and revealed that, among 74,571 adult respondents in 12 states, more than one-third (35.3%) reported getting less than 7 hours of sleep per night on average (Centers for Disease Control and Prevention, 2011). The National Sleep Foundation 2013 Bedroom Poll yielded similar results, with 21% of U.S. adults getting less than 6 hours, and 32% getting 6 to 7 hours, of sleep on a typical weekday (National Sleep Foundation, 2013).

Shorter sleep duration, as demonstrated by these statistics, can have multiple
negative psychological consequences. For example, shorter sleep duration has been significantly associated with higher levels of stress (Galambos, Vargas Lascano, Howard, & Maggs, 2013) and depression (Hamilton, Nelson, Stevens, & Kitzman, 2007).

Relatedly, poor sleep quality has revealed similar effects, such that individuals who report poorer sleep quality have been found to consistently report higher scores on depressive symptoms (Pilcher et al., 1997) and perceived stress (Galambos, Dalton, & Maggs, 2009; Lund et al., 2010). Furthermore, troubled sleep can also lead to increased body weight and obesity. However, it is important to note that the relationship between sleep and mood, stress, and weight variables may be bidirectional in nature. As such, it is possible that increased depression, stress, and body weight may lead to sleep problems, as well as sleep problems may lead to increased depression, stress, and body weight.

In conclusion, sleep is a unique factor that could explain the increase in obesity during the college years; however, this relationship has not been adequately evaluated in the college weight gain literature. The next section will review the literature on the relationship between sleep and obesity, primarily in the child and adult populations.

**Sleep and Obesity**

Sleep behavior is a possible factor that may contribute to obesity. As the prevalence of obesity has risen, there has been a parallel increase in work hours and sleep deprivation (Gupta, Mueller, Chan, & Meininger, 2002; Lerger, 2000). In addition, cross-sectional studies in both children (von Kries, Toschke, Wurmser, Sauerwald, & Koletzko, 2002; Sugimori et al., 2004) and adults (Vioque, Torres, & Quiles, 2000; Cournot et al., 2004; Gangwisch, Malaspina, Boden-Albala, & Heymsfield, 2005) have repeatedly found an association between reduced sleep and increased weight, with adult studies suggesting
that the risk for obesity is much higher for individuals who sleep less than 7 hours per
night. Furthermore, in a systematic review and meta-analysis by Cappuccio and
colleagues (2008), a pooled odds ratio of 1.89 in children and 1.55 in adults was found
for short sleep duration and its relationship with obesity. Table 1 outlines several studies
that have examined the association between sleep duration and obesity. These studies
demonstrate that shorter sleep duration (e.g., less than 6 hours per night) is associated
with increased risks for obesity.
### Table 1

**Studies on sleep duration and obesity**

<table>
<thead>
<tr>
<th>First author (year)</th>
<th>Study details</th>
<th>Participant characteristics</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chen (2008)</td>
<td>Sleep duration, meta-analysis</td>
<td>Reviewed studies of children</td>
<td>OR=1.58 for short sleep duration and overweight/obesity compared to children/adolescents with a recommended level of sleep</td>
</tr>
<tr>
<td>Gangwisch (2005)</td>
<td>Sleep duration, cross sectional</td>
<td>9,588 adults, ages: 32-49</td>
<td>ORs of obesity for different sleep durations: OR=2.35 (2-4 hours/night), OR=1.60 (5 hours/night), OR=1.27 (6 hours/night), ORs of different sleep durations are compared to 7 hours of sleep per night</td>
</tr>
<tr>
<td>Gupta (2002)</td>
<td>Sleep duration</td>
<td>383 adolescents, ages: 11-16</td>
<td>OR=.20 for every hour of increased sleep time, the odds of obesity decreases by 80%</td>
</tr>
<tr>
<td>Sekine (2002)</td>
<td>Sleep duration</td>
<td>8274 children, ages: 6-7</td>
<td>ORs of obesity for different sleep durations: OR=1.49 (9-10 hours/night), OR=1.89 (8-9 hours/night), OR=2.87 (&lt;8 hours/night), ORs of different sleep durations are compared to &gt;10 hours of sleep per night</td>
</tr>
<tr>
<td>van den Berg (2008)</td>
<td>Sleep duration</td>
<td>983 adults, ages: &gt;55</td>
<td>OR=2.76 for obesity with a short sleep duration of &lt;5 hours/night compared to participants sleeping 7-&lt;8 hours per night</td>
</tr>
<tr>
<td>Vioque (2000)</td>
<td>Sleep duration</td>
<td>814 males, 958 females, ages: 15+</td>
<td>Prevalence OR=.76, for each additional hour spent sleeping per day, risk of obesity decreases by 24%</td>
</tr>
</tbody>
</table>
There are various pathways through which sleep loss might adversely affect energy balance and lead to weight gain, including factors such as alterations in appetite and glucose regulation, increased food intake, and reduced energy expenditure (van Cauter & Knutson, 2008). These factors are reviewed below.

**Neuroendocrine Hormones**

Numerous studies have found that insufficient sleep is associated with a dysregulation of the neuroendocrine control of appetite, with a decrease in levels of the satiety hormone, leptin, and an increase in levels of the hunger-stimulating hormone, ghrelin (Taheri, Lin, Austin, Young, & Mignot, 2004; Spiegel, Leproult, & van Cauter, 1999; Spiegel et al., 2004; Guilleminault et al., 2003). Leptin is an anorexigenic hormone that helps regulate energy intake and expenditure, including appetite and hunger, metabolism, and behavior; whereas ghrelin is an orexigenic hormone that stimulates hunger and food intake, induces appetite and feeding behaviors, and reduces energy expenditure and promotes retention of fat (Taheri et al., 2004). As such, it has been proposed that these two hormones work together as a regulatory system to inform the brain about the current state of energy balance (Muccioli et al., 2002).

Several studies have demonstrated the effect of sleep on appetite hormones. For example, in a study conducted by Spiegel and colleagues (1999), healthy young men were subjected to 6 nights of 4 hours in bed followed by 7 nights of 12 hours in bed, and all participants had the same caloric intake and amount of physical activity. The results from this study showed that mean leptin levels were lower and mean ghrelin levels higher during sleep restriction compared to sleep extension. Glucose levels were also elevated.
following breakfast on the last day of sleep restriction, and participants disposed of glucose at a slower rate in response to an intravenous glucose tolerance test (Spiegel, Leproult, & van Cauter, 1999). Furthermore, the insulin response to glucose was 30% lower after sleep restriction, which may be an early sign of diabetes (Spiegel et al., 1999; Kahn, 1995).

Spiegel and colleagues (2004) conducted a second study with a similar design where participants were subjected to 2 days of 4 hours in bed and 2 days of 10 hours in bed. The results replicated those from the first study in that mean leptin levels were 18% lower during sleep restriction compared to sleep extension. In addition, mean ghrelin levels also differed between the two conditions, and were found to be 28% higher during sleep restriction compared to sleep extension. Guilleminault et al. (2003) conducted a similar study where healthy men, aged 18 to 25 years, were subjected to 7 nights of 4 hours in bed followed by 3 nights of sleep recovery. The yielded results were comparable to that of Spiegel et al. (1999; 2004), where mean leptin levels were 33% lower after sleep restriction compared to sleep recovery. Furthermore, Taheri et al. (2004) used data from the Wisconsin Sleep Cohort Study that included over 1000 subjects and also found that short sleep duration was associated with decreased leptin and increased ghrelin levels.

Schmid et al. (2008) subjected male participants to one night of 7 hours of sleep, one night of 4.5 hours of sleep, and one night of total sleep deprivation. Results showed that ghrelin levels were 22% higher after total sleep deprivation compared to 7 hours of sleep with intermediate levels of ghrelin after 4.5 hours of sleep (Schmid, Hallschmid, Jauch-Chara, Born, & Shultes, 2008). Hogenkamp et al. (2013) subjected young men to
one night of 8 hours in bed and one night of total sleep deprivation and found that subjects had a 13% increase in ghrelin levels the morning after total sleep deprivation. Finally, Benedict et al. (2011) subjected health male participants to either normal sleep or a night of total sleep deprivation and found that glucose levels decreased and late nocturnal ghrelin levels increased the morning after sleep deprivation. Table 2 outlines the aforementioned studies that have examined the association between sleep duration and neuroendocrine hormones.

Thus, the findings of these studies suggest that reduced sleep duration may increase the risk of obesity by increasing appetite via decreases in leptin and insulin sensitivity, and increases in ghrelin.

**Eating Behavior and Energy Consumption**

It has been demonstrated that insufficient sleep can alter appetite and glucose regulation; the next step would be for these alterations to affect eating behavior by increasing energy intake. This appears to be the most plausible explanation as to why and how sleep contributes to obesity, and this relationship has been studied extensively. In one study, poor subjective sleep quality (as measured with the Pittsburgh Sleep Quality Index) was associated with eating behaviors characterized by increased hunger, uncontrolled and emotional eating (disinhibition), and more cognitive restraint over eating in a sample of adults at risk for type 2 diabetes (Kilkus et al., 2012). Although this sample of young adults reported more cognitive restraint over eating, they may be susceptible to failure of restraint because they also exhibited potentially problematic eating behaviors, such as uncontrolled and emotional eating (Kilkus et al., 2012; van
Strien, 1997). Another study subjected participants to 2 days of 4 hours in bed and 2 days of 10 hours in bed and found that subjective appetite was 23% higher during sleep.
Table 2

*Studies on sleep duration and neuroendocrine hormones*

<table>
<thead>
<tr>
<th>First author (year)</th>
<th>Study details</th>
<th>Participant characteristics</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benedict (2011)</td>
<td>normal sleep (~8 hours), total sleep deprivation</td>
<td>14 healthy males, mean age: 22.6, mean BMI: 23.9</td>
<td>During the morning after sleep deprivation, participants reported greater hunger and exhibited increased late nocturnal ghrelin levels and decreased glucose levels</td>
</tr>
<tr>
<td>Guilleminault (2003)</td>
<td>7 nights of 4 hours in bed, 3 nights of sleep recovery</td>
<td>8 young adult males</td>
<td>In the sleep dept condition (4 hours in bed) participants exhibited decreased leptin levels</td>
</tr>
<tr>
<td>Hogenkamp (2013)</td>
<td>night 1: 8 hours sleep, night 2: total sleep deprivation</td>
<td>16 males, mean age: 23, mean BMI: 23.6</td>
<td>During the morning after sleep deprivation, participants exhibited increased ghrelin levels</td>
</tr>
<tr>
<td>Schmid (2008)</td>
<td>night 1: 7 hours sleep, night 2: 4.5 hours sleep, night 3: total sleep deprivation</td>
<td>9 healthy young men, mean age: 24.2, mean BMI: 23.8</td>
<td>In the total sleep deprivation condition participants exhibited increased ghrelin levels. In the 7 hours sleep and 4.5 hours sleep conditions participant ghrelin levels did not differ</td>
</tr>
<tr>
<td>Spiegel (1999)</td>
<td>16 consecutive nights, night 1-3: 8 hours sleep, night 4-9: 4 hours sleep, night 10-16: 12 hours sleep</td>
<td>11 healthy young men, ages: 18-27</td>
<td>In the sleep debt condition (nights 4-9) participants exhibited decreased insulin response to glucose, decreased glucose tolerance, decreased leptin levels, and increased ghrelin levels</td>
</tr>
<tr>
<td>Spiegel (2004)</td>
<td>2 days of 4 hours in bed, 2 days of 10 hours in bed</td>
<td>12 healthy men, mean age: 22, mean BMI: 23.6</td>
<td>In the sleep dept condition (4 hours in bed) participants exhibited decreased leptin levels and increased ghrelin levels</td>
</tr>
<tr>
<td>Taheri (2004)</td>
<td>Data were collected with self-report sleep measures, a 6-day sleep diary, and polysomnography</td>
<td>1,024 adults, mean age: 52.7, mean BMI: 29.7</td>
<td>Short sleep duration was associated with decreased leptin levels and increased ghrelin levels</td>
</tr>
</tbody>
</table>
restriction compared to sleep extension (Spiegel et al., 2004). In addition, during sleep restriction participants had a greater craving for foods that were high in calories and carbohydrates than for other food types. Taken together, these results suggest that both the quality and duration of sleep can have effects on subjective eating behavior.

