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LOYOLA UNIVERSITY CHICAGO

CONSISTENCY OF HEALTH BEHAVIORS AND RELATIONS TO BMI IN FIRST YEAR COLLEGE STUDENTS

A THESIS SUBMITTED TO
THE FACULTY OF THE GRADUATE SCHOOL
IN CANDIDACY FOR THE DEGREE OF
MASTER OF ARTS

PROGRAM IN CLINICAL PSYCHOLOGY

BY
LAURA M. NICHOLSON
CHICAGO, IL
DECEMBER 2018

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Thank you to everyone who has made this project possible. Specifically, I could not have done this project without the support of my advisor, Amy Bohnert, or my trusted lab mates, Amy Heard Egbert and Carolyn Bates, who all assured me that this could get done. Finally a special thanks goes out to my cohort (Carol, Cynthia, Diana, & Ian) and my loving partner, Brandon.

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ABSTRACT

Existing research suggests that individuals with erratic schedules (e.g., shift workers) may be at greater risk for weight gain. This may be due, in part, to the inconsistent timing of health behaviors, such as sleep. Little is known, however about the relevance of the consistent timing of health behaviors among other populations, including college students who are risk for weight gain. For many students, college represents a transition to a more self-directed and less structured environment making it an ideal time to consider health behaviors. The current study examined the consistency of three health behaviors (i.e. sleep, eating occurrences, and physical activity) and relations with body weight among first year college students at a large Midwestern university. Daily diary methods were used to collect self-report data on the timing of these health behaviors over a seven day period. The timing of these variables were transformed to calculate several indices of consistency, and are described for the full sample as well as by gender. In addition, these consistency variables were examined using bootstrapping to determine relations to body mass index (BMI) among first year college students, and whether these relations are moderated by gender. Results demonstrate that sleep variability in wake time was positively associated with BMI, above and beyond sleep duration. Consistency of EO and PA were not associated with BMI, though were significantly intercorrelated with consistency of sleep timing calling for additional research. Finally, while not a variable of interest initially, nap duration was also positively correlated with BMI. This suggests that college students may benefit from waking up at a consistent time every morning, calling for health education programs within universities to encourage students to maintain consistent sleep schedules.

CHAPTER ONE

INTRODUCTION

The high rates of overweight and obesity in children and adults is a major public health concern. Many adverse consequences are associated with obesity such as cardiovascular disease, type 2 diabetes, and many types of cancers (Bray, 2004). A critical agenda item in preventing disease is identifying risky time periods for weight gain as well as influential factors during these periods. Obesity prevalence peaks during early adulthood and college students are at greater risk for weight gain than non-attenders (Holm-Denoma Joiner, Vohs, & Heatherton, 2008; Mokdad et al., 1999). A large percentage of male and female college students (40.1% and 35%) are classified as overweight or obese (American College Health Association, 2017), and the first year of college may be a period of accelerated weight gain. Colloquially referred to in popular media as the ‘Freshman 15,’ students were reported to gain, on average, 15 pounds during their first year of college. However, a meta-analysis summarized 24 studies on weight gain reported that first-year students gain closer to five pounds (Vella-Zarb & Elgar, 2009). While lower than presented in the media, studies report this rate of weight gain is still 11 times greater than adults (Holm-Denoma et al., 2008).

One unique factor that characterizes college and may contribute to weight gain at this transition point is the change to a less consistent daily schedule. Unlike high school, college students have class schedules that vary considerably depending on the day. Drawing on research with individuals with erratic schedules (e.g., shift workers), a central premise of this study is that this relative lack of consistency in schedules from day to day may influence the timing of health behaviors. The present study examined consistent timing of three health behaviors (sleep, eating occurrences, and physical activity) during the first year of college as well associations with body weight.

The premise that schedules and structure are relevant for health is informed, in part, by research with children suggesting that health behaviors are likely disrupted by unstructured versus structured days as well as disorganization of the family home environment. This is clearly seen when comparing the summertime (unstructured) versus the schoolyear (structured), as well as weekday-weekend differences. Exponentially more weight is gained in the summertime (Von Hippel, Powell, Downey, & Rowland, 2007; Von Hippel & Workman, 2016; Moreno, Johnston, & Woehler, 2013) as compared to the schoolyear among school-age children. Recently, researchers have proposed the Structured Day Hypothesis (SDH) to explain how structured settings may facilitate better health among youth. The SDH posits that the structure and routine found in a school setting promotes more regular sleep/wake cycles, eating occurrences, and opportunities for physical activity (Brazendale et al., 2017). Therefore, a school day that consists of a high degree of structure may promote better health behaviors which may protect against excess weight gain. Similarly, the organization in the family home environment may influence children's weight by promoting more consistent health behavior routines. In a recent systematic review on this topic, the implementation of bedtime routines, family meals, and limit setting around screen time were associated with lower weight in children (Bates et al., 2018). In sum, this work suggests the clear benefits of regular, structured schedules in children as they facilitate consistent timing of sleep, eating occurrences, and physical activity. Not only is there evidence of the importance of having stable routines when it comes to health behaviors among children, research on shift workers suggest these benefits may extend into adulthood.

The shift work literature illuminates how the timing of health behaviors may be important to consider for adults. Shift work schedules cause daily routines (e.g., sleep, eating) to readjust which may disrupt internal mechanisms linked to obesity. Shift work has been theorized to create circadian rhythm disruption, referred to as chronodisruption (Erren & Reiter, 2009), which in turn, increases obesity risk (Garaulet & Madrid, 2009; Reiter, Tan, Korkmaz, & Ma, 2012). The circadian rhythm is a naturally occurring biological process that aims to synchronize both internal functions and health behaviors to oscillate within the 24-hour day (Westerterp-Plantenga, 2016). Health behaviors that coincide with these internal rhythms has been thought to assist the body in productive energy metabolism. The superchiasmatic nucleus (SCN) in the hypothalamus has been thought to control circadian timing, along with timing of other peripheral tissues (e.g. liver) involved in metabolic functioning (Cagampang & Bruce, 2012). Sleep, eating, and energy utilization (e.g. physical activity) are synchronized by the SCN and if disrupted, could lead to chronodisruption and impair health (Mistlberger & Antle, 2011; Westerterp-Plantenga, 2016). For this reason, there are many metabolic consequences of shift work, the strongest evidence being for impaired glucose tolerance and increased weight as observed in several systematic reviews (Van Drongelen et al., 2011; Proper et al., 2016). Within these reviews, one study observed work behaviors over a 10-year period and found that individuals who shifted their work from day to nights and those who were consistent shift workers exhibited greater increases in body weight over time when compared with individuals who only worked day shifts (Morikawa et al., 2007). To summarize, disruptions in daily schedules and routines appears to have a deleterious effect on weight and other health parameters, however, despite being at risk for weight gain and disrupted schedules, almost nothing is known about first year college students.

As suggested, college is a time of transition. Most students move from highly regimented and structured schedules in high school to more open-ended and inconsistent class schedules. As mentioned previously, a central premise of this work is that these schedule changes affect the consistent timing of health behaviors across the week. High school students typically arrive at school the same time every day promoting consistent wake times. Similarly, scheduled lunch periods can encourage consistent meal timing. Further, gym, sports practices, and games are likely held consistently across the week. For many, college offers alternating class schedules which may have different start times from day to day. For example, the start of students' first class differs by an hour, on average, when observing Mon/Wed/Fri classes versus Tues/Thurs classes (Dills & Hernandez-Julian, 2008). This hour difference could influence sleep timing, eating occurrences, and even when to engage in physical activity throughout the day and over the course of a week. Therefore, the current study used daily dairy methods to capture these health behaviors as they naturally occur across a week. Therefore, the first aim of the current study was to describe consistency of sleep, eating occurrences, and physical activity during the first year of college, and describe differences based on gender.

Consistent Sleep Timing

Prior to reviewing the research on the relevance of sleep timing, characterizing consistent sleep timing is necessary for understanding potential relations to BMI. In non-shift work populations, sleep consistency has been analyzed by capturing changes in sleep either from weekdays to weekends or day to day changes. Averaged weekday to weekend shifts in sleep timing has been described as “social jetlag” and occurs when individuals wake up earlier than their preferred rhythm on days they have work, school, or social obligations (i.e., weekdays) and then sleep later on weekends (Roenneberg, Allbebrandt, Merrow, & Vetter, 2012; Wittmann, Dinich, Merrow, & Roenneberg, 2006). Further, there are several ways to characterize consistency from day to day and this concept has been recently termed sleep intraindividual variability or sleep IIV (Bei, Wiley, Trinder, & Manber, 2016). Two prevalent methods that characterize consistency are intraindividual standard deviation (SD) and mean square of successive differences (difference scores from day to day). Both are intended to measure how much fluctuation in sleep timing variables occurs across several days, but differ in how they capture day to day variations.

Less consistent sleep timing has been associated with increased weight and worsened metabolic functions in both children and adults. In Parsons and colleagues’ study (2015) using a large birth cohort of adults (assessed at age 38), greater differences between weekday and weekend sleep duration was associated with increased BMI, body fat percentage, obesity odds, and metabolic markers related to obesity. In addition, a systematic review suggests that sleep IIV relates to a variety of outcomes, including body weight (Bei et al., 2016). One of the studies included in this review found that higher sleep IIV was significantly associated with higher rates of obesity in females and higher BMIs in males aged 65 years or older (Patel et al., 2014). Specifically, an hour increase in sleep duration variability was related to a 63% increase in obesity odds in males and 22% increase in females (Patel et al., 2014). Becker and colleagues (2017) did a similar review of sleep IIV and body weight within pediatric samples. Within this review, sleep IIV was not associated with BMI in school-age children. However in a community sample of adolescents (13-16 years), higher sleep duration IIV was associated with higher BMI (Moore et al., 2011). As mentioned, inconsistent and erratic schedules may impact sleep consistency and subsequently BMI, but less is known about consistent sleep timing and BMI among college students.

Research suggests that college students shift their sleep timing later from weekday to weekends in college, indicating low sleep consistency. On average, college students reported one hour and 15 minutes delay in sleep timing from weekdays to weekends (Lund, Reider, Whiting, & Prichard, 2010). Referencing the Patel and colleagues study (2014) above, an hour difference between weekday and weekend sleep has been associated with heightened obesity odds. In addition to weekday and weekend differences, large fluctuations in sleep are seen from day to day in college. Wake time variability increases during the transition from high school to college when measuring sleep across the weekday (Doane, Gress-Smith, & Breitenstein, 2015). Specifically, sleep timing from day to day shifts approximately 60 to 90 minutes for wake time and bedtime and sleep duration in college (Whiting & Murdock, 2016). Only two studies have examined consistent sleep timing in relation to body weight among a sample of college students. Roane and colleagues (2015) collected daily diary data over a nine-week period averaged the difference scores in sleep duration over a range of four-day windows. Higher variability in sleep duration was a predictor of weight gain in males during the first semester of college, but not in females. Using a female only sample, Bailey and colleagues (2014) found that the standard deviation of bedtime was significantly associated with BMI when using objective measures over a seven day period. Both studies found that higher variability in sleep measures were associated with increased BMIs, though these relations were not consistent across gender. In addition, both of these studies analyzed sleep duration, however, sleep duration was either less strongly associated with BMI (Bailey et al., 2014) or no longer a statistically significant predictor (Roane et al., 2015) when sleep IIV was included in analyses. Given that short sleep duration has been consistently associated with increased body weight (Bayon et al., 2014), more attention should be given to sleep consistency as it predicts BMI. The present study examined consistent sleep timing by capturing (1) weekday versus weekend and (2) day to day shifts in sleep (difference scores and standard deviation) to analyze how this health behavior relates to BMI and whether these relations vary by gender (see Table 1).

