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# A prospective study of weight gain associated with chronotype among college freshmen

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## Abstract

A prospective study of chronotype as a predictor of increased weight gain and body mass index (BMI) among college freshman was undertaken. At baseline, 137 college freshmen were characterized as morning, neutral, or evening types using the reduced version of the Morningness-Eveningness Questionnaire. Additionally, information was collected regarding weight, BMI, and health habits (e.g., junk food and alcohol consumption). These additional measures consisted of a descriptive questionnaire, the Pittsburgh Sleep Quality Index, the International Physical Activity Questionnaire, the Gray-Donald Eating Patterns Questionnaire, and the Positive and Negative Affect Scale. Participants included 79 females and 80 males with a mean age of 18.25 (SD=0.56) yrs. Eight weeks later, participants returned (N=54) to complete follow-up measures, which were identical to baseline assessments with the exception of the descriptive questionnaire, in which demographic questions were removed. Evening types had a significantly greater BMI gain ($p<0.05$) when compared with morning/neutral types. Health behaviors did not differ by chronotype. Future studies should seek to clarify the mechanisms underlying the chronotype-BMI/ weight gain relationship.

### Keywords

BMI; chronotype; college freshmen; health behaviors; weight gain

Adolescent obesity is a growing epidemic and global public health concern. Overweight and obesity place adolescents at a greater risk for numerous adverse physical consequences, such as cardiovascular disease (Freedman et al., 2007), asthma (Beuther & Sutherland, 2007), insulin resistance (Lee et al., 2006), and obstructive sleep apnea (Redline et al., 1999). Additionally, overweight and obese adolescents have reported lower health-related quality of life (Schwimmer et al., 2003), oppositional disorder, and among males, depression (Mustillo et al., 2003). Furthermore, adult men and women who had been obese during adolescence were found to be at an increased risk of mortality from coronary heart disease (Must et al., 1992). Additionally, obesity among adolescents is associated with an increased risk of developing colorectal cancer among men and arthritis among women (Must et al., 1992). Identifying the factors that confer risk of weight gain and obesity among adolescents



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may aid in the development and implementation of interventions that may reduce the public health burden of adolescent obesity.

A number of factors are believed to contribute to adolescent overweight and obesity, specifically diet (Berkey et al., 2000), decreased physical activity (Trost et al., 2001), and increased sedentary time (television viewing) (Andersen et al., 1998). Sleep curtailment is also hypothesized to contribute to increased body mass index (BMI), yet this is not frequently addressed in the adolescent BMI literature, and the relationship remains equivocal due to conflicting study results (Calamaro et al., 2010; Culnan et al., 2013; see Guidolin & Gradisar, 2012, for review; Hart & Jelalian, 2008; Hitze et al., 2009; Knutson, 2005; Shi et al., 2010; Snell et al., 2007). Therefore, it is important to examine further correlates of this relationship, as adolescent cohorts are vulnerable to sleep disturbance (see Crowley et al., 2007; Gradisar et al., 2011, for review) in addition to weight gain (Ogden et al., 2002).

Short sleep duration may be linked to weight gain among adolescents through several pathways (see Guidolin & Gradisar, 2012, for review). For example, short sleep duration is associated with decreases in the anorexinogenic hormone leptin and increases of the Submitted August 6, 2012, Returned for revision appetite-stimulating hormone ghrelin (Spiegel et al., 2004; Taheri et al., 2004). These alterations begin to occur after even one night of sleep restriction when examining ghrelin levels (Schmid et al., 2008), and after two nights of sleep restriction for leptin levels (Spiegel et al., 2004). Furthermore, both leptin and ghrelin demonstrate circadian patterning in rodents (Sanchez et al., 2004), suggesting that these endogenous hormones may be influenced by other circadian systems (Froy, 2010). These sleep-satiety mechanisms are even more relevant in the context of circadian changes that commonly occur in adolescence.