Moreover, the relationship between sleep and eating behavior can be examined more objectively by measuring energy intake. For example, McNeil and colleagues (2013) had participants complete three-day food records and found a difference in carbohydrate intake between poor and good sleepers, with good sleepers (333.67 ± 68.43g) consuming significantly more carbohydrates than poor sleepers (291.81 ± 81.03g); however, the authors did not find any differences between sleep duration groups. In addition, the authors did not breakdown carbohydrate intake into specific food groups; thus, it is unknown whether the sleepers differed on fruit/vegetable intake, breads/grains, and/or snack foods, for example. Furthermore, there were no differences between groups for total energy, fat, or protein intake (McNeil et al., 2013). A final study examined two groups of sleepers—subjects who slept <7 hours per night and subjects who slept 7-8 hours per night—and found that shorter sleepers demonstrated an increase in fast food and high-fat food consumption and a decrease in fruit and vegetable consumption (Stamatakis & Brownson, 2008).

Because sleep is known to affect energy consumption, and college is a time when weight gain is common (i.e., the “freshman 15”), it is important to examine the relationship between sleep and energy consumption within the college population. However, there have been a limited amount of studies that have examined this relationship. Haghighatdoost and colleagues (2012) conducted a study with female
students, aged 18 to 28 years old, and found that subjects with a sleep duration of less
than 6 hours a day had a higher intake of energy than those with a sleep duration of more
than 8 hours a day (2406 ± 825 versus 2092 ± 700 kcal). In addition, the mean
percentages of protein and carbohydrate intake were 14% and 58% for the short sleepers
and 19% and 52% for the long sleepers; thus, short sleepers consumed significantly more
carbohydrates and significantly less protein in comparison to long sleepers. In terms of
food groups, short sleepers consumed significantly less fruits, whole grains, and beans
than long sleepers. In terms of nutrients, short sleepers had a significantly lower mean
intake of niacin, vitamin C, and vitamin B12 as compared to long sleepers
(Haghighatdoost, Karimi, Esmaillzadeh, & Azadbakht, 2012).

In a second study conducted by Hicks and colleagues (1986), college students
responded to a sleep habits questionnaire and recorded the number and timing of all
meals and snacks for a typical day. Results showed that short sleepers (6 or less hours of
sleep per night) were more likely to deviate from the “normal” three meals a day pattern
and ate more small meals and snacks as compared to long sleepers (8 or more hours of
sleep per night) (Hicks, McTighe, & Juarez, 1986). Schmid et al. (2008) subjected male
participants to one night of 7 hours of sleep, one night of 4.5 hours of sleep, and one
night of total sleep deprivation and found that subjects perceived stronger feelings of
hunger after total sleep deprivation than after 7 hours of sleep or 4.5 hours of sleep.
Additionally, hunger feelings did not significant differ between 7 and 4.5 hours of sleep.
Hogenkamp et al. (2013) subjected young men to one night of 8 hours in bed and one
night of total sleep deprivation and found that subjects chose larger portion sizes during
breakfast and their self-reported hunger was enhanced after total sleep deprivation.
Furthermore, Benedict et al. (2011) subjected male participants to either normal sleep or total sleep deprivation and found that participants reported greater levels of hunger on visual analogue scales during the morning following sleep deprivation. Table 3 outlines the aforementioned studies that have examined the association between sleep and energy consumption.

In addition to energy consumption from food, research has also investigated the relationship between sleep and alcohol and caffeine intake. Research has demonstrated that consumption of alcohol and caffeine interferes with sleep quality. For example, in a study by Nakade and colleagues (2009), students who consumed more alcohol exhibited higher unhealthy sleep scores than those who did not drink. Moreover, Hicks and colleagues (1983) discovered an inverse relationship between caffeine use and sleep duration in college students. Although caffeine is thought to enhance performance, research suggests that—under conditions of habitual sleep—caffeine merely restores performance degraded by sleepiness, which may be due to basal sleep insufficiency and circadian sleep schedule reversals (Roehrs & Roth, 2008). However, Hicks and colleagues (1983) found no relationship between caffeine use and sleep satisfaction. Furthermore, Lund and colleagues (2010) found that alcohol and caffeine consumption were not significant predictors of sleep quality in a college population.

Taken together, these findings suggest that sleep problems are common within the college population and that sleep deprivation does affect eating behavior and energy consumption. However, due to the limited amount of studies investigating this relationship in college students, further research is needed to replicate and extend these findings.
**Energy Expenditure**

In addition to alterations in appetite and glucose regulation, sleep disturbance may also lead to reduced energy expenditure. Although there are no published studies on the relationship between sleep and energy expenditure in college students specifically, there is some research examining this relationship in the general child/adolescent and adult populations. Within the child/adolescent population, Gupta and colleagues (2002) found that the amount of daytime physical activity in adolescents was inversely associated with sleep disturbance time; where for every hour of sleep disturbance, there was a 3% decrease in daytime physical activity. The results also showed that for every hour of increased sleep time, the odds of obesity decreased by 80%. Garaulet et al. (2011) also found that adolescents who slept less than 8 hours per day were more sedentary as assessed by accelerometry.

Wennman et al. (2014) investigated the relationship between physical activity and sleep in adults and found that the likelihood for high leisure time physical activity co-
Table 3

Studies on sleep and energy consumption

<table>
<thead>
<tr>
<th>First author (year)</th>
<th>Study details</th>
<th>Participant characteristics</th>
<th>Outcome measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bosy-Westphal (2008)</td>
<td>One group design, long term study 2 nights: &gt;8 hours sleep; 4 nights: sleep curtailment (7 hrs, 6 hrs, 6 hrs, 4 hrs), 2 nights: sleep recovery (&gt;8 hrs)</td>
<td>14 healthy females, ages: 23-38, BMIs: 20-36</td>
<td>Energy intake (self-report record), Body weight</td>
<td>Energy intake increased by 20% (mean increase was 415 cal/day), mean body weight increased by 400 grams, and plasma leptin levels increased by 24%</td>
</tr>
<tr>
<td>Brondel (2010)</td>
<td>2-condition crossover design, acute sleep deprivation (48 hour study), 8 hours of sleep, 4 hours of sleep, standardized meals</td>
<td>12 male students, ages: 18-29, BMIs: normal (19-24.6)</td>
<td>Energy intake (self-report record), Hunger</td>
<td>In the 4 hours of sleep condition, participants exhibited greater hunger before breakfast and dinner, had a greater total energy intake, and had an increased consumption of fats</td>
</tr>
<tr>
<td>Calvin (2013)</td>
<td>Parallel-group design, long-term study, experimental = 8 days/8 nights, recovery = 4 days/3 nights, control = ad lib sleep duration, sleep deprivation = 2/3 of normal sleep time, food ad lib</td>
<td>17 adults (11 male, 6 female), ages: 18-40, BMIs: normal (18.5-24.9)</td>
<td>Energy intake (dieticians assessed using receipts of food and nutritional labels)</td>
<td>During the sleep deprivation condition, participants exhibited an increase in total energy intake</td>
</tr>
</tbody>
</table>

*table continues*
<table>
<thead>
<tr>
<th>First author (year)</th>
<th>Study details</th>
<th>Participant characteristics</th>
<th>Outcome measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grandner (2013)</td>
<td>Self-report measurements of sleep and energy intake: sleep: &quot;how much sleep do you usually get at night on weekdays or workdays?&quot; energy intake: 24 hour recall</td>
<td>4548 adults, mean age: 46.3, mean BMI: 28.7</td>
<td>Total energy intake, Macronutrient intake</td>
<td>The short sleep group had the highest total energy intake and the highest intake for all fats (saturated, monounsaturated, polyunsaturated, cholesterol). The very short sleep group had the lowest total energy intake and the lowest consumption of protein and carbohydrates.</td>
</tr>
<tr>
<td>Haghighatdoost (2012)</td>
<td>Cross-sectional study, Self-report measurements of sleep and energy intake</td>
<td>410 female students, ages: 18-28</td>
<td>Energy intake (food frequency questionnaire), Body weight</td>
<td>Subjects who slept &lt;6 hours a night were more likely to be overweight and obese, consumed more dietary energy and carbohydrates, and consumed less fiber, protein, and fruits.</td>
</tr>
<tr>
<td>Kilkus (2012)</td>
<td>14 days of sleep monitoring at home; 1 night of lab polysomnography (8.5 hours); used Pittsburgh Sleep Quality Index to assess subjective sleep quality</td>
<td>53 healthy adults, parental history of type-2 diabetes, ages: 21-40, BMIs: 19-27</td>
<td>Eating behavior (Three-Factor Eating Questionnaire)</td>
<td>Reduced subjective sleep quality (higher Pittsburgh Sleep Quality Index score) was associated with increased hunger, uncontrolled and emotional eating, and more cognitive restraint.</td>
</tr>
</tbody>
</table>