Consistent Eating Occurrences

Consistent eating occurrences was characterized slightly differently than sleep, since multiple eating occurrences (EO) occur throughout the day. Present research has captured consistency in several ways, though, one particular measure was included in the present study. Average daily EO frequency across a week has been used to get a sense of daily eating behavior and the degree to which EO fluctuates across a week could reflect consistency. Some studies have defined “irregular” versus “regular” eaters by asking participants how regularly they consume the three main meals of the day (i.e., breakfast, lunch, dinner; Sierra-Johnson et al. 2008). However, this type of categorization does not determine if individuals are eating consistently from day to day nor does it assess for snacking. Therefore, measures should include both meals and snacks and when they were eaten to capture how consistently someone is eating. Specifically, inconsistency across a week can be measured by calculating the average daily EO and how much this varies from day to day. This characterization of EO was explored in a study by Farshchi and colleagues (2004) that experimentally manipulated the number of EO from day to day.

Table 1. Conceptualization and Measurement of Consistent Health Behaviors

Construct	**Calculation of Variable**	**Type of Variable(s)**	***n***
Consistent Sleep Timing			
Weekday vs Weekend (WvW)	Average weekday and average weekend of each sleep timing measure (sleep duration, waketime, bedtime). Calculate difference scores for each measure.*	3 continuous variables (sleepdurationSJL; waketimeSJL; bedtimeSJL)	96
Day to Day Fluctuation (Sleep D2D)	Subtract sleep timing measures (sleep duration, waketime, bedtime) from day to day and average across all days: (Day 2 - Day 1) + (Day 3 - Day 2) + (Day 4 - Day 3) + (Day 5 - Day 4) + (Day 6 - Day 5) + (Day 7 - Day 6) = (Total Sleep D2D) / (# of Days)	3 continuous variables (sleepdurationD2D; waketimeD2D; bedtimeD2D)	109
Variability Across the Week (Sleep SD)	Standard deviation of sleep timing measures (sleep duration, waketime, bedtime) averaged across all days.	3 continuous variables (sleepdurationSD; waketimeSD; bedtimeSD)	109
Consistent Eating Occurrences			
Day to Day Fluctuation (Eating Occurrence D2D)	Subtract EO frequency from day to day and average across all days: (Day 2 - Day 1) + (Day 3 - Day 2) + (Day 4 - Day 3) + (Day 5 - Day 4) + (Day 6 - Day 5) + (Day 7 - Day 6) = (Total EO D2D) / (# of Days)	1 continuous variable (EOD2D)	109
Consistent Physical Activity			
Consistency Across the Week (PA Episode Consistency)	Determine proportion of PA episodes that occur at consistent time periods across all days: Morning: 6AM – 11AM Middle Day: 11AM – 3PM Late Afternoon: 3PM – 8PM Evening: 8PM – 12AM If at least 50% of all PA episodes fall into one time period across the week, then dummy coded as ‘consistent,’ otherwise coded as ‘inconsistent.'	1 dichotomous variable (PA_in_consistent)	35

Notes:
*Only 1 day of weekend data required for inclusion. If only 1 day reported, then that day will be used as a comparison.

Consistent eating occurrences, as discussed above, may be associated with weight and metabolic markers of obesity as it may promote beneficial circadian timing. Chrononutrition is a relatively new area of research that is concerned with the patterns and distribution of eating occurrences across a day which plays a large role in the maintaining regularity of metabolic homeostasis (Eckel-Mahan et al., 2013; Pot, Almoosawi, & Stephen, 2016). When it comes to weight management, how often and when we should eat our meals throughout the day is contested within the literature. In a meta-analysis, consuming ≥ 4 meals/snacks per day had a lower probability (17%) of becoming obese (Wang et al., 2016). Conversely, consuming greater than five meals as opposed to three or less had higher risk for overweight and obesity in a large representative sample (Murakami & Livingstone, 2015). Similarly, Leech and colleagues (2017) utilized latent class analysis for 9,338 adults (≥ 19 years) and found that a “grazing” eating pattern, or a high eating frequency, emerged and was associated with increased BMI in women, but not men. These studies suggest that a greater frequency of EO (> 5) is associated with higher BMI, particularly among women. A possible theory may be that high frequency of eating occurrences may not allow for an appropriate fasting period. Research suggests that fasting may improve metabolic markers of obesity and body composition (Hutchison & Heilbronn, 2016). In addition, varying the frequency of EO from day to day (e.g., 9 meals/snacks then 3 meals/snacks) was associated with worsen insulin resistance and lipid profiles in healthy lean women (ages 18-42; Farshchi et al., 2004). Taken together, these findings suggest that consistency of meals may have important implications for weight and metabolic health and these effects may be stronger in women. Although findings are somewhat mixed and do not provide clear recommendations for the appropriate number of EO, consistency is still an important variable to consider in explaining differences in BMI. Measures of consistency will be largely exploratory due to the limited, and sometimes conflicting, literature. However, the unstructured nature of college makes this area of research valuable to explore in college populations, specifically how consistent eating occurrences relate to BMI.

There is a dearth of research on consistent eating occurrences, especially in college populations. This is, in large part, to the various ways that meals are assessed in studies often asking for estimations over a week. For example, 33.9% of college students “always/often snacked in the daytime” and 32.5% “ate a snack in the evening” (DeBate, Topping, & Sargent, 2001) while other studies found 47% of students ate an “afternoon snack” (Driskell, Kim, & Goebel, 2005). Snacking may have deleterious effects on metabolic health and body weight. In a longitudinal study on snacking behavior in college students, 34.6% reported snacking between main meals and these individuals had a greater risk of developing metabolic syndrome 8.3 years later (Pimenta et al., 2016). Similarly, a study by Levistksy and Youn (2004) found that meal frequency on the weekend, evening snacks, and junk food consumption made up 47% of the variance in college students’ BMI. Another study reported that males consumed 2.04 meals and 2.41 snacks (4.45 EO) compared to women who consume 2.88 meals and 2.33 snacks (5.21 EO) during the first year of college (Kapinos & Yakusheva, 2011). Though neither of these studies described the timing of EO, snacking appears to be common among college students and is associated with higher BMI. More research is necessary to shed light on the relation between consistent eating occurrences and body weight among college students. In the present study, consistent eating occurrences was measured by capturing how EO frequency differed from day to day (see Table 1) and relative associations to BMI. Further, this study analyzed if there were gender differences and if gender contributes to relations between consistent EO and body weight.

Consistent Physical Activity

Unlike sleeping and eating, physical activity (PA) is voluntary and not necessary for immediate survival. There are many health benefits of engaging in PA, like preventing disease and maintenance of weight. Episodes of PA at a moderate to vigorous intensity are reported to be beneficial if lasting longer than ten minutes (Center for Disease Control, 2015). Therefore, a PA episode will be defined as: (1) greater than or equal to 10 minutes and (2) reported to be of moderate to vigorous intensity. Less is known about the importance of consistent PA timing and how to categorize this across a week, which speaks to another element of consistency.

Many studies have found that PA plays a vital role in managing body weight (e.g., Chaput et al., 2013). In addition, budding evidence suggests that PA coincides with the circadian rhythm. Reviews that link the circadian rhythm to obesity suggest that PA plays an important role in facilitating the entrainment of other health behaviors and internal bodily functions (Schroeder et al., 2012; Schroeder & Colwell, 2013; Tahara, Aoyama, Shibata, 2016; Tranel et al., 2015; Wolff & Esser, 2012). Most research that assesses how PA timing influences metabolic and weight-related outcomes has typically focused on the stage of digestion within the body since the last meal. A systematic review summarized experimental studies on scheduled PA and suggested that postprandial (right after eating) or postabsorptive (around 6 hours post meal) exercise offered more beneficial lipid control or glycemic control, respectively (Haxhi, Di Palumbo, & Sachetti, 2013). However, there may be benefits of PA timing that are not related to digestive states. Since PA coincides with the circadian rhythm and regarded as a weight management technique, the time of day an individual participates in PA warrants further investigation as it relates to BMI. Studies have found that even if ‘irregular,’ more PA is better for individuals than no PA at all (Andersen et al., 1999). However, consistent PA timing may have additive benefits to body weight. This has gone relatively unexplored, particularly in college age youth.

When entering college, PA typically declines and this may contribute to weight gain during this time. Along with a decline in sports participation during the first semester, 40-50% of students are considered “inactive” (Butler, Black, Blue, & Gretebeck, 2004; Keating, Guan, Pinero, & Bridges, 2005). Only 39% of college students reported exercising three or more times per week (Haberman, & Luffey, 1998). Similarly, other studies found that males have greater PA episodes in a week than compared to females (Huang et al., 2003). Less is known about the consistent timing of PA episodes across the week and if there are relations to body weight. In an attempt to capture consistency across days, the present study characterized PA episodes across a week as either ‘consistent’ or ‘inconsistent.’ Specifically, ‘consistent’ captured PA episodes that fall into the same time period of the day (e.g., early morning 6:00 AM – 11:00 AM; middle day 11:00 AM – 3:00 PM; late afternoon 3:00 PM – 8:00 PM; evening 8:00 PM – 12:00 AM) at least 50% of the time, otherwise they will be labeled as ‘inconsistent.’ Additional research is necessary to shed light on the relation between consistent physical activity and body weight and again, how this may differ by gender. The present study measured whether or not PA is consistent or inconsistent based on if the timing PA occurs each day (see Table 1).

Gender

As has been suggested throughout this review, there may be important main effects of gender differences in terms of the consistency of various health behaviors. In addition, the relations of these consistency measures to BMI may vary by gender. That is, gender may be a moderator of the relation between consistency of health behaviors and BMI. In part, this is theorized to be because sex differences may exist in how the SCN in the hypothalamus receives input due to its proximity to gonadal steroid receptors (Bailey & Silver, 2014). A review of gender differences within the shift work literature demonstrated that female shift workers tend to have less favorable outcomes compared to men (Saksvik, et al., 2011; Santhi et al., 2015). Specifically, shift working women were more likely to have impaired glucose tolerance, increased triglycerides, and higher rates of obesity when compared to their male counterparts (Karlsson, Knutsson, & Lindahl, 2001). Changing work schedules could seriously impact health behaviors and metabolic homeostasis, particularly in women, leading to increases in weight.

Patterns of weight gain appear to vary by gender in college, also calling for the need to analyze gender differences. Contrary to the shift work literature, males may be at greater risk for weight gain in college. Males have been shown to gain more weight (3.7—6.4 pounds) during the first year of college than females (1.7—4.4 pounds; Bodenlos, Gengarelly, & Smith, 2015; Cluskey & Grobe, 2009; Mihalopoulos, Auinger, & Klein, 2008). Specifically, participating in poor lifestyle choices (e.g., increased alcohol use) are predictors of weight gain in males (Bodenlos et al., 2015) whereas, changes in eating habits and decreased consumption of fruits and vegetables were significant predictors in college women (Deforche, Van Dyck, Deliens, & Bourdeaudhuij, 2015. Smith-Jackson & Reel, 2012). Taken together, college men and women may engage in different obesogenic behaviors that could lead to increased BMIs and certain behaviors may have stronger effects on weight depending on gender. Therefore, the present study seeks to examine gender differences in the consistency of various health behaviors (e.g., sleep, eating occurrences, and physical activity) and body weight. This study will also consider whether associations between consistency of health behaviors and BMI vary by gender (see Figure 1).