Adolescents undergo circadian changes that involve shifts from morningness (early bed- and wake time preferences) to eveningness (late bed- and wake time preferences) (Kim et al., 2002). This shift is initiated by pubertal maturation; the more advanced an adolescent’s pubertal status, the more evening characteristics that adolescent will display (Carskadon et al., 1993; Laberge et al., 2001). In addition to altering sleep timing preferences, this shift causes many evening types to curtail their sleep during the week (Fernandez-Mendoza et al., 2010), creating a greater likelihood of shortened sleep, which may contribute to weight gain. Evening chronotypes also tend to lead a less-regulated lifestyle and have poorer self-regulation of exercise (Digdon & Howell, 2008; Monk et al., 2004) and meal timings (Fleig & Randler, 2009), which might contribute to risk of weight gain. Additionally, eveningness is related to the personality characteristics of disorderliness, impulsivity, and extravagance (Caci et al., 2004), which could affect the regulation of health behaviors that are important in maintaining a healthy weight. For example, eveningness is associated with greater use of alcohol (Giannotti et al., 2002) and an increased intake of fast foods (Fleig & Randler, 2009). Given that both alcohol and fast food are calorically dense, increased consumption of these foods may adversely affect weight (Isganaitis & Lustig, 2005; Nelson et al., 2009). Additionally, Nelson and colleagues (2009) found that alcohol consumption may induce alcohol-related eating, which was associated with a 25% increase in overweight status among their college student sample.

Two previous studies have examined the relationship between eveningness and overweight status. Pabst and colleagues (2009) found that eveningness was associated with greater depressive symptomatology in both normal-weight and overweight groups. Interestingly, this association was stronger among the overweight group. This study did not find an association between chronotype and BMI status; however, 25% of their sample was premenarcheal and may not have undergone the phase-shift characteristic of puberty.

Recently, Roenneberg and colleagues (2012) found that chronotype, along with sleep duration, predicted BMI of normal-weight individuals (ages 10–65+), whereas ‘‘social jetlag’’ (a discrepancy between weekday and weekend sleep timings) predicted BMI of participants in the overweight group while controlling for age and sex. Similarly, Olds and colleagues (2011) examined the association between sleep patterns (bedtime and rise time) and weight status among a cohort of 9- through 16-yr-olds. They found that those in the late bedtime and late wake time group were 1.5 times more likely to be obese. However, Olds and colleagues (2011) carefully note that there is a distinction between social practices of sleep timing and chronotype. For example, students may appear to be evening types based on their sleep timing choices, when in actuality they may be going against their underlying circadian preferences due to academic and social demands. Thus, decisions with bedtimes and wake times may not directly correspond with morningness-eveningness preferences. Each study utilized cross-sectional designs, which limits the conclusions that can be drawn from either study. The use of cross-sectional designs precludes causal inferences; however, the use of a prospective design may increase the validity of making claims that are temporal in nature.

The purpose of our study, therefore, was to conduct a preliminary, prospective investigation of weight gain and chronotype among a sample of late adolescents. The freshman year of college provides an ideal opportunity to study this phenomenon. During the freshman year of college, adolescents are especially prone to gain weight (Gropper et al., 2009). It is well documented that college students gain approximately 5–9 pounds on average (Gropper et al., 2009; Kasparek et al., 2008; Racette et al., 2005), leading to an increase in BMI (Lloyd-Richardson et al., 2009). Several previous studies have attributed this weight gain to the development of adverse health behaviors, which create an increased energy intake and decreased energy expenditure (Nelson et al., 2009; Racette et al., 2005). Moreover, college students are at an age (late adolescence) where they are more likely to present as evening types (Roenneberg et al., 2004), which may additionally contribute to weight gain during the freshman year. Taken together, college students have a high proportion of individuals who are evening types, as well as individuals at risk of weight gain, which may enable us to assess the nature of the relationship between chronotype and weight.

To expand upon Olds and colleagues, we aimed to directly test the relationship between chronotype (versus sleep timing practices) in relation to BMI. First, we sought to examine the relationship between weight status and chronotype among a sample of college freshmen. Second, we aimed to assess whether weight gain during the initial term of the freshman year in college differed by chronotype. We hypothesized that students who were characterized as evening types would gain significantly more weight, resulting in an increased BMI, relative to students who were morning or neutral types. Additionally, we sought to conduct exploratory analyses to determine if chronotype groups varied relative to energy expenditure, dietary habits, mood, sleep quality, or alcohol consumption, which may correlate with weight gain and BMI (Gupta et al., 2002; Nelson et al., 2009; Scott et al., 2008). Thus, this is the first study to investigate chronotype and weight gain prospectively among freshman.