*table continues*
<table>
<thead>
<tr>
<th>First author (year)</th>
<th>Study details</th>
<th>Participant characteristics</th>
<th>Outcome measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Markwald (2013)</td>
<td>2-condition crossover design, long-term study: 14 days, 5 days in either 5-hour or 9-hour sleep condition</td>
<td>16 adults</td>
<td>Ad libitum energy intake, Satiety and hunger hormones</td>
<td>During the 5-hour condition: 24-hour food intake was 6% greater than in the 9-hour condition, subjects consumed more carbohydrates, subjects consumed 42% more calories as after dinner snacks (which contained more carbohydrates, protein, and fiber) than in the 9-hour condition, more calories were consumed at night after dinner than calories consumed for an individual meal, average 24-hour leptin levels increased by 22%, average 24-hour ghrelin levels decreased by 30% (and by 21% in 9-hour condition)</td>
</tr>
<tr>
<td>Nedeltcheva (2009)</td>
<td>2-condition crossover design, long-term study (two 14-day periods), hours of sleep: 5.5 or 8.5, dietician made individual meal plans</td>
<td>11 sedentary adults (6 male, 5 female), ages: 34-49, BMIs: overweight (24-29)</td>
<td>Energy intake (weighed food before and after)</td>
<td>During the 5.5 hours of sleep condition, participants showed an increased consumption of energy from snacks (late-night) and a greater total energy intake (due mostly to snacks, not meals) However, the difference in total energy intake was no longer significant after baseline weight was controlled</td>
</tr>
<tr>
<td>Schmid (2008)</td>
<td>3 nights: night 1: 7 hours of sleep, night 2: 4.5 hours of sleep, night 3: total sleep deprivation</td>
<td>9 healthy males, normal weight</td>
<td>Feelings of hunger (self report Likert scale from 1-9)</td>
<td>Participants perceived stronger feelings of hunger after total sleep deprivation than after 7 or 4.5 hours of sleep Hunger feelings did not significantly differ between 7 and 4.5 hours of sleep.</td>
</tr>
<tr>
<td>First author (year)</td>
<td>Study details</td>
<td>Participant characteristics</td>
<td>Outcome measures</td>
<td>Results</td>
</tr>
<tr>
<td>---------------------</td>
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</tr>
<tr>
<td>Spaeth (2013)</td>
<td>Repeated measures design, long-term study 2 baseline nights (10-12 hours of sleep), 5 experimental nights (4 or 10 hours of sleep), 2 recovery nights (12 hours of sleep)</td>
<td>37 adults, ages: 22-50, BMIs: 19-30</td>
<td>Energy intake (weighed/recorded by study personnel), Macronutrients</td>
<td>For the control participants (those who were assigned to the 10 hours of sleep experimental condition), caloric intake did not differ across protocol days. For participants who were assigned to the sleep restriction condition (4 hours of sleep), they consumed more calories during the experimental night than during baseline and recovery nights; they consumed more calories than control participants during experimental phase; they consumed more grams of protein, carbohydrates, and fats on experimental nights versus baseline or recovery nights; they consumed more meals during experimental nights than during baseline or recovery nights; and they consumed larger meals during experimental nights versus baseline or recovery nights.</td>
</tr>
<tr>
<td>St-Onge (2011)</td>
<td>2-condition crossover design, long-term (two 6-day periods), hours of sleep: ~4 or ~9, controlled food intake first 4 days, ad lib last 2 days</td>
<td>26 adults (13 men, 13 women), ages: means 36.3 (5.6), 33.9 (4.3) BMIs: means 24.1 (1.1), 23 (1.1)</td>
<td>Ad lib energy intake weighed and recorded by personnel</td>
<td>During the short sleep (~4 hours) condition participants exhibited greater energy intake, greater fat and saturated fat intake, and ate more often (more eating occasions).</td>
</tr>
</tbody>
</table>
occurs with normal sleep range and subjective sleep satisfaction. Furthermore, their findings also suggested that risk factors for low physical activity included a subjective feeling of not sleeping enough, short sleep duration, and being an evening type (Wennman et al., 2014).

In a study conducted by Schmid et al. (2009), 15 healthy men were subjected to 2 nights of 8.25 hours in bed and 2 nights of 4.25 hours in bed, and physical activity was measured by accelerometry. Results showed that sleep restriction significantly decreased physical activity after the first night of sleep manipulation, and the intensities of physical activity were also shifted towards lower levels, resulting in less time spend engaging in intense activities (Schmid et al., 2009).

**Factors Confounded with Sleep**

Several additional factors can affect weight gain and are often confounded with sleep. These factors will be controlled for in the analyses of this thesis and are described here. These include stress, mood/anxiety, and gender. For example, in a meta-analysis on the effect of stress on eating behavior, and how stress-induced eating may contribute to the development of obesity, researchers concluded that stress appears to both increase and decrease food intake (Torres & Nowson, 2007). Additionally, when individuals respond to stress by eating more, the authors state there is evidence that suggests the selected foods are usually high in sugar and fat (Torres & Nowson, 2007). Anxiety may also alter eating behavior by decreasing energy intake. For example, according to Herman and colleagues (1987), normal (i.e, nonobese and nondieting) individuals who are responsive to their physiological state, are expected to react to anxiety by eating less.
Mood has also been shown to affect eating behavior. One study induced either a depressed or nondepressed mood in obese and nonobese dieters and nondieters (Baucom & Aiken, 1981). Results showed that dieters ate more when depressed than when nondepressed, and nondieters ate less when depressed than when nondepressed. In other words, both groups reversed their typical eating patterns when depressed. The eating behaviors of depressed and nondepressed students were also examined. The authors found that, among depressed students, dieters ate more than nondieters; among nondepressed students, dieters ate less than nondieters. This pattern was found both for obese and nonobese students (Baucom & Aiken, 1981). In another study investigating mood, participants were asked to record everything they ate over a 2-week period, including their moods during the meals. Results showed that meals eaten in positive and negative moods were significantly larger than meals eaten in a neutral mood (Patel & Schlundt, 2001).

Furthermore, gender differences in eating behavior are also commonly observed. For example, the energy needs of men continue to exceed those of women. In terms of food choices, men have been found to eat fewer fruits, vegetables, and low-fat foods compared to women (Li et al., 2000; Liebman, Cameron, Carson, Brown, & Meyer, 2001). Moreover, research has also found women to be more likely to diet and attach greater importance to healthy eating than men, which can influence their food choices and energy intake (Wardle, Haase, & Steptoe, 2004). Taken together, these findings suggest that other factors, such as stress, mood, anxiety, and gender, may affect eating behavior and, thus, should be taken into consideration when assessing the relationship between sleep and eating behavior.
Summary

In summary, the prevalence of overweight and obesity is extremely high across stages of the lifespan, and tends to increase with age. As such, the college years in particular have been suggested to be an important time for the development of obesity. Factors that are thought to contribute to obesity in college students include excess energy intake, decreased energy expenditure, and sleep. The various pathways through which sleep loss might lead to weight gain include factors such as alterations in appetite and glucose regulation, increased food intake, and reduced energy expenditure. In order to work towards the prevention and treatment of obesity, it is important to study the relationship between sleep and obesity especially within the college population. Furthermore, while most studies have focused on the role of sleep duration in this relationship, relatively few have investigated the role of sleep quality.

Study Aims

There are two main rationales for conducting this study. First, not much is known about the relationship between sleep and obesity in the college population. The majority of studies investigating this relationship have focused on more general populations, such as child/adolescents and adults. It is important to take a closer look at this relationship in college students as the college years in particular have been suggested to be an important time for the development of obesity. The college years have been shown to be a critical period for weight gain. The second rationale for conducting this study is that most studies that have examined the link between sleep and obesity have focused on sleep duration and not on sleep quality. While sleep duration is an objective measure which refers to the actual time during which an individual is asleep, sleep quality is subjective and more
multi-dimensional, measuring how sleep is experienced, including feeling rested when waking up and satisfaction with sleep. As such, although an individual may get 8 hours of sleep a night—which is the recommended duration—they may not feel rested when waking up. This suggests that the restorative nature of sleep depends on its quality in addition to quantity and, thus, sleep quality may have unique effects on eating behavior. The purpose of the current study is to extend the existing literature on sleep and eating behavior by assessing sleep quality, rather than sleep duration alone, to a sample of college students.

This study has three aims and three hypotheses:

Aim 1: To compare the energy intake and macronutrients of poor- and good-quality sleepers, using dietary recall data.

Hypothesis 1: Poor-quality sleepers will consume less protein and more carbohydrates, fat, total calories, alcohol, and caffeine compared to good-quality sleepers.

Aim 2: To compare the eating attitudes and behaviors of poor- and good-quality sleepers, using the Three-Factor Eating Questionnaire and Night Eating Questionnaire.

Hypothesis 2: Poor-quality sleepers will demonstrate increased hunger, disinhibition, and rigid control, and decreased flexible control, on the Three-Factor Eating Questionnaire, and will score higher on the Night Eating Questionnaire, compared to good-quality sleepers.

Aim 3: To compare levels of physical activity of poor- and good-quality sleepers, using the Seven-Day Physical Activity Recall.

Hypothesis 3: Poor-quality sleepers will demonstrate lower frequencies of moderate, hard, and very hard physical activity compared to good-quality sleepers.
Eligible participants included male and female college students who were recruited as part of a larger study on the prevalence and characteristics of night eating behavior among college students. In order to enroll in the larger study participants had to be age 18 years and older and enrolled in a general psychology course at the University of Missouri–Kansas City at the time of data collection. Instructors of psychology courses were asked for permission to visit their classes and recruit participants for the study. Trained research assistants then visited the approved classes, provided a brief overview of the study, and distributed a sign-up sheet that included the time(s) and location(s) of the study. Upon arrival for testing, students were provided a detailed description of the study and gave their consent to participate. Participants then had their height and weight measured and completed several self-report measures of demographic characteristics, eating patterns and attitudes, lifestyle activities associated with eating at night, physical activity, mood, and anxiety (described below). Total estimated time to complete the study was one hour. Patients did not receive direct compensation for participation in the study; however, instructors of the general psychology courses had the option of awarding extra credit for participation. Data collection occurred from January 2007 to January 2008. Data on non-participants was not available for comparison, so it is unknown whether there was a sample selection bias. Table 4 describes participant demographic characteristics. There were no statistically significant differences between sleep quality (good vs. poor) groups on demographic characteristics.
Table 4

*Participant characteristics*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total Sample ((N = 84))</th>
<th>Poor-Quality Sleep ((n = 32))</th>
<th>Good-Quality Sleep ((n = 52))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age ((M, SD))</td>
<td>23.06, 5.79</td>
<td>22.97, 5.08</td>
<td>23.12, 6.26</td>
</tr>
<tr>
<td>% Female</td>
<td>81.9</td>
<td>81.3</td>
<td>82.4</td>
</tr>
<tr>
<td>% Caucasian</td>
<td>66.7</td>
<td>71.9</td>
<td>63.5</td>
</tr>
<tr>
<td>BMI kg/m(^2) ((M, SD))</td>
<td>25.33, 5.25</td>
<td>24.44, 4.61</td>
<td>25.87, 5.57</td>
</tr>
</tbody>
</table>

**Measures**

**Height and Weight**

Height and weight were measured with a commercial grade digital scale and stadiometer. Body mass index (BMI) was then calculated using the following equation:

\[
BMI = \frac{Weight(kg)}{Height(m^2)}.
\]

**Demographic and Lifestyle Questionnaire**

The Demographic and Lifestyle Questionnaire was developed for the larger study by the research team to assess both participant characteristics and behaviors. Demographic items included year in school, age, and gender, as well as factors that may affect circadian eating and sleeping patterns (i.e., medication use and shift work). Lifestyle items assessed drug and alcohol use, sexual activity, and study habits, in addition to their association with food intake after the evening meal. Demographic and lifestyle information will be used descriptively to describe the study sample for the current secondary analysis project.

**Pittsburgh Sleep Quality Index (PSQI)**
The PSQI (Buyessee, Reynolds, Monk, Berman, & Kupfer, 1989) is a 19-tem self-report measure designed to assess sleep quality over the past month. The PSQI has strong internal consistency (Cronbach’s $\alpha = .83$) across its 7 subscales, which measure subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. The seven subscales are added to determine a global sleep quality score, with a range of 0 to 21. A global cutoff score of 5 correctly identified 88.5% of all patients and controls (Cohen’s kappa = .75, $p < .001$); thus, in the current study, a PSQI global score greater than 5 was indicative of a poor-quality sleeper, and a score less than 5 was indicative of a good-quality sleeper.