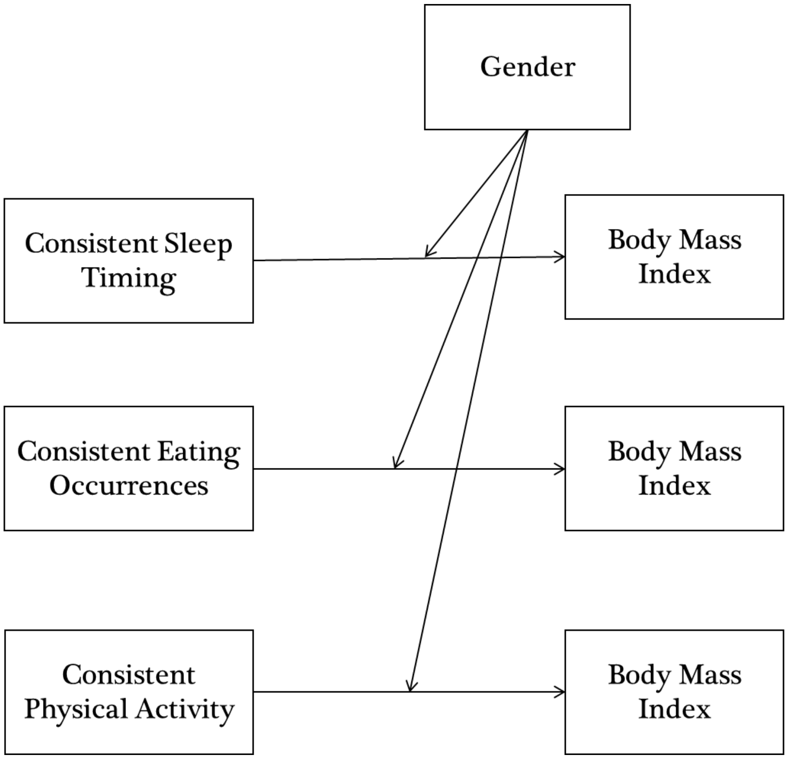

Figure 1. Consistency of Health Behaviors and Relation to BMI using Gender as a Moderator

Covariates

To examine the additive impact of consistency of these health variables it is necessary to control for other variables that may be related to BMI. Specifically, short sleep has been independently associated with weight and short sleep may also be associated with less consistent sleep timing (Bayon et al., 2014; Bei et al., 2016). In the same vein, consistent EO and consistent PA will be handled in similar ways. EO frequency has been significantly related to BMI, though studies are mixed regarding directionality (Leech et al., 2017; Murakami & Livingstone, 2015; Wang et al., 2016). Further, PA duration has been inversely related to weight (i.e., Fogelholm & Kukkonen-Harjula, 2000; Sulemana, Smolensky, & Lai, 2006). In sum, to understand how consistency of health behaviors relates to BMI necessitates that standard predictors of weight (e.g., sleep duration, EO frequency, PA duration) are used as covariates in analyses. In addition, environmental characteristics such as amount of light and temperature have been theorized to affect aspects of health behaviors. Light exposure is considered the most influential mechanism that entrains the circadian rhythm and internal timing mechanisms (Baehr, Revelle, & Eastman, 1999; Hirayama et al., 2007). Therefore, it is possible that greater amounts of daily light can change health behaviors and thus weight. Further, studies that examine the effect of ambient temperature on health behaviors find that lower temperatures are associated with greater PA and energy intake (Moellering & Smith, 2012). Therefore, average amount of light and average temperature will be potentially included within analyses as a covariate depending on their relation to body weight and height within this study.

Specific Aims and Hypotheses

To summarize, research suggests that children and adults who have unstructured or erratic home or work lives are at greater risk for obesity (Bates et al., 2018; Brazendale et al., 2017). Specifically this kind of risk causes health behaviors to become irregular, potentially disrupting the circadian rhythm (Westerterp-Plantenga, 2016). However, minimal work has been done to understand consistency of health behaviors among college students. Daily diary methods were utilized to capture accurate reporting of these variables and will be considered cross-sectional since the three health variables will be comprised of data collapsed across a week (or at a minimum, four days). The transition to college may be a particularly risky time as these three health behaviors are likely to become irregular due to the fluctuating nature of how classes are set up in college as compared to high school. For many students, this may be the first time making autonomous health decisions, making it an ideal time to consider health behaviors related to weight gain (Anderson, Shapiro, & Lundgren, 2003). Finally, no study has measured consistency of these three variables together as they relate to BMI, nor fully accounted for potential gender differences.

Utilizing a college age sample from a mid-sized urban Midwestern University, the purpose of this daily-diary study was to detail the timing and consistency of three health behaviors among male and female students as well and how they relate to BMI during the first year of college. The following aims and hypotheses were proposed:

1. Describe health behaviors and their consistency among a sample of first year college students, and analyze data to determine if there are gender differences in these variables.
    a. Consistent sleep timing defined as (1) weekday to weekend shifts in sleep and (2) the variability of sleep timing measures (difference scores and standard deviation of sleep). This will be measured across a week. It is hypothesized that college students will have low consistency of sleep across all measurements.
    b. Consistent eating occurrences defined as EO frequency difference scores from day to day. This will be measured across a week. It is hypothesized that college students will have low consistency of EO from day to day.
    c. Consistent physical activity will be coded as either consistent or inconsistent based on what time of day PA episodes occur and if they are similar or dissimilar across a week. It is hypothesized that the majority of students would have PA labeled as inconsistent.

2. Examine associations between BMI and consistent sleep timing (as defined above) consistent eating occurrences (as defined above), consistent physical activity (as defined above) among a sample of first year college students, and analyze whether these relations are moderated by gender (see Figure 1). It is hypothesized that significant relations will be observed among consistency of health behaviors and BMI, such that lower consistency (greater variability) will be associated with higher BMI.

CHAPTER TWO

METHOD

Participants

In the current study, participants (*n* = 109) were majority female (83.5%) and between the ages of 18-23 (*M* = 18). Of those who reported race, 70% were Caucasian, 7% were African American, 8% were East-Asian, 1% were Native Hawaiian or other Pacific Islander, 11% were multiples races, and 3% were described as other. Regarding ethnicity, 13.8% identified as Hispanic or Latino. Majority of participants lived in a residential hall (97.2%).

Participants were recruited from a Midwestern urban university as part of an ongoing study that aims to examine the effects of television food commercials on measures of inhibitory control and executive functioning. The currently study only included the following participants for analysis: (1) first year undergraduate students and (2) those living on campus or an apartment near campus. These inclusion criteria aimed to ensure that the study captures students who are transitioning out of their home into a college setting, presumably for the first time. Participants were recruited though an online system that grants study credits required for introductory psychology courses. This credit was prorated depending on how many days of surveys they completed, with more days leading to more credit granted. In addition, if students completed all seven days of questionnaires, they were entered into a raffle for a $50 gift card.

Procedure

The study was approved by the university’s Institutional Review Board. The data for this study comes from a larger study examining how television food commercials impacts outcomes related to inhibitory control and executive functions. The present study only utilized data from the daily diary component. The daily diary was a web-based study and consists of two parts. First, participants completed an initial survey with a consent page that includes information about the overall study and directions for the daily diary. The initial survey took about an hour to complete and included measures relevant to the present study, such as background demographics and self-reported height and weight. Second, if participants completed this initial survey they were automatically signed up to receive follow up daily diary surveys. The daily diary method collected information about health behaviors (e.g., sleeping, eating, and physical activity) over the course of seven days and takes less than 15 minutes per day to complete. Participants were emailed the survey links to complete the initial survey and follow up daily dairy questions each day at 8:00 PM. They were given explicit instructions to complete the surveys before 12:00 PM the following day to facilitate more accurate reporting. In addition, participants were given a reminder at 11:00 PM if they did not open or complete the survey. This window between 8:00 PM and 12:00 PM was selected so that students could complete the surveys near the end of the day but before they started participating in social activities. Each daily diary provided prompts about what day they were reporting on at the top of each page to aid in accurate reporting. Drawing on work done by Roane and colleagues (2015), at least four daily diaries needed to be completed to have been included in the final analytic sample. Individuals were compensated in the form of credits for participating regardless of if they met inclusion criteria. For participants who completed seven days of daily dairy, ten raffle winners were randomly selected using a random number generator.

Measures

The present study utilized measures from the daily diary portion of the survey which assessed a variety of health behaviors, including sleep, eating occurrences, and physical activity. These three health behaviors were analyzed in the present study and participants were asked to recall what time they engaged in these behaviors each day, and again over a week's time. Descriptions of how these variables were transformed are presented in Table 1. Additional health behaviors were measured using this daily diary method, but were not included in the present study nor described here. Finally, measures of body weight and height were self-reported. While not considered the "gold standard" measurement, Quick and colleagues (2015) found that measured and self-reported height and weight were highly correlated ($r = 0.97$-0.99) within a large college sample from eight different universities.

Sleep

Sleep measures were asked about for the previous night. Participants were first asked if they went to sleep the previous night (yes or no). If yes, follow-up questions included (1) what time they went to bed (2) how long it took them to fall asleep (3) how many hours of sleep they estimated getting. Participants were all asked (1) what time they woke up that day and (2) what time they physically got out of bed. Bedtime was coded as the time they went to bed and wake time was coded as the time they woke up that day. Sleep duration at night was calculated using the question of how many hours of sleep they estimated getting. Additionally, participants were asked if they took a nap that day (yes or no). If yes, they were asked follow-up questions such as

(1) what time they started their nap (2) how long they estimated sleeping. Nap duration was calculated using the second question estimating how long their nap was. Finally, sleep duration total was an accumulation of both sleep duration at night and nap duration.

Calculating ‘consistent sleep timing.’ Consistency variables (i.e., weekday vs. weekend [WvW], day to day variability [D2D], and standard deviation [SD]) were captured across three aspects of sleep and sleep timing including (1) sleep duration (2) wake time and (3) bedtime. Weekday to weekend shifts in sleep were calculated by subtracting the difference in sleep duration from weekdays to weekends (weekday sleep duration – weekend sleep duration = # minutes). Differences in weekdays to weekends used the nomenclature WvW following the variable term (e.g., bedtime WvW). Variability was captured using two methods. First, night-to-night variability is the difference between measurements (night 2 – night 1) + (night 3 – night 2) + (night x – night x) then averaged across number of days completed (e.g., Jahng, Wood, & Trull, 2008; Sánchez-Ortuño, Carney, Edinger, Wyatt, & Harris, 2011; Suh et al., 2012). This method typically involves squaring the difference between measurements before averaging across days, however the current study utilized the absolute value to keep the unit as minutes. This was done for each aspect of sleep timing (e.g. bedtime, wake time, and sleep duration) and used D2D (day to day) as the nomenclature following variable terms (e.g., bedtime D2D). Second, standard deviation of sleep variables was calculated and the nomenclature SD was used following variable terms (e.g., bedtime SD). See Figure 2 for a visual representation of these calculations.