**Dietary Recall**

A dietary recall measure was developed for the larger study by the research team to calculate the amount of carbohydrates, fat, protein, total calories, alcohol, and caffeine consumed in the past 24-hour period. The recall data were collected in-person using a paper-and-pencil approach with standardized probes (e.g., visual aids of food measurements). Participants were asked to record an accurate and complete listing of all food and drink consumed in the last 24 hours. Caloric content of food and drink were analyzed using publically available nutrition information (http://www.sparkpeople.com). Two trained research assistants entered the dietary recall information into the nutritional analysis program and extracted the total calories, carbohydrates, fat, protein, alcohol, and caffeine content of each item. When there were discrepancies between the two raters’ information/calorie content for a single item, a third research assistant was brought in to make sure the previous two dietary recall entries did not include any mistakes, and then the calorie and macronutrient content from the two dietary recall entries were averaged.
Participants were also asked if their 24-hour dietary recall was representative of their typical eating pattern. If participants reported that their dietary recall was not typical, then they were excluded from further statistical analyses.

**Three-Factor Eating Questionnaire (TFEQ)**

The TFEQ (Stunkard & Messick, 1985) is a 51-item self-report questionnaire designed to measure cognitive and behavioral components of eating, which include three specific dimensions: cognitive restraint of eating, disinhibition, and hunger. The cognitive restraint of eating scale measures conscious control over food intake in order to influence body weight and/or body shape. The disinhibition scale is designed to measure episodes of loss of control over eating, while the hunger scale assesses subjective feelings of hunger and food cravings and their behavioral consequences. Each of the three scales of the TFEQ demonstrates acceptable internal consistency (Cronbach’s alphas = .70-.90) (Karlsson, Persson, Sjostrom, & Sullivan; 2000).

Furthermore, researchers have proposed that the cognitive restraint of eating scale can be divided into two additional subscales—rigid control and flexible control—to better understand the relationship between restraint and disinhibition (Westenhoefer, Stunkard, & Pudel, 1999). The rigid control subscale measures a pattern of restraint that is associated with more disturbed eating, such as binge eating, that is not helpful in weight reduction or weight maintenance. The flexible control subscale, on the other hand, measures a pattern of restraint that is associated with less disturbed eating, lower body weight, and more successful weight reduction and maintenance. These two additional subscales of the TFEQ have demonstrated acceptable internal consistency (Cronbach’s alphas = .69-.70) (Westenhoefer et al., 1999).
**Night Eating Questionnaire (NEQ)**

The NEQ (Allison et al., 2008) is a 14-item self-report questionnaire designed to assess the behavioral and psychological symptoms of Night Eating Syndrome (NES). Previous research has supported that the NEQ consists of a four-factor structure measuring nocturnal ingestions, evening hyperphagia, morning anorexia, and mood/sleep, in addition to an overarching factor of night eating symptomatology (Allison et al., 2008). The NEQ demonstrates acceptable internal consistency (Cronbach’s alpha = .70), convergent validity, and discriminant validity.

**Seven-Day Physical Activity Recall (PAR)**

The PAR (Blair, 1984) is a self-report measure that assesses the type and frequency of moderate, hard, and very hard physical activity during the previous seven days. The PAR is a commonly used, validated measure of physical activity in the general population (Montoye, Kemper, Saris, & Washburn, 1996; Sallis, 1997) and demonstrates good reliability (intraclass correlation coefficient: .94-.97) (Hayden-Wade, Coleman, Sallis, & Armstrong, 2003).

**State Trait Anxiety Inventory (STAI)**

The STAI (Spielberger, Gorsuch, & Lushene, 1970) is a 20-item self-report questionnaire that includes separate measures of state and trait anxiety. State anxiety refers to how a person may feel at the time of a perceived threat and is considered temporary, whereas trait anxiety refers to relatively stable individual differences in anxiety proneness (Spielberger et al., 1970). Internal consistency coefficients for the STAI have ranged from .86 to .95, and test-retest reliability coefficients have ranged from .65 to .75 for two-month intervals (Spielberger, Gorsuch, Lushene, Vagg, & Jacobs,
The STAI has also demonstrated good construct and concurrent validity (Spielberger, 1989). The STAI was used as a covariate in this study, and was therefore controlled for in the statistical analyses.

**Beck Depression Inventory-II (BDI-II)**

The BDI-II (Beck, Steer, & Brown, 1996) is a widely used, 21-item, self-report questionnaire designed to measure severity of depression over the past two-weeks. The BDI-II demonstrates high internal consistency with coefficients ranging from .92 for outpatients to .93 for college students, and good test-retest reliability with a coefficient of .93 for a one-week interval. The BDI-II has also been found to demonstrate adequate content and construct validity (Beck et al., 1996). The BDI-II was used as a covariate in this study, and was therefore controlled for in the statistical analyses.

**Perceived Stress Scale (PSS)**

The PSS (Cohen, Kamarck, & Mermelstein, 1983) is a 14-item questionnaire designed to measure the degree to which situations in one’s life are thought of as stressful. The PSS demonstrates good internal consistency (Cronbach’s alpha = .84-.86) in various samples. In addition, the PSS demonstrates acceptable to good test-retest reliability, with coefficients ranging from .85 for two-day intervals to .55-.64 for six-week intervals (Cohen et al., 1983). The PSS was used as a covariate in this study, and was therefore controlled for in the statistical analyses.

**Statistical Analysis**

**Hypothesis One**

The first aim of this study is to compare the energy (kcal), macronutrient (carbohydrates, fat, and protein), alcohol, and caffeine consumption of poor- and good-
quality sleepers, using dietary recall data. Gender and scores on anxiety, depression, and stress measures will be controlled for. It is hypothesized that poor-quality sleepers will consume less protein and more carbohydrates, fat, total calories, alcohol, and caffeine compared to good-quality sleepers. Analyses of covariance (ANCOVAs) will be conducted to test this hypothesis.

**Hypothesis Two**

The second aim of this study is to compare the eating attitudes and behaviors of poor- and good-quality sleepers using the TFEQ and NEQ. Gender and scores on anxiety, depression, and stress measures will be controlled for. It is hypothesized that poor-quality sleepers will demonstrate increased hunger, disinhibition, and rigid control, and decreased flexible control, on the TFEQ, and will score higher on the NEQ, compared to good-quality sleepers. ANCOVAs will be conducted to test this hypothesis.

**Hypothesis Three**

The third aim of this study is to compare the amount of physical activity of poor- and good-quality sleepers. Gender and scores on anxiety, depression, and stress measures will be controlled for. It is hypothesized that poor-quality sleepers will demonstrate lower frequencies of moderate, hard, and very hard physical activity compared to good-quality sleepers. ANCOVAs will be conducted to test this hypothesis.

**Power Analysis**

For the ANCOVA approaches above, a power analysis was conducted to detect differences between the poor and good sleep quality groups in terms of effect sizes (Cohen, 1988). The calculations assumed a Type I error rate of .05, a Type II error rate of .02 (power of .80), and a two-tailed statistical test. Previous effect sizes were extracted.
from two studies similar in nature to the current study (Grandner, Jackson, Gerstner, & Knutson, 2013; Haghighatdoost et al., 2012), and were averaged. With 75 participants for the total sample and four covariates, this study can detect an effect size of .33, which is considered a moderate association (Cohen, 1988).
CHAPTER 4

RESULTS

Descriptive Statistics

The final sample consisted of 84 undergraduate students (81.9% female; 66.7% Caucasian; mean age = 23.06; mean BMI: 25.33 kg/m2). There were no demographic differences between sleep groups in age, gender, race, or BMI. The mean global and component PSQI scores for each sleep quality group are presented in Table 5. The poor-quality sleep group scored significantly higher on all PSQI scales. The mean BDI, STAI, and PSS global scores for each sleep quality group are presented in Table 6. These scores were used as covariates in subsequent analyses.

Table 5

Global and component PSQI scores for poor- and good-quality sleep groups

<table>
<thead>
<tr>
<th>Scale</th>
<th>Poor-Quality (n = 32)</th>
<th>Good-Quality (n = 52)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Global</td>
<td>8.31</td>
<td>2.25</td>
</tr>
<tr>
<td>Subjective sleep quality</td>
<td>1.59</td>
<td>0.67</td>
</tr>
<tr>
<td>Sleep latency</td>
<td>1.88</td>
<td>0.83</td>
</tr>
<tr>
<td>Sleep duration</td>
<td>1.06</td>
<td>0.76</td>
</tr>
<tr>
<td>Habitual sleep efficiency</td>
<td>0.94</td>
<td>0.98</td>
</tr>
<tr>
<td>Sleep disturbances</td>
<td>1.31</td>
<td>0.54</td>
</tr>
<tr>
<td>Use of sleeping medications</td>
<td>0.38</td>
<td>0.91</td>
</tr>
<tr>
<td>Daytime dysfunction</td>
<td>1.16</td>
<td>0.51</td>
</tr>
</tbody>
</table>

Note. Higher scores indicate poorer (worse) sleep quality. Group differences on all scales were significant at \( p < .01 \)
Table 6

Global BDI, STAI, and PSS scores for poor- and good-quality sleep groups

<table>
<thead>
<tr>
<th>Measure</th>
<th>Poor-Quality (n = 32)</th>
<th>Good-Quality (n = 52)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>BDI**</td>
<td>15.22</td>
<td>12.15</td>
</tr>
<tr>
<td>STAI**</td>
<td>87.94</td>
<td>24.84</td>
</tr>
<tr>
<td>PSS*</td>
<td>29.25</td>
<td>8.58</td>
</tr>
</tbody>
</table>

* Significant at $p < .05$, ** Significant at $p < .01$

Hypothesis One: Poor-quality sleepers will consume less protein and more carbohydrates, fat, total calories, alcohol, and caffeine compared to good-quality sleepers

ANCOVAs were conducted on a subset of the sample to test hypothesis one. While the initial sample consisted of 84 undergraduate students, 37 were excluded for indicating that their dietary recalls were not representative of their typical eating pattern, so only 48 students were included in the analysis for hypothesis one (poor-quality $n=17$; good-quality $n=31$). Those who were excluded from analysis did not differ from those who were included on any of the variables examined in hypothesis one. In addition, there were no differences in the proportion of excluded participants between sleep groups.

It was hypothesized that poor-quality sleepers would consume less protein and more carbohydrates, fat, total calories, alcohol, and caffeine compared to good-quality sleepers. Results indicated that poor-quality sleepers consumed significantly more calories, $F(1,41)=8.10, p=.007, \eta^2=.17$, fats, $F(1,41)=14.97, p<.001, \eta^2=0.27$, and
carbohydrates, $F(1,41)=5.48$, $p=.02$, $\eta^2=0.12$, as compared to good-quality sleepers.

However, there were no significant differences between sleep-quality groups in protein, alcohol, or caffeine consumption. Mean quantities of protein, carbohydrates, fat, calories, alcohol, and caffeine consumed are presented for both groups in Table 7.