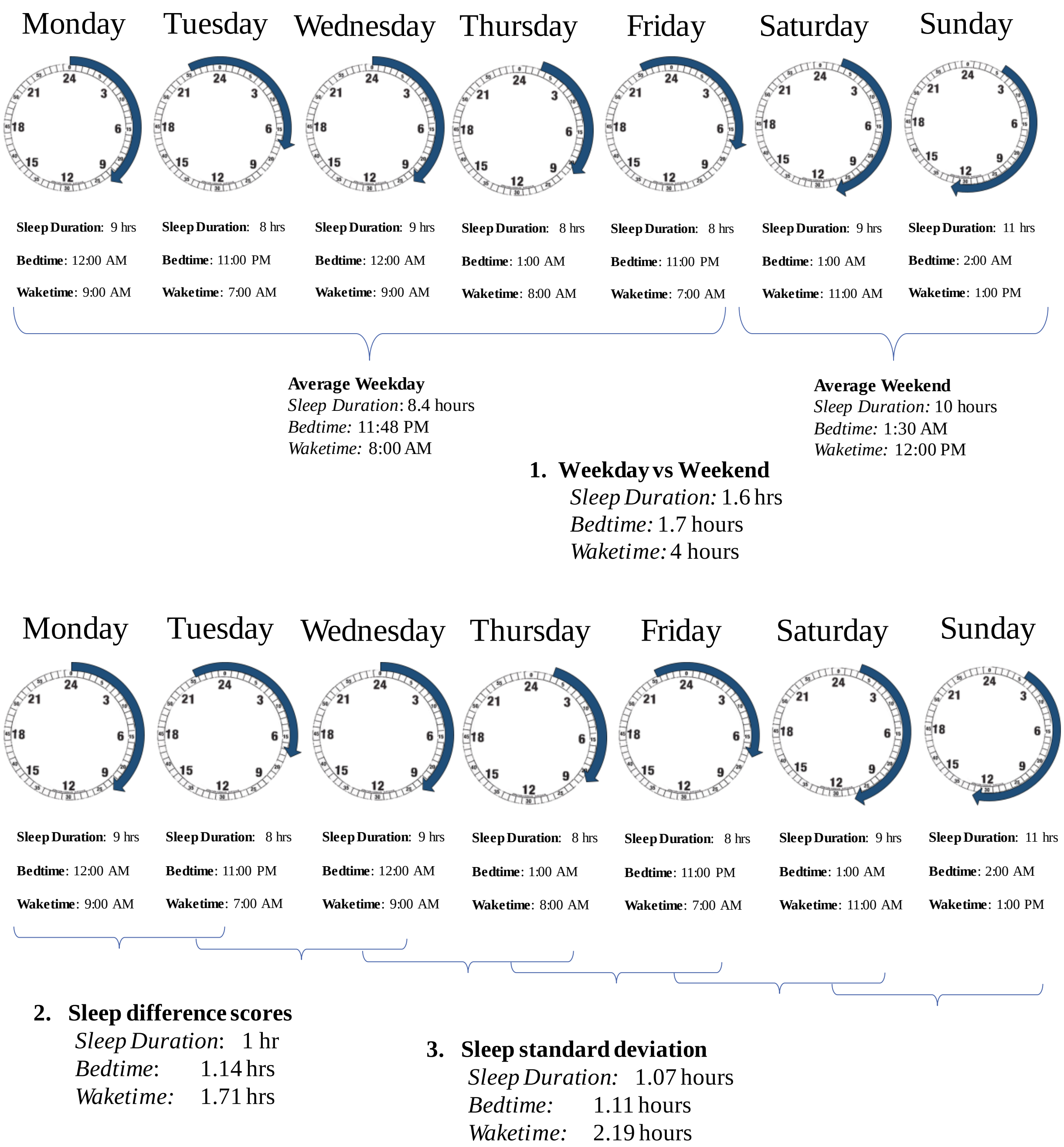

Figure 2. Calculation of Consistency of Sleep Timing

Eating Occurrences

Meal and snack consumption were asked about for the previous day and the current day in order to capture a 24-hour window of eating occurrences (EOs). Participants were first asked if they ate anything since their last submission (yes or no). If yes, they had three slots where they could enter their EOs. Each EO slot asked (1) what time they ate that meal/snack (2) what did they eat (i.e., breakfast, brunch, lunch, dinner/supper, snack, other). Participants were then asked if they ate anything that day (yes or no) with the same options but were able to fill in ten EO slots. The EO frequency for each day was calculated by adding the number of reported meals and snacks together for a 24 hour period. Therefore, if a participant stayed awake past midnight and reported consuming meals or snacks after this time, those EOs were included in the following day. After the EO frequency was calculated for each day, the average was taken to get the average daily EO frequency.

Calculating 'consistent eating occurrences.' Once frequency of EOs were calculated for each day, differences scores from day to day were calculated similar to consistency of sleep timing (see Figure 3). The difference of EO frequency across days were calculated by subtracting the amount of meals and snacks from day to day then averaging across a week. The same nomenclature was used for these variables as for sleep (e.g., EO D2D).

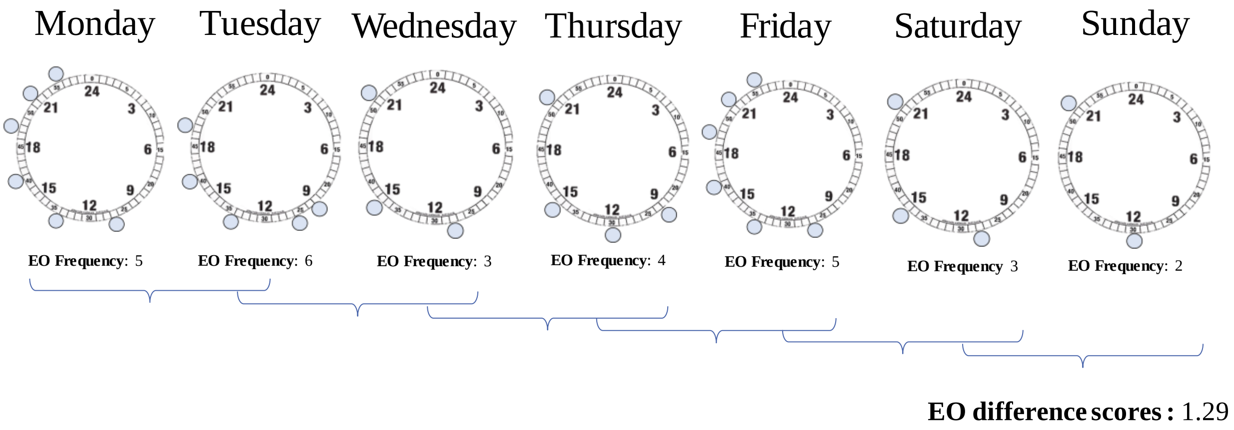

Figure 3. Calculation of Consistency of EO

Physical Activity

Physical activity was assessed via the modified 7-Day Recall which asks about physical activity over a seven day period and uses four levels of intensity (Sallis et al., 1985). For brevity, participants were asked a single-item question of physical activity daily that used the 7-Day Recall levels of intensity (i.e., light, moderate, hard, and very hard). Research has found that single item questions of physical activity asking about >30 minutes of moderate to vigorous physical activity (MVPA) are moderately correlated (*r* = 0.46) with objective measures of MVPA using accelerometer data (Milton, Clemes, & Bull, 2011). However, the Center for Disease Control (CDC) suggests that MVPA could be done in increments of 10 minutes to see effects (CDC, 2015). The present study was interested in frequency of PA episodes of at least a moderate intensity lasting 10 minutes. Participants were asked if they engaged in physical exercise that day (yes or no). If yes, they were asked follow up questions about (1) how long they exercised (2) what time they exercised (3) what kind of exercise (open-ended) and (4) how intense the exercise was (light, moderate, hard, and very hard). Frequency of PA was the added number of reported PA episodes across a week and PA duration was the number of minutes they reported engaging in physical activity.

Calculating 'consistent physical activity.' The time at which participants reported engaging in physical activity was used to calculate consistency of PA timing. Participants' PA was categorized into a specific time of day: early morning (6:00 AM – 11:00 AM); middle day (11:00 AM – 3:00 PM); late afternoon (3:00 PM – 8:00 PM); evening (8:00 PM – 12:00 AM). If participants engaged in exercise during the similar time periods across days (at least 50%) they were dummy coded with a 1 and categorized as 'consistent'. If they are not exercising in the same time periods they were coded as 0 and categorized as 'inconsistent' (see Figure 4).

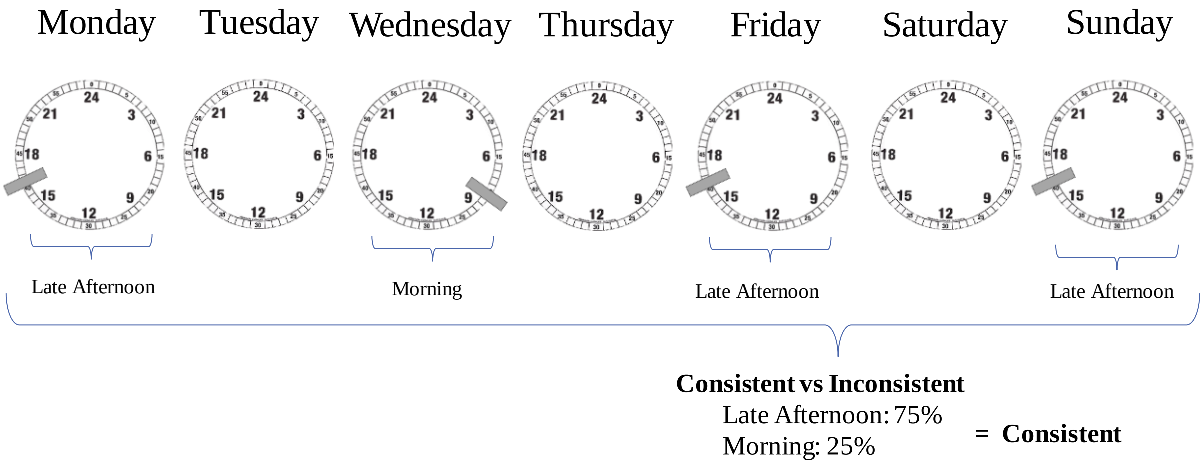

Figure 4. Calculation of Consistency of PA

BMI

Participants were asked to self-report their height and weight as part of the Eating Disorder Examination Questionnaire (not described here), which assessed disordered eating behavior and used for the experimental portion of the overarching study (Fairburn & Beglin, 1994). BMI was calculated using standard formula (BMI = kg/m^2) and classification of underweight, normal weight, overweight, and obese were based off of predefined BMI cut off scores (World Health Organization, 1995). As mentioned, previous research has demonstrated that self-reported BMI was highly associated with objective measures of height and weight in college samples, and self-report BMI classifications were correctly identified 96% of the time in a sample of adolescents (Goodman, Hinden, & Khandelwal, 2000; Quick et al., 2015).

Demographics

During the initial survey, participants will be asked to answer questions that relate to background demographic information. Demographics included birthday, gender, race/ethnicity, income, standing in school (e.g., freshman, sophomore), and where they live (e.g., residential hall). Gender will be used as a moderator in analyses that compare the three health behaviors to BMI.