Table 7

*Average quantities of protein, carbohydrates, fat, and calories consumed*

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Poor-Quality ($n = 17$)</th>
<th>Good-Quality ($n = 31$)</th>
<th>$F$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein (g)</td>
<td>77.72 32.87</td>
<td>65.06 28.13</td>
<td>0.48</td>
</tr>
<tr>
<td>Carbohydrates (g)</td>
<td>269.63 79.71</td>
<td>196.79 77.96</td>
<td>5.48*</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>84.17 40.63</td>
<td>49.29 22.22</td>
<td>14.97***</td>
</tr>
<tr>
<td>Total calories</td>
<td>2105.03 680.28</td>
<td>1499.37 514.59</td>
<td>8.10**</td>
</tr>
<tr>
<td>Alcohol (mg)</td>
<td>0.76 3.15</td>
<td>2.38 8.37</td>
<td>0.30</td>
</tr>
<tr>
<td>Caffeine (mg)</td>
<td>70.18 94.57</td>
<td>39.23 72.97</td>
<td>0.68</td>
</tr>
</tbody>
</table>

* Significant at $p < .05$, ** Significant at $p < .01$, *** Significant at $p < .001$

**Hypothesis Two:** Poor-quality sleepers will demonstrate increased hunger, disinhibition, and rigid control, and decreased flexible control, on the TFEQ, and will score higher on the NEQ, compared to good-quality sleepers

ANCOVAs were conducted to test hypothesis two. The entire sample was used in analysis. It was hypothesized that poor-quality sleepers would demonstrate increased hunger, disinhibition, and rigid control, and decreased flexible control, on the TFEQ, and would score higher on the NEQ, compared to good-quality sleepers. Results indicated that poor-quality sleepers reported higher levels of night eating as compared to good-quality sleepers, $F(1,77)=4.22$, $p=.04$, $\eta^2=0.05$. However, after running post-hoc analyses
on each NEQ item, it was revealed that the items that assessed sleep and mood drove this finding, in that poor-quality sleepers reported more sleep and mood disturbances. As such, the NEQ was re-scored by excluding the sleep and mood items (items 6, 7, and 8) and a second post-hoc analysis was conducted on the new NEQ scores while controlling for covariates. Results indicated that poor-quality sleepers still reported higher levels of night eating as compared to good-quality sleepers F(1,77)=3.97, p=.05, η²=0.05. Furthermore, there were no significant differences between sleep-quality groups in levels of hunger, disinhibition, rigid control, or flexible control. Mean global NEQ scores and TFEQ subscale scores are presented for both groups in Table 8.

Table 8

*Average scores on NEQ (re-scored) and TFEQ scales*

<table>
<thead>
<tr>
<th>Scale</th>
<th>Poor-Quality (n = 32)</th>
<th>Good-Quality (n = 51)</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEQ (re-scored)</td>
<td>11.88 15.91</td>
<td>8.39 3.38</td>
<td>3.97*</td>
</tr>
<tr>
<td>Hunger</td>
<td>6.38 3.15</td>
<td>5.08 2.87</td>
<td>1.86</td>
</tr>
<tr>
<td>Disinhibition</td>
<td>6.00 3.66</td>
<td>5.25 3.26</td>
<td>0.01</td>
</tr>
<tr>
<td>Rigid Control</td>
<td>2.41 2.14</td>
<td>2.41 2.22</td>
<td>0.11</td>
</tr>
<tr>
<td>Flexible Control</td>
<td>3.00 1.80</td>
<td>3.16 1.96</td>
<td>0.01</td>
</tr>
</tbody>
</table>

* Significant at p ≤ .05

**Hypothesis Three: Poor-quality sleepers will demonstrate lower frequencies of moderate, hard, and very hard physical activity compared to good-quality sleepers**

ANCOVAs were conducted to test hypothesis three. The entire sample was used in analysis. It was hypothesized that poor-quality sleepers would demonstrate lower frequencies of moderate, hard, and very hard physical activity compared to good-quality.
sleepers. Results indicated that poor-quality sleepers reported lower frequencies of moderate physical activity, $F(1,77)=3.98$, $p=.05$, $\eta^2=.05$, as compared to the good-quality sleepers. However, poor-quality sleepers actually reported higher frequencies of very hard physical activity, $F(1,77)=5.45$, $p=.02$, $\eta^2=.07$, as compared to the good-quality sleepers.

After inspecting the data more closely, it was found that two participants—both of whom were poor-quality sleepers—were skewing the distribution of very hard physical activity (i.e., they were more than two standard deviations away from the mean). One participant reported playing basketball for 710 minutes per week, and the other reported having track practice for 1020 minutes per week. A post-hoc analysis was conducted excluding these two participants and the original results did not hold; after excluding these two outliers, there were no longer significant differences in very hard physical activity frequencies between the two sleep groups.

Furthermore, there were no significant differences between sleep-quality groups in frequencies of hard or total physical activity. Average minutes of moderate, hard, very hard, and total weekly physical activity are presented for both groups in Table 9.

Table 9

*Average minutes of varying intensity weekly physical activity*

<table>
<thead>
<tr>
<th>Physical Activity Intensity Level</th>
<th>Poor-Quality ($n = 32$)</th>
<th>Good-Quality ($n = 51$)</th>
<th>$F$</th>
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</thead>
<tbody>
<tr>
<td>Moderate</td>
<td>347.00 543.24</td>
<td>712.67 795.40</td>
<td>3.98*</td>
</tr>
<tr>
<td>Hard</td>
<td>99.69 118.25</td>
<td>91.27 117.16</td>
<td>1.82</td>
</tr>
<tr>
<td>Very hard</td>
<td>101.25 227.12</td>
<td>35.76 80.28</td>
<td>5.45*</td>
</tr>
<tr>
<td>Total exercise</td>
<td>547.94 649.52</td>
<td>839.71 788.77</td>
<td>1.53</td>
</tr>
</tbody>
</table>

* Significant at $p \leq .05$
CHAPTER 5

DISCUSSION

This study evaluated the relationship between sleep quality and energy consumption and exercise behaviors among college students. It is important to study this relationship in the college population because the college years have been suggested to be an important time for the development of obesity because of factors such as excess energy intake, decreased energy expenditure, and poor sleep. Consequently, poor sleep has the potential to lead to altered appetite and glucose regulation, increased food intake, and reduced energy expenditure. As such, studying the relationship between sleep and obesity within the college population will help work towards the prevention and treatment of obesity. Furthermore, while most studies have focused on the role of sleep duration in this relationship, relatively few have investigated the role of sleep quality.

This study had three aims and three hypotheses. The first aim was to compare the energy intake and macronutrients of poor- and good-quality sleepers, using dietary recall data. It was hypothesized that poor-quality sleepers would consume less protein and more carbohydrates, fat, total calories, alcohol, and caffeine compared to good-quality sleepers. The second aim was to compare the eating attitudes and behaviors of poor- and good-quality sleepers, using the Three-Factor Eating Questionnaire and Night Eating Questionnaire. It was hypothesized that poor-quality sleepers would demonstrate increased hunger, disinhibition, and rigid control, and decreased flexible control, on the Three-Factor Eating Questionnaire, and would score higher on the Night Eating Questionnaire, compared to good-quality sleepers. The final aim was to compare levels of physical activity of poor- and good-quality sleepers, using the Seven-Day Physical
Activity Recall. It was hypothesized that poor-quality sleepers would demonstrate lower frequencies of moderate, hard, and very hard physical activity compared to good-quality sleepers.

The first hypothesis was partially supported; the poor-quality sleepers consumed significantly more carbohydrates, fat, and total calories as compared to good-quality sleepers, but there were no significant differences in protein, alcohol, or caffeine consumption. These results are consistent with the findings from previous studies that show that individuals who are sleep deprived often increase their consumption of fattening foods (Stamatakis & Brownson, 2008; Brondel, Romer, Nougues, Touyarou, & Davenne, 2010; Spaeth, Dinges, & Goel, 2013), carbohydrates (Haghhighatdoost et al., 2012; Markwald et al., 2013; Spaeth et al., 2013), and total calories (Haghhighatdoost et al., 2012; Brondel et al., 2010; Calvin et al., 2013; Markwald et al., 2013). These findings have also been replicated in individuals with poor sleep quality (McNeil et al., 2013). Furthermore, the increase in carbohydrate and fat consumption evident in the poor-quality sleepers may be indicative of this subset of college students being more likely to choose snack or junk foods rather than healthy foods. Indeed, this has been supported by prior research that has revealed that sleep deprived participants demonstrate a decrease in healthy food consumption such as fruits, vegetables, and fiber (Stamatakis & Brownson, 2008; Haghhighatdoost et al., 2012).

Moreover, although poor-quality sleepers consumed significantly more carbohydrates, fat, and total calories as compared to good-quality sleepers, the two groups did not differ in terms of BMI. One possible explanation for this discrepancy is that increased consumption of carbohydrates, fats, and calories—or unhealthy eating—
may add minimal weight to a student during their time in college (e.g., one pound per year) which may seem insignificant; however, this weight gain may become more significant over time as weight is consistently being put on each year. To more closely examine the notion of weight gain over time, the BMIs of poor-quality sleepers were compared across grade levels (i.e., freshman, sophomore, junior, senior), while controlling for gender. Surprisingly, there were no statistically significant BMI differences between grade levels, which suggests that it may take more time than just four years for weight gain from unhealthy eating behaviors to become apparent. As such, perhaps a more distinct difference in BMI between sleep quality groups would be apparent as unhealthy eating behaviors continue over time, and into later adulthood.

Aside from the findings that the poor- and good-quality sleep groups differed in consumption of carbohydrates, fats, and total calories, there was no difference in protein, alcohol, or caffeine consumption. While these findings only partially support the first hypothesis, it is important to note that previous research has shown mixed results in regard to these variables. In regards to protein, McNeil et al. (2013) studied a sample of overweight/obese men, ages 30 to 50, and failed to find a difference in protein consumption between the poor- and good-quality sleepers. Spaeth et al. (2013) studied a sample of normal/overweight adults, ages 22 to 50, and found an increase in protein consumption in participants who were experimentally sleep deprived as compared to their baseline and recovery consumption. Finally, Haghighatdoost et al. (2012) studied a sample of normal weight female students, ages 18 to 28, and found a decrease in protein consumption in short sleepers as compared to long sleepers. In regards to alcohol and caffeine, while some research suggests that consumption interferes with sleep quality,
Hicks and colleagues (1983) found no relationship between caffeine use and sleep satisfaction, and Lund and colleagues (2010) found that alcohol and caffeine consumption were not significant predictors of sleep quality in a college population. Taken together, these findings suggest that more research is needed to better understand the relationship between consumption of protein, alcohol, and caffeine and sleep quality and duration.

The second hypothesis yielded some unexpected results. First, poor-quality sleepers reported higher levels of night eating as compared to good-quality sleepers, which was expected. Post-hoc analyses on each NEQ item revealed that the sleep and mood items were driving this result, in that poor-quality sleepers reported more sleep and mood disturbances. Nonetheless, after these particular items were excluded from the NEQ global score, the result that poor-quality sleepers reported higher levels of night eating as compared to good-quality sleepers still held. Thus, this finding suggests that poor sleep quality may increase the risk for developing night eating syndrome, which may, in turn, be a risk factor for obesity (Cleator, Abbott, Judd, Sutton, & Wilding, 2012). Moreover, although mood was controlled for in the analyses of this study, future research should examine mood and sleep as independent risk factors for disturbed eating.