Covariates

The standard health behavior covariates (e.g., **s**leep duration total, average daily EO frequency, and PA duration) are described in detail above. Average sunlight was calculated by subtracting sunset by sunrise and then averaging the amount of sunlight across the participation week expressed in minutes. Average temperature was calculated by taking the average temperature across each day and average across the participation week expressed in Fahrenheit degrees.

CHAPTER THREE

RESULTS

Data Preparation and Analytic Plan

Initially, daily diary data were examined to assess for valid days. If a participant's response style suggested they did not understand the survey (e.g., reported "not sleeping," but included a wake up time) that daily dairy day was removed for that participant. In total, 18 participants had a daily diary day that was considered invalid, though only one participant was eliminated from the sample because they no longer met the four day inclusion criteria. This resulted in 662 valid daily diary days with participants completing six out of seven days, on average. Next, examination of the descriptive analyses identified several outliers. Two participants were removed because scores were considered highly unlikely given what would be expected of this sample. Specifically, one participant reported not sleeping three out of the four reported days and another participant reported an extremely low height and weight (BMI = 12.54). Additionally, correlational analyses were run to examine relations between BMI and proposed covariates (i.e., sunlight and temperature) to determine if they should be used within main analyses. These proposed covariates were not significantly associated with BMI and thus not included as covariates. Descriptive analyses indicated that the majority of variables were negatively skewed with two variables (i.e., wake time D2D and bedtime D2D) being extremely skewed (skewness statistic >5). For these two variables, three transformations were conducted (i.e., square root, log, and natural log) resulting slightly skewness statistics for these variables (between |1.43| and |1.87|).

To address study aims, the following analyses were conducted. For Aim 1, descriptive analyses were run for each variable, including means, standard deviation, and correlations. Then, to examine gender differences among variables, analyses of variance tests (ANOVA) were performed for all continuous variables, whereas chi-square analyses were run for categorical variables (i.e., consistency of PA). For Aim 2, correlational analyses as well as hierarchical multiple regression analyses were conducted to investigate relations between each health consistency variable and BMI as well as whether this relation was moderated by gender. In these regressions, the covariate was entered on the first step of the hierarchical multiple regression. To account for the main effects of each health consistency variable on BMI, the health consistency variable (e.g., bedtime D2D) was entered on the second step. Gender was entered on the third step. Finally, in order to test for gender as a moderator, an interaction term (e.g., gender x bedtime D2D) was entered on the fourth and final step. All continuous variables in the model were centered prior to analysis and simple slope analyses were conducted for all significant interactions according to recommendations by (Aiken & West, 1991; Holmbeck, 2002).

Several approaches were taken to ensure that variables were not violating assumptions of the proposed analyses. First, for slightly skewed variables (skewness statistic > 1 and < 2), bootstrapping methods have been suggested to replace other parametric tests, such as square root (Russell & Dean, 2000; Sainani, 2012). Therefore, bootstrapping methods were used for all the hierarchical multiple regressions and moderation analyses for these variables. Second, for highly skewed variables (skewness statistic > 5), the three transformations (i.e., square root, log, and natural log) of both variables (wake time D2D and bedtime D2D) were used in the hierarchical multiple regressions, also using bootstrapping methods, to assess if consistent findings were observed across the three transformations.

Descriptive Statistics of Health Behaviors and Consistency

Means, medians, and standard deviations among all study variables were calculated and presented in Table 2. Participants were mostly female (83.5%) and lived in a residential hall on campus (97.2%). Participants self-reported a mean BMI of 23.78, with females reporting a higher BMI than males. With regard to weight status, 10.1% were underweight (*n* = 11), 57.8% normal weight (*n* = 63), 23.9% overweight (*n* = 26), and 8.3% obese (*n* = 9).

With regard to sleep variables, results indicated that sleep duration at night averaged seven hours and 23 minutes whereas sleep duration total (including naps) was slightly longer, seven hours and 39 minutes. Average wake time was 8:31 AM and ranged from 5:24 AM to 10:49 AM. Average bedtime was 12:50 AM and ranged from 9:12 PM to 3:13 AM. Changes from weekday to weekend sleep suggest that wake time shifted one hour 33 minutes and bedtime shifted 48 minutes later. Further, sleep duration at night on the weekends was 41 minutes longer than sleep duration at night during the week. Finally, the majority (63%) of participants took naps at some point across the week (*n* = 69). These naps lasted one hour and 39 minutes on average.

Table 2. Means, Medians, and Standard Deviations of Study Variables

Variables	*n*	Mean	Median	*SD*
BMI	109	23.78	22.85	4.63
Wake time	109	8:31 AM	8:26 AM	62.34
Bedtime	109	12:50 AM	12:47 AM	66.72
Sleep Duration Total	109	458.92	465.00	57.22
Sleep Duration at Night	109	443.23	450.00	58.58
Nap Duration	69	98.79	87.50	60.39
Sleep Duration WvW	96	80.77	72.00	62.63
Sleep Duration D2D	109	97.26	84.00	63.85
Sleep Duration SD	109	84.29	75.00	44.71
Wake Time WvW	96	108.75	102.00	84.08
Wake Time D2D	109	75.97	67.50	70.87
Wake Time SD	109	75.67	73.74	43.69
Bedtime WvW	96	71.24	60.75	64.86
Bedtime D2D	109	70.34	57.50	67.82
Bedtime SD	109	65.39	60.06	36.07
EO Frequency	109	2.96	2.86	0.86
EO D2D	109	0.82	0.75	0.53
PA Duration	57	185.68	135.00	147.66
PA Episodes	57	2.42	2.00	1.55
	n	%		
PA consistency	35			
Consistent	24	68.60		
Inconsistent	11	31.40		

Sleep variables expressed in minutes, unless otherwise stated
WvW = Weekday vs weekend
D2D = day to day
SD = standard deviation

Consistency of sleep timing is also described in Table 2. Results demonstrate that consistency of sleep duration (WvW, D2D, and SD) ranged from one hour 21 minutes to one hour 37 minutes on average, suggesting low consistency. Additionally, consistency of wake times (WvW, D2D, and SD) were low and ranged from one hour 16 minutes to one hour 49 minutes on average. Finally, consistency of bedtimes (WvW, D2D, and SD) ranged from one hour five minutes to one hour 11 minutes on average. Taken together, these findings suggest that participants had low consistency of sleep timing, particularly with regard to sleep duration and wake times.

Data on EOs indicated that average daily EO frequency was 2.96, meaning that participants reported eating roughly three meals and/or snacks each day. Across participants, EO frequency ranged from less than 1 EO to 5 EO on average per day. Consistency of EOs was high, with the difference in EO frequency from day to day being less than 1 (*M* = .817). This suggests that participants had a similar number of meals and snacks consumed each day.

PA data suggested that approximately half (52.3%) of participants engaged in PA (*n* = 57) at some point across their participation week. Of these participants, average PA episodes per week was between 2-3 times (*M* = 2.42), and students reported about 3 hours (186 minutes), on average, of PA accumulated over the week. Only 35 participants were able to be classified as either consistent or inconsistent because at least two PA episodes were needed to determine if episodes fell within similar or dissimilar time periods (further described in Table 1). The majority of participants (68.6%, *n* = 24) were considered having consistent PA, or at least 50% of their PA episodes falling into the same time period.

Gender Differences in Health Behaviors and Consistency

One-way ANOVAs were conducted to examine for gender differences across health behaviors and consistency of health behaviors (see Table 3). Across all variables, a statistically significant difference between genders was found only for PA duration. Specifically, males reported significantly more minutes of PA over the week (*M* = 277 minutes) than females (*M* = 159 minutes). Of note, several gender differences were approaching significance. Namely, females had greater BMIs than males, greater shifts in wake time from weekday to weekends, and bed time. Chi-square analyses indicated no significant gender differences in consistency of PA.

Relations among BMI, Sleep, EO, and PA

Correlational analyses were performed to examine relations between health behaviors and BMI (see Table 4). BMI was associated with several sleep variables, though not EO or PA variables. Greater BMI was associated with both longer nap durations and less consistency in wake time variables (WvW, D2D, & SD). In addition, several notable intercorrelations between sleep, EO, and PA variables also emerged. Nap duration was positively associated with average bedtime, suggesting that taking longer naps may be related to later bedtimes. Regarding sleep consistency, sleep variables were highly correlated. More specifically, sleep duration total was negatively associated with bedtime D2D, such that greater fluctuations in bedtime from day to day is related to less sleep overall. Additionally, nap duration was positively associated with consistency of sleep variables, while also negatively associated with average daily EO frequency, PA duration and PA episodes. These results suggest that longer nap durations may be related to less consistent sleep, as well as fewer EOs, and less time spent engaging in PA. Interestingly,

Table 3. Gender Differences between Study Variables

Variables	Gender	*n*	*M*	*SD*	*F*	*p*
BMI	Female	91	24.15	4.79	3.54	0.06
	Male	18	21.92	3.22		
Sleep Duration Total	Female	91	458.63	59.58	0.01	0.91
	Male	18	460.37	44.77		
Sleep Duration WvW	Female	84	81.80	59.95	0.18	0.67
	Male	12	73.53	81.81		
Sleep Duration D2D	Female	91	100.94	67.49	1.84	0.18
	Male	18	78.66	36.67		
Sleep Duration SD	Female	91	86.34	46.43	1.17	0.28
	Male	18	73.89	33.88		
Wake Time WvW	Female	84	114.46	84.38	3.17	0.08
	Male	12	68.79	73.11		
Wake Time D2D	Female	91	75.68	74.44	0.01	0.92
	Male	18	77.45	50.64		
Wake Time SD	Female	91	78.25	44.86	1.93	0.17
	Male	18	62.67	35.42		
Bedtime WvW	Female	84	73.90	69.38	3.15	0.08
	Male	12	37.65	32.47		
Bedtime D2D	Female	91	71.13	72.34	0.08	0.78
	Male	18	66.31	38.74		
Bedtime SD	Female	91	66.81	36.58	0.85	0.36
	Male	18	58.24	33.39		
EO Frequency	Female	91	2.93	0.83	0.64	0.42
	Male	18	3.11	0.98		
EO D2D	Female	91	0.82	0.55	0.00	0.95
	Male	18	0.81	0.46		
PA Duration	Female	44	158.66	121.88	7.18	0.01
	Male	13	277.15	191.75		

	Females	Males	*df*	X^2	*p*
PA Consistency	17 (48.57%)	7 (20.00%)	1	1.724[a]	0.189
PA Inconsistent	10 (28.57%)	1 (2.86%)			

[a] Expected counts were less than statistically expected

both WvW and D2D in wake time as well as bedtime, and sleep duration were negatively associated with average daily EO frequency. These findings suggest that a less consistent sleep schedule from day to day and across a week is associated with fewer EO, on average. Further, consistency of wake time (SD) and consistency of sleep duration (WvW) were negatively associated with both PA duration and PA episodes, such that less consistent wake times and less consistent sleep duration were associated with less PA. Finally, EO variables were significantly associated with several PA variables. EO frequency was positively associated with PA duration and PA episodes. Rather, the greater the EO frequency, the longer amount of time engaging in PA across the week. Of note, consistent EO were not significantly associated with BMI or the other health variables.

Next, hierarchical multiple regressions were performed using bootstrapping methods to examine associations between BMI and consistency of health behaviors (i.e., sleep, EO, and PA) accounting for health behavior covariates. All analyses used a bootstrapped sample of *n* = 1,000. Significant relations were observed for consistency of wake time measures (WvW, SD) as well as all three wake time D2D variables that were transformed (e.g., square root, log, natural log). Consistent with the correlational findings, results demonstrate that less consistent wake times using multiple indices were associated with higher BMI even when accounting for sleep duration (see Table 5). These findings suggest that individuals with less consistent wake times were heavier regardless of how much overall sleep they were getting. With regard to consistency of EOs and PA, no significant main effects were found suggesting that these variables were not associated with BMI.

Table 4. Correlations among Main Study Variables

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
1. BMI	-																
2. Sleep dur total	-.12	-															
3. Nap dur	.22*	.07	-														
4. Avg BT	-.02	-.20	.31**	-													
5. Avg WT	-.16	.46**	.11	.61**	-												
6. Sleep dur WvW	.14	-.08	.26*	.12	.07	-											
7. Sleep dur D2D	.12	-.06	.17	.11	.16	.40**	-										
8. Sleep dur SD	.09	-.05	.20*	.10	.16	.55**	.88**	-									
9. BT WvW	.07	.07	.04	.14	.11	.06	-.10	-.06	-								
10. BT D2D	.17	-.23	.06	-.15	-.11	.26*	.55**	.46**	.01	-							
11. BT SD	.12	-.06	.22*	.14	.13	.29**	.46**	.47**	.56**	.59**	-						
12. WT WvW	.24*	.01	.25*	.20*	.11	.45**	.16	.30**	.31**	-.01	.16	-					
13. WT D2D	.25**	-.16	.03	-.14	-.09	.26*	.54**	.49**	-.01	.73**	.18	.12	-				
14. WT SD	.29**	.08	.36**	.14	.13	.44**	.38**	.51**	.19	.17	.21*	.82**	.47**	-			
15. Avg EO freq	-.07	.11	-.21	-.16	-.14	-.12	-.23*	-.28**	-.02	-.21*	-.20*	-.17	-.21*	-.31**	-		
16. EO D2D	-.07	-.07	-.15	-.16	-.01	-.09	.01	.01	.08	.05	.06	-.01	.03	.06	.01	-	
17. PA dur total	-.05	-.01	-.25**	-.06	-.10	-.22*	-.14	-.17	-.10	-.08	-.10	-.21*	-.06	-.19*	.24*	.04	-
18. PA episodes	-.07	.05	-.27**	-.15	-.13	-.25*	-.11	-.17	-.15	-.10	-.15	-.20*	-.09	-.20*	.25**	.05	.91**

* $p < 0.05$ level; ** $p < 0.01$ level.

Table 5. Significant Hierarchical Regressions Examining Relations between BMI, Consistency of Health Variables, and Gender as a Moderator

Wake Time Weekday to Weekend (WvW)

Step	Variable	*B*	*SE B*	*5%, 95% CI*	*5%, 95% BC, CI*	*p*
1	Sleep Duration Total	-.012	.010	-.032	.006	.221
*2	Sleep Duration Total	-.012	.009	-.031	.005	.194
	Wake Time WvW	.014	.066	.002	.027	.036
3	Sleep Duration Total	-.011	.009	-.030	.006	.217
	Wake Time WvW	.012	.006	.001	.026	.057
	Gender	-2.41	1.177	-4.769	-.171	.032
4	Sleep Duration Total	-.011	.009	-.030	.006	.224
	Wake Time WvW	.013	.007	.001	.026	.062
	Gender	-2.61	2.404	-5.124	1.414	.088
	Wake Time WvW *Gender	-.006	.031	-.035	.054	.787

***Step 2:** $R^2 = .078$, Standard Error: 4.663, *F* (1, 93): 5.864, $p < .05$

1,000 bootstrap samples

Wake Time Standard Deviation (SD)

Step	Variable	*B*	*SE B*	*5%, 95% CI*	*5%, 95% BC, CI*	*p*
1	Sleep Duration Total	-.009	.009	-.027	.009	.295
*2	Sleep Duration Total	-.011	.008	-.026	.005	.158
	Wake Time SD	.032	.013	.010	.060	.009
3	Sleep Duration Total	-.011	.008	-.026	.005	.172
	Wake Time SD	.030	.013	.007	.057	.019
	Gender	-1.737	.888	-3.593	-.043	.057
4	Sleep Duration Total	-.011	.008	-.026	.005	.153
	Wake Time SD	.029	.014	.007	.060	.039
	Gender	-1.653	1.034	-3.679	.302	.093
	Wake Time SD *Gender	.007	.027	-.048	.057	.774

***Step 2:** $R^2 = .322$, Standard Error: 4.428, *F* (1, 106): 10.690, $p < .01$

1,000 bootstrap samples

Wake Time Day to Day Differences (Square Root)

Step	Variable	*B*	*SE B*	*5%, 95% CI*	*5%, 95% BC, CI*	*p*
1	Sleep Duration Total	-.009	.009	-.026	.007	.276
*2	Sleep Duration Total	-.009	.008	-.026	.006	.278
	Wake Time D2D_sq	.039	.125	.136	.687	.001
3	Sleep Duration Total	-.008	.008	-.026	.006	.287
	Wake Time D2D _sq	.407	.125	.173	.696	.001
	Gender	-2.316	.891	-4.080	-.486	.007
4	Sleep Duration Total	-.008	.008	-.025	.006	.305
	Wake Time D2D _sq	.413	.126	.168	.710	.001
	Gender	-2.302	.882	-3.949	-4.52	.006
	Wake Time D2D _sq *Gender	.388	.345	-.484	.950	.216

***Step 2:** $R^2 = .086$, Standard Error: 4.471, *F* (1, 106): 8.453, $p < .01$

1,000 bootstrap samples

Wake Time Day to Day Differences (Log)

Step	Variable	*B*	*SE B*	*5%, 95% CI*	*5%, 95% BC, CI*	*p*
1	Sleep Duration Total	-.009	.009	-.028	.007	.279
*2	Sleep Duration Total	-.010	.008	-.027	.006	.204
	Wake Time D2D _log	3.064	1.007	1.262	5.198	.002
3	Sleep Duration Total	-.010	.008	-.026	.006	.197
	Wake Time D2D _log	3.175	.979	1.324	5.292	.002
	Gender	-2.361	.886	-4.059	-.658	.013
4	Sleep Duration Total	-.010	.008	-.027	.006	.218
	Wake Time D2D _log	3.227	.995	1.385	5.397	.002
	Gender	-2.408	.883	-4.007	-.602	.009
	Wake Time D2D _log *Gender	3.823	3.00	-3.124	8.139	.154

***Step 2:** $R^2 = .076$, Standard Error: 4.495, *F* (1, 106): 7.216, $p < .01$

1,000 bootstrap samples

Waketime Day to Day Differences (Natural Log)

Step	Variable	*B*	*SE B*	*5%, 95% CI*	*5%, 95% BC, CI*	*p*
1	Sleep Duration Total	-.009	.009	-.027	.007	.298
*2	Sleep Duration Total	-.01	.008	-.028	.005	.220
	Wake Time D2D_ln	1.331	.434	.548	2.199	.007
3	Sleep Duration Total	-.01	.008	-.028	.005	.212
	Wake Time D2D_ln	1.379	.425	.602	2.277	.004
	Gender	-2.361	.897	-4.083	-.670	.014
4	Sleep Duration Total	-.01	.008	-.027	.005	.234
	Wake Time D2D_ln	1.402	.429	.631	2.329	.002
	Gender	-2.408	.898	-3.994	-.608	.011
	Wake Time D2D_ln*Gender	1.66	1.311	-1.636	3.644	.142

***Step 2:** $R^2 = .076$, Standard Error: 4.495, *F* (1, 106): 7.216, $p < .01$

1,000 bootstrap samples

Gender as a Moderator

As shown in Table 6, no significant interaction effects were found for any of the health consistency variables, suggesting that the relation between consistency of health variables (sleep, EO, and PA) and BMI did not vary by gender.

Table 6. Null Hierarchical Regressions Examining Relations between BMI, Consistency of Health Variables, and Gender as a Moderator

Sleep Duration Weekday vs Weekend (WvW)

Step	Variable	*B*	*SE B*	*5%, 95% CI*	*5%, 95% BC, CI*	*p*
1	Sleep Duration Total	-.012	.010	-.032	.007	.221
2	Sleep Duration Total	-.011	.010	-.030	.007	.244
	Sleep Duration WvW	.010	.010	-.009	.028	.334
3	Sleep Duration Total	-.010	.009	-.029	.008	.273
	Sleep Duration WvW	.009	.009	-.009	.026	.332
	Gender	-2.90	1.17	-5.19	-.564	.019
4	Sleep Duration Total	-.010	.009	-.028	.008	.297
	Sleep Duration WvW	.011	.010	-.010	.031	.293
	Gender	-2.96	2.59	-5.14	.197	.014
	Sleep Duration WvW *Gender	-.010	.043	-.036	.062	.644
Step 2: R^2 = .036, SE: 4.769, *F* (1, 93): 5.864, *p* = .225						
Step 4: R^2 = .079, SE: 4.713, *F* (1, 91): .007, *p* = .597						

1,000 bootstrap samples

Bedtime Weekday vs Weekend (WvW)

Step	Variable	*B*	*SE B*	*5%, 95% CI*	*5%, 95% BC, CI*	*p*
1	Sleep Duration Total	-.012	.010	-.032	.008	.254
2	Sleep Duration Total	-.013	.010	-.033	.007	.225
	Bedtime WvW	.008	.008	-.007	.027	.334
3	Sleep Duration Total	-.011	.010	-.032	.008	.269
	Bedtime WvW	.005	.009	-.010	.024	.564
	Gender	-2.77	1.19	-5.23	-.282	.029
4	Sleep Duration Total	-.012	.010	-.033	.007	.238
	Bedtime WvW	.003	.009	-.012	.023	.684
	Gender	-1.27	2.78	-3.84	.801	.227
	Bedtime WvW *Gender	.046	.055	-.021	.106	.093
Step 2: R^2 = .031, SE: 4.781, *F* (1, 93): 1.031, *p* = .313						
Step 4: R^2 = .077, SE: 4.717, *F* (1, 91): 1.064, *p* = .305						

1,000 bootstrap samples

Sleep Duration Standard Deviation (SD)

Step	Variable	*B*	*SE B*	*5%, 95% CI*	*5%, 95% BC, CI*	*P*
1	Sleep Duration Total	-.009	.009	-.028	.006	.283
2	Sleep Duration Total	-.009	.008	-.025	.007	.276
	Sleep Duration SD	.009	.011	-.012	.031	.402
3	Sleep Duration Total	-.009	.008	-.025	.006	.281
	Sleep Duration SD	.007	.011	-.014	.030	.507
	Gender	-2.12	.986	-4.04	-.012	.037
4	Sleep Duration Total	-.009	.008	-.026	.006	.259
	Sleep Duration SD	.009	.011	-.013	.033	.435
	Gender	-2.55	1.14	-4.94	-.489	.016
	Sleep Duration SD *Gender	-.024	.025	-.075	.017	.296

Step 2: R^2 = .021, SE: 4.628, *F* (1, 106): .782, *p* = .379

Step 4: R^2 = .005, SE: 4.590, *F* (1, 104):.601 , *p* = .440

1,000 bootstrap samples

Bedtime Standard Deviation (SD)