Contrary to what was expected, the two sleep quality groups did not differ in hunger, disinhibition, rigid control, or flexible control. It was hypothesized that poor-quality sleepers would exhibit increased hunger and disinhibition as this relationship has been demonstrated in previous research that used a sample of adults at risk for type 2 diabetes (Kilkus et al., 2012). However, it is important to note that the relationship between these subjective eating behaviors and sleep did not hold when groups were
formed on the basis of sleep duration rather than sleep quality (Kilkus et al., 2012), which obscures the relationship between sleep and subjective eating behavior. Furthermore, it was hypothesized that poor-quality sleepers would exhibit more rigid control—or disturbed eating—than good-quality sleepers, and that good-quality sleepers would exhibit more flexible control—or less disturbed eating—than poor-quality sleepers. Due to the fact that both of these variables measure different patterns of restraint, it is possible that the sample was a poor representation of restrained eaters and, as a result, no differences emerged between groups on these restraint variables. Indeed, both of the sleep groups scored relatively low in both flexible and rigid control—as evidenced by low means and positively skewed distributions—and there was little variability in scores.

The third hypothesis also yielded both supportive and unexpected results. First, good-quality sleepers reported higher frequencies of moderate physical activity as compared to the poor-quality sleepers, which was in support of hypothesis three. However, there were no differences between poor- and good-quality sleep groups in frequencies of hard or total exercise, which did not support the third hypothesis. Furthermore, the most surprising result was that poor-quality sleepers actually reported higher frequencies of very hard physical activity as compared to the good-quality sleepers; however, it was revealed that two participants were skewing the data and, once they were excluded from post-hoc analyses, this relationship did not hold. Due to the complexity of these results, it is important to put these findings into context when interpreting them.

One factor to consider when interpreting these physical activity data is the nature of PAR instrument and what it intends to measure. The PAR provides a list of examples
for each intensity level of physical activity, which aids in the interpretation of results. For example, moderate physical activities require light exertion and include waiting on tables, dishwashing, gardening, playing ping-pong, and brisk walking. Hard physical activities require more exertion and include scrubbing floors, weight lifting, dancing, and aerobics. Very hard physical activities require the most exertion and include cycling on hilly terrains, jogging, swimming, soccer, football, and basketball (Blair, 1984). As such, the finding that good-quality sleepers reported higher frequencies of moderate physical activity as compared to poor-quality sleepers does not necessarily mean that the good-quality sleepers were going to the gym more often. In fact, participants with the highest frequencies of moderate physical activity most often reported their activity as work-related, such as waiting on tables or hosting.

Furthermore, as described above, the finding that poor-quality sleepers reported higher frequencies of very hard physical activity as compared to good-quality sleepers did not hold once two outliers were excluded from post-hoc analyses. These extreme instances may represent student athletes who compete in collegiate sports teams and, as a result, may not accurately represent the physical activity behavior of all college students with poor sleep quality. These findings may also suggest that student athletes are not getting enough sleep due to their demanding sport schedules.

The findings from this study have several important clinical implications. First, the identification of factors, such as poor sleep quality, that influence weight gain and poor diet in college students is a valuable source of information that can be used to design interventions specifically targeting the college population. Such interventions may be carried out by college health centers and aim to educate students about reasons for the
“freshmen 15”—or the trend for weight gain to occur in college—and how to go about preventing this gain and staying healthy. These types of interventions may also help to reduce the incidence of overweight and obesity later in life and decrease the risk of acquiring health problems associated with being overweight. Furthermore, the findings from this study may also be used in more general sleep hygiene promotion and intervention among college students.

Another important finding from this study that may be useful to know on college campuses is the relationship between mood, stress, and sleep. This study has demonstrated that poor-quality sleepers score higher on these variables, and both college health and counseling centers may use this knowledge to inform students of the risk factors for mood disturbances and stress. College health and counseling centers can use this information to let students know that regular and restful sleep is essential for good physical and mental health. It is critical to acknowledge that college students often lead very busy and stressful lives, and everyday activities can strain their mind and bodies. Furthermore, sleep deprivation and disturbances can negatively affect important aspects of the mind and body, such as mood, judgment, energy, and efficacy. As such, good sleep is vital to restore energy, rest and rejuvenate the brain, and keep both the mind and body functioning properly. However, it is important to acknowledge that the relationship between sleep and mood and stress is likely to be bidirectional in nature, whereby low mood and increased stress may lead to sleep problems, as well as sleep problems may lead to low mood and increased stress.

In terms of implementing such interventions on college campuses, it may be beneficial to target subgroups of college students who are at risk for experiencing the
negative effects of poor sleep. For example, students who seek services at the counseling center for mental health issues such as depression, anxiety, and stress, or students who are struggling with grades or their schoolwork, may particularly benefit from educational sleep interventions. In addition, students who are in their first year of college may benefit from sleep interventions as they are likely going through significant transitions that may alter their sleeping patterns. If sleep interventions are educational in nature, it is possible for them to be delivered via the Internet, in face-to-face groups or classes, or through educational handouts. Sleep interventions may also include elements such as offering students earplugs and eye masks to help them get sleep, or eliminating early (i.e., 8 a.m.) classes in an effort to help sleep-deprived students.

This study has several strengths and limitations. To the author’s knowledge, this is one of the only studies to investigate the effects of sleep quality—as opposed to sleep duration—on dietary choices in college students. The construct of sleep quality is important to assess as it significantly impacts the restorative nature of sleep and encompasses more dimensions of sleep than does duration. Furthermore, the findings from this study may serve as a valuable source of information that can be used to design interventions specifically targeting the college population. Because sleep is often negatively affected during the college years due to busy class, work, and homework schedules, interventions aimed at promoting healthy sleep hygiene behaviors may have a significant impact on student’s physical and mental health.

This study also has some limitations. The method used to measure food intake, which consisted of recalling all foods consumed in the past 24-hour period, can be considered a limitation. This method, which relies on retrospective memory, may have
introduced recall bias whereby participants were not entirely accurate or complete in their dietary recall; however, if this bias is present, then it can be assumed that all observations are equally flawed. Moreover, the dietary assessment was not administered by a clinician and did not utilize the multiple pass approach. However, standardized probes (e.g., visual aids of food measurements) were utilized to help improve recall precision, and a test meal or prospective food recording were not feasible for this study as testing only lasted one hour. A similar limitation was the method used to assess physical activity, which consisted of recalling all physical activities completed in the past week. Again, this method is subjective and may have introduced recall bias; objective measurements of physical activity, such as a pedometer or metabolic equivalents, may have been more accurate. A third limitation was that participants volunteered for this study to receive course credit and thus were self-selected, which may have introduced some sampling bias.

A final limitation of this study was a confound between sleep quality and sleep duration of the participants. Because there was a statistically significant difference between sleep groups on the sleep duration component of the PSQI, the self-reported actual sleep time of participants were compared. It was found that the good-quality sleepers reported significantly more hours of sleep per night. However, participants were also asked to report the times they got in bed and woke up, and an ‘hours in bed’ variable was calculated based on these times. Surprisingly, when sleep duration was calculated this way, the two sleep groups did not differ from one another. The fact that the self-reported actual sleep time of participants was significantly different between the two sleep groups can be considered a limitation; however, this sleep time variable was
subjective in nature. As such, it is possible that participants with sleep problems underestimated the actual amount of time that they sleep, and vice versa for the participants without sleep problems—a finding that has been supported in previous research (Vanable, Aikens, Tadimeti, Caruana-Montaldo, & Mendelson, 2000).

The confound between sleep quality and sleep duration was further investigated to ensure that sleep duration did not account for all of the variability in participant responses on the PSQI. In other words, statistical analyses were conducted to ensure that the PSQI assessed for other dimensions of sleep quality, as opposed to sleep duration alone. The sleep duration item on the PSQI was correlated with the PSQI global score, in addition to the six component scores (excluding the Sleep Duration component), and the correlation coefficients ranged from -0.11 to -0.54, suggesting that the PSQI did, indeed, assess for other dimensions of sleep quality aside from sleep duration alone. Given that the correlation coefficients were not large, which would be indicative of a problem, the sleep duration item was entered as a covariate in the statistical analyses of all three hypotheses. The addition of sleep duration as a covariate changed some results in that night eating scores and frequency of moderate physical activity no longer differed between sleep quality groups. This suggests that the variable of sleep duration may have driven the results that poor-quality sleepers reported higher night eating scores than good-quality sleepers, and that good-quality sleepers reported greater moderate physical activity frequencies than poor-quality sleepers.

With regard to future research directions, studies should continue to investigate the effects of sleep quality—as opposed to just sleep duration—on energy consumption and physical activity in college students, and should consider using more objective
measures that do not rely on self-report. Furthermore, future intervention studies would be beneficial to determine whether or not the promotion of the importance of healthy sleep hygiene behavior on mental and physical health would positively influence students with current unhealthy sleeping behaviors, and the best way to disseminate this information to college students.

In conclusion, this study evaluated the relationship between sleep quality and energy consumption and exercise behaviors among college students and found that poor sleep quality was associated with lower diet quality as demonstrated by an increased intake of carbohydrates, fat, and total calories. Poor sleep quality was also associated with higher levels of night eating symptomatology and lower frequencies of moderate physical activity as compared to good sleep quality. These findings suggest that poor sleep quality may be related to increased energy consumption, unhealthy eating behavior, and decreased energy expenditure, all of which are risk factors for obesity. As such, this information may be useful to college health and counseling centers in developing interventions to prevent and treat obesity, and promote healthy sleep hygiene habits that may have a positive impact on student’s physical and mental health.
APPENDIX A

PITTSBURGH SLEEP QUALITY INDEX

Name __________________________ ID# _________ Date ________ Age __________

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, when have you usually gone to bed at night?
   USUAL 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, when have you usually gotten up in the morning?
   USUAL 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 spend 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 Three or more times a week ________
past month________  once a week_______  twice a week_______  times a week______

(e) Cough or snore loudly.
Not during the ________  Less than Once or Three or more
past month________  once a week_______  twice a week_______  times a week______

(f) Feel too cold.
Not during the ________  Less than Once or Three or more
past month________  once a week_______  twice a week_______  times a week______

(g) Feel too hot.
Not during the ________  Less than Once or Three or more
past month________  once a week_______  twice a week_______  times a week______

(h) Had bad dreams.
Not during the ________  Less than Once or Three or more
past month________  once a week_______  twice a week_______  times a week______

(i) Have pain.
Not during the ________  Less than Once or Three or more
past month________  once a week_______  twice a week_______  times a week______

(j) Other reason(s), please describe___________________________________________
_______________________________________________________________________

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 (Prescribed or "over the
counter") to help you sleep?
Not during the ________  Less than Once or Three or more
past month________  once a week_______  twice a week_______  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 ________  Less than Once or Three or more
past month________  once a week_______  twice a week_______  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 share a room?
   No bed partner or do not share a room __________
   Partner/ flatmate in other room __________
   Partner in same room, but not same bed __________
   Partner in same bed __________

11. If you have a bed partner or share a room, 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 B

DIETARY RECALL

Please list all of the foods you consumed yesterday. Begin with the first thing you ate all the way through until you woke up this morning. Please include all snacks, drinks, and even any times that you may have woken up and eaten in the middle of the night. Please refer to the portion size guide attached to this recall for references of the size or quantity of food that you ate. Thank you!