Step	Variable	*B*	*SE B*	*5%, 95% CI*	*5%, 95% BC, CI*	*p*
1	Sleep Duration Total	-.009	.009	-.027	.008	.285
2	Sleep Duration Total	-.009	.008	-.024	.009	.286
	Bedtime SD	.015	.018	-.021	.049	.428
3	Sleep Duration Total	-.009	.008	-.024	.009	.292
	Bedtime SD	.013	.018	-.022	.048	.488
	Gender	-2.10	.913	-3.99	-.260	.023
4	Sleep Duration Total	-.009	.008	-.024	.009	.282
	Bedtime SD	.011	.021	-.029	.050	.622
	Gender	-2.02	.987	-3.10	.015	.038
	Bedtime SD*Gender	.013	.033	-.061	0.072	0.657

Step 2: R^2 = .027, SE: 4.614, *F* (1, 106): 1.436, *p* = .233

Step 4: R^2 = .056, SE: 4.587, *F* (1, 104): 3.145, *p* = .713

1,000 bootstrap samples

Sleep Duration Day to Day Differences (D2D)

Step	Variable	*B*	*SE B*	*5%, 95% CI*	*5%, 95% BC, CI*	*p*
1	Sleep Duration Total	-.009	.009	-.027	0.008	0.281
2	Sleep Duration Total	-.009	.008	-.025	0.008	0.290
	Sleep Duration D2D	.008	.008	-.007	0.025	0.290
3	Sleep Duration Total	-.009	.008	-.025	0.008	0.272
	Sleep Duration D2D	.007	.008	-.010	0.023	0.393
	Gender	-2.06	.961	-4.05	-0.285	0.032
4	Sleep Duration Total	-.009	.008	-.025	0.008	0.263
	Sleep Duration D2D	.008	.009	-.009	0.027	0.327
	Gender	-2.52	1.10	-4.97	-0.688	0.018
	Sleep Duration D2D *Gender	-.027	.026	-.081	0.019	0.260

Step 2: $R^2 = .027$, SE: 4.614, *F* (1, 106): 1.472, *p* =.228

Step 4: $R^2 = .061$, SE: 4.581, *F* (1, 104): .749 , *p* = .389

1,000 bootstrap samples

Bedtime Day to Day Differences (Square Root)

Step	Variable	*B*	*SE B*	*5%, 95% CI*	*5%, 95% BC, CI*	*P*
1	Sleep Duration Total	-.009	.009	-.027	.007	.302
2	Sleep Duration Total	-.008	.008	-.023	.007	.313
	Bedtime D2D_sq	.179	.184	-.261	.511	.283
3	Sleep Duration Total	-.008	.008	-.023	.007	.311
	Bedtime D2D_sq	.177	.181	-.255	.502	.279
	Gender	-2.20	.942	-4.09	-.296	.030
4	Sleep Duration Total	-.008	.008	-.023	.007	.311
	Bedtime D2D_sq	.160	.204	-.331	.517	.392
	Gender	-2.20	.982	-4.07	-.203	.026
	Bedtime D2D_sq*Gender	.173	.416	-.697	.945	.656

Step 2: $R^2 = .027$, SE: 4.614, *F* (1, 106): 1.439, *p* = .233

Step 4: $R^2 = .059$, SE: 4.579, *F* (1, 104): .130, *p* = .719

1,000 bootstrap samples

Bedtime Day to Day Differences (Log)

Step	Variable	*B*	*SE B*	*5%, 95% CI*	*5%, 95% BC, CI*	*p*
1	Sleep Duration Total	-.009	.009	-.027	.006	.266
2	Sleep Duration Total	-.009	.008	-.027	.007	.273
	Bedtime D2D_log	1.05	1.54	-1.88	4.34	.484
3	Sleep Duration Total	-.009	.008	-.026	.007	.271
	Bedtime D2D_log	1.09	1.50	-1.76	4.19	.453
	Gender	-2.22	.923	-4.14	-.382	.018
4	Sleep Duration Total	-.009	.008	-.026	.008	.299
	Bedtime D2D_log	.813	1.72	-2.53	4.25	.629
	Gender	-2.25	.920	-4.07	-.335	.017
	Bedtime D2D_log*Gender	2.51	3.68	-5.30	9.06	.466

Step 2: R^2 = .019, SE: 4.632, *F* (1, 106): .624, *p* = .431

Step 4: R^2 = .054, SE: 4.577, *F* (1, 104): .360, *p* = .550

1,000 bootstrap samples

Bedtime Day to Day Differences (Natural Log)

Step	Variable	*B*	*SE B*	*5%, 95% CI*	*5%, 95% BC, CI*	*p*
1	Sleep Duration Total	-.009	.009	-.027	.007	.272
2	Sleep Duration Total	-.009	.008	-.026	.008	.279
	Bedtime D2D_ln	.456	.631	-.739	1.72	.460
3	Sleep Duration Total	-.009	.008	-.026	.007	.283
	Bedtime D2D_ ln	.473	.618	-.722	1.76	.422
	Gender	-2.22	.960	-4.10	-.206	.028
4	Sleep Duration Total	-.009	.008	-.026	.008	.305
	Bedtime D2D_ ln	.353	.698	-1.09	1.82	.576
	Gender	-2.25	.955	-4.10	-.265	.023
	Bedtime D2D_ ln*Gender	1.09	1.48	-2.37	3.53	.418

Step 2: R^2 = .019, SE: 4.632, *F* (1, 106): .006, *p* = .431

Step 4: R^2 = .054, SE: 4.591, *F* (1, 104): .360, *p* = .550

1,000 bootstrap samples

CHAPTER FOUR

DISCUSSION

The current study aimed to describe the consistency of three health behaviors (i.e., sleep, EO, and PA) and relations to BMI among first year college students. As previously described, unstructured and erratic environments may increase risk for weight gain (Bates et al., 2018; Brazendale et al., 2017; Proper et al., 2016; Van Drongelen et al., 2011) potentially through disruptions of health behavior routines and misalignment of the circadian rhythm (Westerterp-Plantenga, 2016). Even though college settings and schedules are highly variable, little is known about consistency of health behaviors in this sample. Using daily diary methods to capture changes across the week, the current study demonstrated that consistency of EO and PA were relatively stable, whereas consistency of sleep was low. Specifically, a similar number of meals and snacks were consumed from day to day and the majority of individuals engaged in PA at consistent times across the week. In contrast, large shifts in sleep were reported from weekdays to weekends (one hour 11 min to one hour 48 minutes) and from day to day (one hour 10 minutes to one hour 37 minutes). These large shifts in sleep have been similarly reported in other samples of college students (Lund et al., 2010; Whiting & Murdock, 2016) often increasing following the transition into college (Doane et al., 2015).

Low consistency of sleep is associated with increased vulnerability for weight gain, with previous reports demonstrating that a one hour difference in sleep from weekdays to weekends was associated with weight gain and increased obesity odds in adults (Patel et al., 2015). In the present study, wake time consistency assessed via several different indices (i.e., weekday vs weekend, day to day differences, and standard deviation) was associated with BMI among college students. Specifically, less consistent wake times were associated with higher BMIs, above and beyond sleep duration, a standard predictor of weight. Previous research using university samples found that consistency of sleep duration (Roane et al., 2015) and consistency of bedtime (Bailey et al., 2014) were also important predictors of weight, weight gain, and BMI. However, it could be the case that individuals with greater BMI have more erratic sleep schedules. Still, this study echoes previous findings that consistency of sleep timing may be important considerations within obesity prevention efforts in college, however, more attention needs to be given to the role of consistent wake times. This presents opportunities to encourage students to explore consistent class start times as a behavioral intervention for college students sleep patterns.

Given previous reports that males and females experience different risks for weight gain during college and females have increased health consequences of shift-work, another purpose of the present study was to identify gender differences among health and consistency variables. As expected, significant gender differences in PA were observed such that males engaged in PA longer than females, with similar trends observed in other samples of college students (Huang et al., 2003). Unexpectedly, females had greater BMIs than males in the current study (though not reaching statistical significance), with males reporting much lower BMIs than consistently observed in the literature (American College Health Association, 2017; McCreary, 2002; Pribis, Burtnack, McKenzie, & Thayer, 2010; Vera-Villarroel, Piqueras, Kuhne, Cuijers, & van Straten, 2014). Although self-report and objective measures of height and weight are highly correlated, measurement error can differ depending on gender, with men underreporting weight and over reporting height, resulting in lower BMIs than women (Quick et al., 2015; Bowman & DeLucia, 1992; Imrhan, Imrhan, & Hart, 1996; Roberts, 1995). Additionally, some gender differences emerged regarding consistency of sleep, such that shifts in wake times and bedtimes from weekdays to weekends were twice as large for females. However, the current study did not find support for a moderated effect of gender when examining any health consistency variables in relation to BMI. This is contrary to what would be expected given relations between consistency of sleep and body weight have been found for either males or females (Bailey et al., 2014; Roane et al., 2015). One explanation for null findings in the current study may be due to the small sample of males (*n* = 18) reducing the ability to detect moderation effects. In sum, males reported greater amounts of PA and higher consistency of sleep timing (i.e., wake time, bedtime), however the small sample and potential measurement error calls for additional research exploring if males or females may be more physiologically susceptible to erratic schedules, as demonstrated in the shift work literature (Saksvik, et al., 2011; Santhi et al., 2015).

Consistency of sleep, EO, and PA have not been explicitly described, or investigated, together in one study and therefore offer unique contributions to the extant literature. Limited research on these topics is likely because consistency of EO and PA have not been well defined within the literature, and thus were considered exploratory in the current study. Still, there were notable findings that call for additional research in how consistency of health variables may be interrelated. With regard to consistency of sleep, more erratic sleep durations, wake times, and bedtimes were associated with less reported EOs, and less PA engagement. Further, greater number of EOs were reported by participants who engaged in more PA. While we cannot infer directionally given the cross-sectional nature of this study, future research should consider the possibility that more erratic sleep schedules impact opportunities to plan for meal and snack consumption and when exercise will occur, including attending the dining hall or gym on campus. Alternatively, individuals who have highly erratic schedules or lifestyles may require changing their sleep habits to meet the needs of their responsibilities. To this point, researchers have investigated the stability of social rhythms, such has daily routines and practices, and found that more highly irregular lifestyles were associated with worse self-reported sleep disturbance (Carney, Edinger, Meyer, Lindman, & Istre, 2005; Monk, Reynolds, Buyssee, DeGrazia, & Kupfer, 2003). Therefore, future research should employ longitudinal designs to elucidate relations among these variables.