<table>
<thead>
<tr>
<th>Meal/Snack Name (breakfast, lunch, dinner, snack)</th>
<th>Time of your Meal/Snack</th>
<th>Description of the Food Eaten</th>
<th>Estimate the Size or Quantity of the Meal/Snack</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

56
Please check here if yesterday was not representative of your typical eating pattern ____
If not typical, please say how it differed from your usual eating pattern.

What time did you go to bed last night? ______

**Portion Size Guide**

- 1 cup of cooked pasta or rice or chopped fruits and vegetables is the size of a tennis ball

- 1 oz. of cheese is the size of 4 dice

- 3 oz. of meat/fish is the size of a deck of cards or the size the palm of a woman’s hand

- 1 tbs. of salad dressing, butter, or oil is the size of the tip of your thumb

- Record the quantity of bread in slices or describe the type of roll.

- Record drinks in oz. – one can of a soft drink is 12oz.; one plastic bottle is 20 oz.

- A handful of chips/pretzels or other snack foods is about 1oz.

- Please record whole fruit as small, medium, or large.

- For cakes and cookies, note the type and how much you ate.
APPENDIX C
THREE-FACTOR EATING QUESTIONNAIRE

Part I

1. When I smell a sizzling steak or see a juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal. T F

2. I usually eat too much at social occasions, like parties and picnics. T F

3. I am usually so hungry that I eat more than three meals a day. T F

4. When I have eaten my quota of calories, I am usually good about not eating anymore. T F

5. Dieting is so hard for me because I just get too hungry. T F

6. I deliberately take small helpings as a means of controlling my weight T F

7. Sometimes things just taste so good that I keep on eating even when I am no longer hungry. T F

8. Since I am often hungry, I sometimes wish that while I am eating, an expert would tell me that I have had enough or that I can have something more to eat. T F

9. When I feel anxious, I find myself eating. T F

10. Life is too short to worry about dieting. T F

11. Since my weight goes up and down, I have gone on reducing diets more than once. T F

12. I often feel so hungry that I just have to eat something. T F

13. When I am with someone who is overeating, I usually overeat too. T F

14. I have a pretty good idea of the number of calories in common food. T F

15. Sometimes when I start eating, I just can't seem to stop. T F

16. It is not difficult for me to leave something on my plate. T F
17. At certain times of the day, I get hungry because I have gotten used to eating then. T F

18. While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it. T F

19. Being with someone who is eating often makes me hungry to eat also. T F

20. When I feel blue, I often overeat. T F

21. I enjoy eating too much to spoil it by counting calories or watching my weight. T F

22. When I see a real delicacy, I often get so hungry that I have to eat right away. T F

23. I often stop eating when I am not really full as a conscious means of limiting the amount that I eat T F

24. I get so hungry that my stomach often seems like a bottomless pit. T F

25. My weight has hardly changed at all in the last ten years. T F

26. I am always hungry so it is hard for me to stop eating before I finish the food on my plate T F

27. When I feel lonely, I console myself by eating. T F

28. I consciously hold back at meals in order not to gain weight. T F

29. I sometimes get very hungry late in the evening or at night. T F

30. I eat anything I want, any time I want. T F

31. Without even thinking about it, I take a long time to eat. T F

32. I count calories as a conscious means of controlling my weight. T F

33. I do not eat some foods because they make me fat. T F

34. I am always hungry enough to eat at any time. T F

35. I pay a great deal of attention to changes in my figure. T F
36. While on a diet, if I eat a food that is not allowed, I often splurge and eat other high calorie foods. T F

Part II

Directions: Please answer the following questions by circling the number above the response that is appropriate to you.

37. How often are you dieting in a conscious effort to control your weight?

1 rarely  2 sometime  3 usually  4 always

38. Would a weight fluctuation of 5 lbs. affect the way you live your life?

1 rarely  2 sometime  3 usually  4 always

39. How often do you feel hungry?

1 rarely  2 sometime  3 usually  4 always

40. Do your feelings of guilt about overeating help you to control your food intake?

1 rarely  2 sometime  3 usually  4 always

41. How difficult would it be for you to stop eating halfway through dinner and not eat for the next four hours?

1 easy  2 slightly difficult  3 moderately difficult  4 very difficult

42. How conscious are you of what you are eating?

1 easy  2 slightly  3 moderately  4 extremely

43. How frequently do you avoid "stocking up" on tempting food?

1 almost never  2 seldom  3 usually  4 almost always
44. How likely are you to shop for low calorie foods?

1 unlikely 2 slightly unlikely 3 moderately likely 4 very likely

45. Do you eat sensibly in front of others and splurge alone?

1 never 2 rarely 3 often 4 always

46. How likely are you to consciously eat slowly in order to cut down on how much you eat?

1 unlikely 2 slightly unlikely 3 moderately likely 4 very likely

47. How frequently do you skip dessert because you are no longer hungry?

1 almost never 2 seldom 3 usually 4 almost always

48. How likely are you to consciously eat less than you want?

1 unlikely 2 slightly unlikely 3 moderately likely 4 very likely

49. Do you go on eating binges though you are not hungry?

1 never 2 rarely 3 often 4 always

50. On a scale of 0 to 5, where 0 means no restraint in eating (eating whatever you want, whenever you want it) and 5 means total restraint (constantly limiting food intake and never "giving in"), what number would you give yourself?

0 eating whatever you want, whenever you want it
1 usually eat whatever you want, whenever you want it
2 often eat whatever you want, whenever you want it
3 often limit food intake, but often "give-in"
4 usually limit food intake, rarely "give-in"
5 constantly limiting food intake, never "giving-in"
51. To what extent does this statement describe your eating behavior?
"I start dieting in the morning, but because of any number of things that happen
during the day, by evening I have given up and eat what I want, promising myself to
start dieting again tomorrow."

1  2    3    4
not like me  little like me    pretty good       describes me
pretty good   description of me      perfectly
APPENDIX D

NIGHT EATING QUESTIONNAIRE

Directions: Please circle ONE answer for each question. Please answer the following questions according to your behavior during the past 4 weeks (28 days).

1. How hungry are you usually in the morning?
   0  1  2  3  4
   Not at all  A little  Somewhat  Moderately  Very

2. When do you usually eat for the first time?
   0  1  2  3  4
   Before 9am 9:01 to 12pm 12:01 to 3pm 3:01 to 6pm 6:01 or later

3. Do you have cravings or urges to eat snacks after supper, but before bedtime?
   0  1  2  3  4
   Not at all  A little  Somewhat  Very much so  Extremely so

4. How much control do you have over your eating between supper and bedtime?
   0  1  2  3  4
   None at all  A little  Some  Very much  Complete

5. How much of your daily food intake do you consume after suppertime?
   0  1  2  3  4
   0%  1-25%  26-50%  51-75%  76-100%
   (none) (up to a quarter) (about half) (more than half) (almost all)

6. Are you currently feeling blue or down in the dumps?
   0  1  2  3  4
   Not at all  A little  Somewhat  Very much so  Extremely

7. When you are feeling blue, is your mood lower in the:
   0  1  2  3  4
   Early  Late  Afternoon  Early  Late Evening/Nighttime
   Morning  Morning  Evening  Evening  Nighttime
   _______ check here if your mood does not change during the day

8. How often do you have trouble getting to sleep?
   0  1  2  3  4
   Never  Sometimes  About half the time  Usually  Always

9. Other than only to use the bathroom, how often do you get up at least once in the middle of the night?
10. Do you have cravings or urges to eat snacks when you wake up at night?

0 1 2 3 4
Not at all  A little  Somewhat  Very much so  Extremely so

11. Do you need to eat in order to get back to sleep when you awake at night?

0 1 2 3 4
Not at all  A little  Somewhat  Very much so  Extremely so

12. When you get up in the middle of the night, how often do you snack?

0 1 2 3 4
Never  Sometimes  About half  Usually  Always

13. When you snack in the middle of the night, how aware are you of your eating?

0 1 2 3 4
Not at all  A little  Somewhat  Very much so  Completely

14. How much control do you have over your eating while you are up at night?

0 1 2 3 4
None at all  A little  Some  Very much  Complete

15. How long have your current difficulties with night eating been going on?

[ ] mos. [ ] years

16. Does your nighttime eating cause you distress?

0 1 2 3 4
Not at all  A little  Somewhat  Very much so  Extremely so

17. Does your nighttime eating cause impairment in your daily functioning?

0 1 2 3 4
Not at all  A little  Somewhat  Very much so  Extremely so
APPENDIX E

SEVEN-DAY PHYSICAL ACTIVITY RECALL

Think about your activities over the past seven (7) days. Here is a sample list of some moderate activities: Occupational tasks: delivering newspapers, house painting, making deliveries, bus boy, waiting on tables, dishwashing. Household activities: mowing, raking the lawn, sweeping and mopping, gardening. Sporting activities: volleyball, ping pong, brisk walking, callisthenic exercises, Frisbee playing, baseball.

Please list the type of MODERATE activities you performed and how long you performed it for those days during the week.

<table>
<thead>
<tr>
<th>Moderate Activity Monday-Friday</th>
<th>Time (in minutes)</th>
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<thead>
<tr>
<th>Moderate Activity Saturday-Sunday</th>
<th>Time (in minutes)</th>
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Here is a sample list of some hard activities: Occupational tasks: heavy carpentry, construction work, climbing hills with no load. Household activities: scrubbing floors, hoeing in garden. Sporting activities: double tennis, dancing, aerobics, cycling on level ground, karate or judo, ice skating, roller skating/blading, weight lifting.

Please list the type of HARD activities you performed and how long you performed it for those days during the week.

<table>
<thead>
<tr>
<th>Hard Activity Monday-Friday</th>
<th>Time (in minutes)</th>
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Here is a sample list of some **very hard** activities: Occupational tasks: very hard physical labor (chopping with heavy tools or digging), carrying heavy loads like bricks or lumber, digging ditches, sawing by hand. Sporting activities: skiing, cycling on hilly terrain, handball, racquetball, singles tennis, jogging, swimming, soccer, football, basketball.

Please list the type of **VERY HARD** activities you performed and how long you performed it for those days during the week.

### Hard Activity Saturday-Sunday

<table>
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<th>Activity</th>
<th>Time (in minutes)</th>
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### Very Hard Activity Monday-Friday

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<th>Time (in minutes)</th>
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### Very Hard Activity Saturday-Sunday

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<th>Activity</th>
<th>Time (in minutes)</th>
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APPENDIX F

STATE TRAIT ANXIETY INVENTORY

Form Y-1

Directions:
A number of statements which people have used to describe themselves are given below. Read each statement and then blacken the appropriate circle to the right of the statement to indicate how you feel right now, that is at this moment. There are not right or wrong answers. Do not spend too much time on any one statement but give the answer which seems to describe your present feelings best.

1. I feel calm

2. I feel secure

3. I am tense

4. I feel strained

5. I feel at ease

6. I feel upset

7. I am presently worrying over possible misfortunes

8. I feel satisfied

9. I feel frightened

10. I feel comfortable

11. I feel self-confident

12. I feel nervous

13. I am jittery

14. I feel indecisive
15. I am relaxed.................................................................................................................................1 2 3 4
16. I feel content...............................................................................................................................1 2 3 4
17. I am worried...............................................................................................................................1 2 3 4
18. I feel confused.............................................................................................................................1 2 3 4
19. I feel steady.................................................................................................................................1 2 3 4
20. I feel pleasant...............................................................................................................................1 2 3 4

Form Y-2

Directions:
A number of statements which people have used to describe themselves are given below. Read each statement and then blacken the appropriate circle to the right of the statement to indicate how you generally feel.

21. I feel pleasant...............................................................................................................................1 2 3 4
22. I feel nervous and restless...........................................................................................................1 2 3 4
23. I feel satisfied with myself...........................................................................................................1 2 3 4
24. I wish I could be as happy as others seem to be.........................................................................1 2 3 4
25. I feel like a failure........................................................................................................................1 2 3 4
26. I feel rested....................................................................................................................................1 2 3 4
27. I am “calm, cool, and collected”................................................................................................1 2 3 4
28. I feel that difficulties are piling up so that I cannot overcome them........................................1 2 3 4
29. I worry too much over something that really doesn’t matter......................................................1 2 3 4
30. I am happy....................................................................................................................................1 2 3 4
31. I have disturbing thoughts...........................................................................................................1 2 3 4

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32. I lack self-confidence........................................................................................................1 2 3 4
33. I feel secure...........................................................................................................................1 2 3 4
34. I make decisions easily.........................................................................................................1 2 3 4
35. I feel inadequate ..................................................................................................................1 2 3 4
36. I am content .........................................................................................................................1 2 3 4
37. Some unimportant thought runs through my mind and bothers me......1 2 3 4
38. I take disappointments so keenly that I can’t put them out of my mind....1 2 3 4
39. I am a steady person.............................................................................................................1 2 3 4
40. I get in a state of tension or turmoil as I think over my recent concerns 
   and interests............................................................................................................................1 2 3 4
APPENDIX G

BECK DEPRESSION INVENTORY

Name:_______________________     Marital Status:________         Age:____      Sex:_____

Occupation:_________________________________     Education:_____________________

Instructions: This questionnaire consists of 21 groups of statements. Please read each group of statements carefully and then pick out the one statement in each group that best describes the way you have been feeling during the past two weeks, including today. Circle the number beside the statement you have picked. If several statements in the group seem to apply equally well, circle the highest number for that group. Be sure that you do not choose more than one statement for any group, including Item 16 (Changes in Sleeping Pattern) or Item 18 (Changes in Appetite).

1. **Sadness**
   0  I do not feel sad.
   1  I feel sad much of the time.
   2  I am sad all the time.
   3  I am so sad or unhappy that I can't stand it.

2. **Pessimism**
   0  I am not discouraged about my future.
   1  I feel more discouraged about my future than I used to be.
   2  I do not expect things to work out for me.
   3  I feel my future is hopeless and will only get worse.

3. **Past Failure**
   0  I do not feel like a failure.
   1  I have failed more than I should have.
   2  As I look back I see a lot of failures.
   3  I feel I am a total failure as a person.

4. **Loss of Pleasure**
   0  I get as much pleasure as I ever did from the things I enjoy.
   1  I don't enjoy things as much as I used to.
   2  I get very little pleasure from then things I used to enjoy.
   3  I can't get any pleasure from the things I used to enjoy.

5. **Guilty Feelings**
   0  I don't feel particularly guilty.
   1  I feel guilty over many things I have done or should have done.
   2  I feel quite guilty most of the time
   3  I feel guilty all they time.

6. **Punishment Feelings**
   0  I don't feel I am being punished.
   1  I feel I may be punished.
   2  I expect to be punished.
   3  I feel I am being punished.

7. **Self-Dislike**
   0  I feel the same about myself as ever.
   1  I have lost confidence in myself
   2  I am disappointed in myself
   3  I dislike myself.

8. **Self-Criticalness**
   0  I don't criticize or blame myself more than usual.
   1  I am more critical of myself than I used to be.
   2  I criticize myself for all of my faults.
   3  I blame myself for everything bad that happens.

9. **Suicidal Thoughts or Wishes**
   0  I don't have any thoughts of killing myself.
   1  I have thoughts of killing myself, but I would not carry them out.
   2  I would like to kill myself.
   3  I would kill myself if I had the chance.

10. **Crying**
    0  I don't cry anymore than I used to.
    1  I cry more than I used to.
    2  I cry over every little thing.
    3  I feel like crying, but I can't.
<table>
<thead>
<tr>
<th>11. Agitation</th>
<th>15. Loss of Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 I am no more restless or wound up than usual.</td>
<td>0 I have as much energy as ever.</td>
</tr>
<tr>
<td>1 I feel more restless or wound up than usual.</td>
<td>1 I have less energy than I used to have.</td>
</tr>
<tr>
<td>2 I am so restless or agitated that it's hard to stay still.</td>
<td>2 I don't have enough energy to do very much.</td>
</tr>
<tr>
<td>3 I am so restless or agitated that I have to keep moving or doing something.</td>
<td>3 I don't have enough energy to do anything.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>12. Loss of Interest</th>
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</thead>
<tbody>
<tr>
<td>0 I have not lost interest in other people or activities.</td>
</tr>
<tr>
<td>1 I am less interested in other people or things than before.</td>
</tr>
<tr>
<td>2 I have lost most of my interest in other people or things.</td>
</tr>
<tr>
<td>3 It's hard to get interested in anything.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>13. Indecisiveness</th>
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</thead>
<tbody>
<tr>
<td>0 I make decisions about as well as ever.</td>
</tr>
<tr>
<td>1 I find it more difficult to make decisions than usual</td>
</tr>
<tr>
<td>2 I have much greater difficulty in making decisions than I used to.</td>
</tr>
<tr>
<td>3 I have trouble making any decisions.</td>
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<table>
<thead>
<tr>
<th>14. Worthlessness</th>
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<tbody>
<tr>
<td>0 I do not feel I am worthless.</td>
</tr>
<tr>
<td>1 I don't consider myself as worthwhile and useful as I used to.</td>
</tr>
<tr>
<td>2 I feel more worthless as compared to other people.</td>
</tr>
<tr>
<td>3 I feel utterly worthless.</td>
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</table>

<table>
<thead>
<tr>
<th>16. Changes in Sleeping Pattern</th>
</tr>
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<tbody>
<tr>
<td>0 I have not experienced any change in my sleeping patterns.</td>
</tr>
<tr>
<td>1a I sleep somewhat more than usual.</td>
</tr>
<tr>
<td>1b I sleep somewhat less than usual.</td>
</tr>
<tr>
<td>2a I sleep a lot more than usual.</td>
</tr>
<tr>
<td>2b I sleep a lot less than usual.</td>
</tr>
<tr>
<td>3a I sleep most of the day.</td>
</tr>
<tr>
<td>3b I wake up 1-2 hours early and can't get back to sleep.</td>
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</tbody>
</table>

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<thead>
<tr>
<th>17. Irritability</th>
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<tbody>
<tr>
<td>0 I am no more irritable than usual.</td>
</tr>
<tr>
<td>1 I am more irritable than usual.</td>
</tr>
<tr>
<td>2 I am much more irritable than usual.</td>
</tr>
<tr>
<td>3 I am irritable all the time.</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>18. Changes in Appetite</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 I have not experienced any change in my appetite.</td>
</tr>
<tr>
<td>1a My appetite is somewhat less than usual.</td>
</tr>
<tr>
<td>1b My appetite is somewhat greater than usual.</td>
</tr>
<tr>
<td>2a My appetite is much less than before.</td>
</tr>
<tr>
<td>2b My appetite is much greater than usual.</td>
</tr>
<tr>
<td>3a I have no appetite at all.</td>
</tr>
<tr>
<td>3b I crave food all of the time.</td>
</tr>
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19. **Concentration Difficulty**

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<tr>
<th></th>
<th>Description</th>
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<tbody>
<tr>
<td>0</td>
<td>I can concentrate as well as ever.</td>
</tr>
<tr>
<td>1</td>
<td>I can't concentrate as well as usual.</td>
</tr>
<tr>
<td>2</td>
<td>It's hard to keep my mind on anything for very long.</td>
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<tr>
<td>3</td>
<td>I find I can't concentrate on anything.</td>
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20. **Tiredness or Fatigue**

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<tr>
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<th>Description</th>
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<tbody>
<tr>
<td>0</td>
<td>I am no more tired or fatigued than usual.</td>
</tr>
<tr>
<td>1</td>
<td>I get more tired or fatigued more easily than usual.</td>
</tr>
<tr>
<td>2</td>
<td>I am too tired or fatigued to do a lot of the things I used to do.</td>
</tr>
<tr>
<td>3</td>
<td>I am too tired or fatigued to do most of the things I used to do.</td>
</tr>
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20. **Loss of Interest in Sex**

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<th></th>
<th>Description</th>
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<tbody>
<tr>
<td>0</td>
<td>I have not noticed any recent change in my interest in sex.</td>
</tr>
<tr>
<td>1</td>
<td>I am less interested in sex than I used to be.</td>
</tr>
<tr>
<td>2</td>
<td>I am much less interested in sex now.</td>
</tr>
<tr>
<td>3</td>
<td>I have lost interest in sex completely.</td>
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</tbody>
</table>
APPENDIX H

PERCEIVED STRESS SCALE

The questions in this scale ask you about your feelings and thoughts during the last month. In each case, you will be asked to indicate how often you felt or thought a certain way. Although some of the questions are similar, there are differences between them and you should treat each one as a separate question. The best approach is to answer each question fairly quickly. That is, don't try to count up the number of times you felt a particular way, but rather indicate the alternative that seems like a reasonable estimate. For each question choose from the following alternatives:

0. never
1. almost never
2. sometimes
3. fairly often
4. very often

1. In the last month, how often have you been upset because of something that happened unexpectedly?

2. In the last month, how often have you felt that you were unable to control the important things in your life?

3. In the last month, how often have you felt nervous and "stressed"?

4. In the last month, how often have you dealt successfully with irritating life hassles?

5. In the last month, how often have you felt that you were effectively coping with important changes that were occurring in your life?

6. In the last month, how often have you felt confident about your ability to handle your personal problems?

7. In the last month, how often have you felt that things were going your way?

8. In the last month, how often have you found that you could not cope with all the things that you had to do?

9. In the last month, how often have you been able to control irritations in your life?

10. In the last month, how often have you felt that you were on top of things?

11. In the last month, how often have you been angered because of things that happened that were outside of your control?
12. In the last month, how often have you found yourself thinking about things that you have to accomplish?

13. In the last month, how often have you been able to control the way you spend your time?

14. In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?
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