The relative lack of findings for associations between BMI and some health variables are worth noting given the extensive literature supporting strong relations. Short sleep has consistently been implicated as a predictor of weight both directly, and indirectly through other health behaviors (for a review, see Bayon et al., 2014). Further, later bedtimes have been implicated as important predictors of BMI (Asarnow, McGlinchey, & Harvey, 2015; Golley, Maher, Matricciani, & Olds, 2013; Gaina et al., 2006; Olds, Maher, & Matricciani, 2011). Contrary to the immense literature supporting relations between BMI and sleep duration and bedtimes, no relations were found in the current study. Similarly, the current study did not find significant correlations between BMI and EO frequency, despite studies finding that EOs were associated with obesity odds and weight gain (Leech et al., 2017; Murakami & Livingstone, 2015; Wang et al., 2016). What was most surprising, was the lack of findings between BMI and PA, given PA is a standard predictor of weight and continually recommended for weight management (CDC, 2015). There are likely several reasons why relations were not found between these standard predictors of weight and BMI. Perhaps the most critical limitation is the use of self-report measures over objective measures. Moderate to large correlations have been reported when comparing self-reported and actigraph-measured of sleep duration and PA, though objective measures would more accurately capture sleep duration as well as PA intensity (Craig et al., 2003; Lauderdale, Knutson, Yan, Liu, & Rathouz, 2008; Lockley, Skene, & Arendt, 1999; Girschik, Fritschi, Heyworth, & Walters, 2012; Lee, Macfarlane, Lam, & Stewart, 2011; Prince et al., 2008; Wolfson et al., 2003). Finally, two systematic reviews investigated associations of eating frequency and body weight, with inconclusive findings on directionality (Canuto, da Silva Garcez, Kac, de Lira, & Olinto, 2017; Wang et al., 2016). Canuto and colleagues (2017) suggest this is because of several methodological concerns within the literature, such as not including energy intake and diet quality as explanatory variables. In sum, the reliability of self-report measures in the current study likely influenced the lack of associations between BMI and standard predictors of body weight. Therefore, future studies should utilize objective measures of sleep, PA, as well as consider methodological concerns outlined by reviews on EOs (Canuto et al., 2017; Wang et al., 2016).

Although not an explicit measure of interest initially, nap duration was one of the only variables (other than wake time consistency variables) that was significantly correlated with BMI, such that longer naps were associated with higher BMIs. As suggested throughout, the transition to college marks a developmental period that shifts from parent-led to self-directed in an environment that is relatively unstructured. The majority (63%) of students in the current sample engaged in napping at some point across the seven day study period, suggesting a need to further explore napping within this population. Importantly, the literature on adults suggests that napping is associated with increased mortality risk, cardiovascular disease, and increased obesity odds (Patel et al., 2015; Stone et al., 2009; Yamada, Hara, Shojima, Yamauchi, & Kadowaki, 2015). Patel and colleagues (2015) found that a 23-29% increase in obesity odds were seen with each hour increase of napping. In the current study, relations were also observed between nap duration, consistency of sleep timing, and PA. Namely, longer naps were correlated with greater variability in sleep timing (e.g., bedtime), as well as lower levels of PA. These associations may be explained by fatigue that comes from sleep variability (Kang & Chen, 2009). That is, if one is sleeping more erratically, they are likely to be fatigued which may prompt them to nap rather than engaging in PA in their discretionary time. Additionally, napping could be considered another element, or characterization, of sleep consistency that may explain associations with body weight. However, napping is not typically accounted for in studies that examine consistency of sleep, or it is calculated as a standalone measure of consistency (e.g., nap duration day to day differences). A group of researchers attempted to address the ubiquity of napping in college samples and created an index of sleep regularity that included napping (Barker, Phillips, & Carskadon, 2017; Phillips et al., 2017). These methods were used to highlight the impact of sleep regularity on academic outcomes rather than BMI. Therefore, opportunities to examine novel measures of sleep consistency, that including napping, should be prioritized in college populations since they have more erratic sleep schedules than both children and working adults.

Along with several limitations and suggestions for future research described above, this study had additional strengths and weaknesses. A relative strength of the study was the use of daily diary methods to capture change across a week long period rather than asking a single question about consistency for each health variable. However, this method relies on both the accuracy and consistency of students self-reporting their health behaviors. Specifically, students who have erratic schedules may have found completing the surveys particularly challenging since the survey was delivered at 8:00 PM. Further, the question types may also have contributed to several limitations; participants may have become aware that they could complete the survey faster if they responded “no” to questions, thereby skipping additional follow up questions related to that health behavior. Questions regarding EOs may have particularly been vulnerable to this question type, as they would need to select “yes” to fill out subsequent EOs (see Appendix A).

Additional methodological concerns should be noted as limitations of the current study. To review, self-report measures are a major limitation and call for additional research using objective reports of consistency. Further longitudinal designs may better describe how health and health consistency may be interrelated with BMI. For example, understanding weight gain across college may offer important contributions to the literature and help clarify directionality. Variables in the current study were collapsed across several days and thus were considered cross-sectional, however other statistical methods (e.g., multilevel modeling) may better capture variability across a week (Jahng et al., 2008). Along these lines, the current study did not examine trends of variability (e.g., if sleep was getting progressively later or earlier as the week went on). Researchers may be interested in examining how temporal trends may contribute to health outcomes and should utilize advanced statistical methods to capture these changes (for statistical considerations and limitations of various methods, see Wang, Hamaker, & Bergeman, 2012).

Future studies should explore other health variables and measures of consistency to investigate associations with BMI. As previously discussed, assessing consistency of sleep in a college sample should include napping behavior as illustrated by Phillips and colleagues' methods (2017). Regarding EO, other measures of consistency should be considered based on preliminary research restricting EO windows and monitoring caloric distribution throughout the day. A recent intervention was employed to reduce weight gain in adults and found that shortening the window of eating time (time between first and last meal) aided in weight loss efforts (Gill & Panda, 2015). Further, researchers have suggested that timing of food intake and caloric distribution across the day can influence weight, such that eating later in the evening leads to adverse health consequences (for a review, see Garaulet & Gómez-Abellán, 2014). PA consistency in the current study may have been too restrictive and should be further explored and conceptualized. For example, physiological effects of PA timing may depend more on digestive states rather than diurnal timing (Haxhi et al., 2012). Referencing the sleep variability literature, weekdays to weekend differences in EO and PA behavior should also be considered. Racette and colleagues (2008) found that weekend patterns in eating and physical activity are contributors to insidious weight gain over time. Finally, there are many other contributors to weight, and weight gain, during college that were not examined in the current study. Future studies may want to also investigate the role of sleep quality and disturbance as explanatory variables for BMI in college students. In a study by Ye and colleagues (2015), nap frequency and length of nap duration was associated with worse sleep quality in college students, with sleep quality often implicated in weight gain in this population (Vargas, Flores, & Robles, 2014). Further, sleep disturbance among college students has been associated with overweight rather than sleep duration, and may be worthwhile to explore (Vargas, Flores, & Robles, 2014). Finally, dietary intake and quality should also be included in studies that explore EO frequency and EO consistency. In sum, research on consistency of health behaviors necessitates greater consideration of the sample of interest, how consistency variables are conceptualized and compared, and the use of other health variables that may influence findings.

Conclusion

The current study investigated health behaviors and consistency of health behaviors in college, as this developmental period and setting are associated with increased prevalence of overweight and obesity. To our knowledge, only two studies have examined relations between consistency of sleep in a college sample (Bailey et al., 2014; Roane et al., 2015), few examining consistency of EO across age groups (Farshchi et al., 2004), and none examining consistency of PA. Greater variability in wake times (weekday vs weekend, day to day differences, and fluctuations across the week) was associated with greater BMI, even when accounting for sleep duration. Unexpectedly, the amount of time students' reported napping was also associated with greater BMI. While this study did not examine the directionality of these findings, preliminary results suggest that various aspects of sleep, including consistency of sleep timing, should be considered within obesity interventions. A review on sleep hygiene education found inconclusive findings on the efficacy within non-clinical samples, calling for additional research in how targeting consistent wake times and eliminating daytime naps may improve intervention outcomes (Irish, Kline, Gunn, Buysse, & Hall, 2015). Interventions that utilize m-health and individualized feedback may increase efficacy of sleep behavior change (Levenson et al., 2016; Murawski et al., 2018) and have been successfully used in obesity interventions that modified the eating window of participants (Gill & Panda, 2015). In sum, researchers investigating contributors to weight gain in college should consider consistency of health behaviors, particularly wake times and napping, as behaviors to target within interventions for students transitioning into college.

APPENDIX A

QUESTIONNAIRE USED IN THE CURRENT STUDY

Demographics

1. Birthdate _______

2. Gender
    a. Male
    b. Female
    c. Other

3. Year in school?
    a. Freshman
    b. Sophomore
    c. Junior
    d. Senior
    e. Other. Please specify: __________________

4. Where do you live?
    a. Residential hall on campus
    b. Off campus apartment
    c. With parent(s)/legal guardian in Chicago area.
    d. Other. Please specify: ________________

Eating Disorders Examination Questionnaire (EDE-Q) – (Only pulled relevant questions)

What is your weight at present (Please give your best estimate.) ____
____ lbs

1. What is your height at present (Please give your best estimate.)
    ____ feet ____ inches

Daily Diary

The following questions refer to <u>specific day of the week (e.g. Monday)</u> night

1. Did you go to sleep last night? (YES / NO)
    (IF YES)
    a. What time did you go to sleep last night? _ _: _ _ AM/PM
    b. How long did it take you go to sleep last night? ___ min ___ hr

2. How many hours of sleep did you get last night? ____ hr ___ min

3. What time did you wake up today? _ _: _ _ AM/PM

4. What time did you physically get out of bed: _ _: _ _ AM/PM

5. Did you take a nap today? (YES/NO)
   (IF YES)
   a. What time did you start your nap: _ _: _ _ AM/PM
   b. How long was your nap? ___ hr ___ min

6. Have you eaten anything today? (YES/NO)
   (IF YES)
   a. What time did you eat your first meal/snack? : _ _: _ _ AM/PM
   b. What did you eat? (Select one)
      i. Breakfast
      ii. Brunch
      iii. Lunch
      iv. Dinner/Supper
      v. Snack
      vi. Other
   c. Did you eat another meal/snack? (YES/NO)
      (IF YES)
   d. (X meal/snack) What time did you eat your x meal/snack? : _ _: _ _ AM/PM
   e. (X meal/snack) What did you eat? (Select one)
      i. Breakfast
      ii. Brunch
      iii. Lunch
      iv. Dinner/Supper
      v. Snack
      vi. Other
   f. Did you eat another meal/snack? (YES/NO)

7. Did you engage in physical exercise today? (YES/NO)
   (IF YES)
   a. How long did you exercise? ____ hr ____ min
   b. When did you exercise? _ _: _ _ AM/PM
   c. What kind of activity did you engage in? _______(open ended)
   d. How intense? (Select one)
      i. Light
      ii. Moderate
      iii. Hard
      iv. Very Hard

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VITA

Laura Nicholson is studying Clinical Psychology at Loyola University Chicago. Prior to starting graduate school, she attended DePaul University, Chicago, where she earned her B.A. in Psychology in 2014. As an undergraduate, she joined several research labs with a focus in social psychology examining perceptions of college students in various arenas. After graduating, Laura worked at the Center for Community Research on a project examining the prevalence of Myalgic Encephalomyelitis / Chronic Fatigue Syndrome in children which stimulated her interest in working in the area of health and wellbeing.

As a member of the Activity Matters Lab working under Dr. Amy Bohnert, Laura has been involved in various projects that aim to promote healthful behaviors and psychosocial functioning in children and adolescents. More recently, she has worked on a project examining the effects of television food commercials on executive functioning. One goal of this project is to investigate the correlates of obesogenic behaviors to body weight, extending to her interest in health psychology. The current study derives from this research. Laura’s work on all of these projects has resulted in poster and paper presentations at national conferences.