## METHODS

### Participants

Participants included freshmen undergraduates at a mid-size, urban university in the northeastern United States. Freshmen were eligible to participate if they were at least 18 yrs of age and entering their initial term of college as a full-time student. Exclusion criteria required that the student had never been fully enrolled at any other college or university. One hundred and thirty-seven participants with a mean age of 18.26 yrs constituted the sample. The majority of the population were non-Hispanic White (60%), followed by those who self-identified as "Other" (those who identified with more than one race/ethnicity category and those who were not of one of the race/ethnicity categories listed) (20.7%), Asian (13.3%), Black/African American (3%) and Hispanic/Latino (3%); 58% were women. The majority of the sample (94.2%) lived on campus and 93.4% had a school meal plan.

## Sampling procedures

Recruitment took place in Introductory Psychology classes, consisting of both psychology majors and non-majors, during the first week of the fall term. Contact for recruitment was made with an estimated 1100 students. All data collected remained completely anonymous. Participants created and tracked their own identification number to link data from baseline to the follow-up sessions. In agreement with the psychology department's policy, participants were compensated with extra credit points toward their course. The protocol was approved by the Institutional Review Board at Drexel University.

## Measures

**Descriptive questionnaire—**A descriptive questionnaire was designed to obtain information on age, sex, race/ethnicity, housing status (on or off campus), meal plan information, caffeine and alcohol consumption, smoking status, employment status, current weight and height, and weighing habits (see Table 1). The height and weight reported on this questionnaire was also used to calculate BMI for each participant. Several studies have found that adolescents' self-report of weight and height yields a highly reliable BMI (Brener et al., 2003).

**Reduced version of the morningness-eveningness questionnaire (rMEQ)—**The rMEQ (Adan & Almirall, 1991) is a 5-item reduced version of the Morningness-Eveningness Questionnaire (MEQ; Horne & Ostberg, 1976). The rMEQ was used to determine the role of sleep preference in gaining weight during the freshman year. The rMEQ is a reliable and valid measure to quickly categorize people into sleep preference groups (Adan & Almirall, 1991). Consistent with Adan and colleagues (2010), the groups were simplified and coded as morning type, neutral type, and evening type.

**The Pittsburgh sleep quality index (PSQI)—**The PSQI was utilized to assess participants' subjective sleep quality (Buysse et al., 1989) in relation to their weight and BMI. The PSQI is a 19-item questionnaire that yields seven subscores that include sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction. These scores are then summed to create a "global score." A cutoff score of 5 or above indicates a "poor sleeper" (Buysse et al., 1989). The PSQI is a well-established, reliable, and valid instrument for subjective sleep quality (Carpenter & Andrykowski, 1998; Grandner et al., 2006).

**The international physical activity questionnaire (IPAQ)—**The short version of the IPAQ, a 7-item questionnaire, was used to assess physical activity levels over the past week. This measure was included because those who engaged in fewer sessions of low-intensity physical activity were more likely to have a higher BMI by the end of their freshman year (Kasparek et al., 2008). This measure yields two subscales: (1) sedentary time and (2) total physical activity. The physical activity subscale may be further analyzed with three subscores: (1) walking per week; (2) moderate physical activity per week; and (3) vigorous physical activity per week. This measure has documented reliability and validity (Craig et al., 2003).

**Gray-donald eating patterns questionnaire—**The Gray-Donald Eating Patterns Questionnaire, a 38-item questionnaire, was used to measure diet habits (Gray-Donald et al., 1997). The scale gave each participant scores in categories of "avoid fat," "high fat," "low fat," "junk food," and "modify meat to reduce fat." This scale was employed to measure the impact of diet on weight gain. Only the "junk food" subscale ($\alpha$=0.75) had acceptable reliability in our sample, and thus was the only subscale used in subsequent analyses.

**The positive and negative affect scale (PANAS)—**The PANAS is a 20-item scale that was used to measure participants' positive and negative affect (Watson et al., 1988). High positive affect scores signify energy and enthusiasm, whereas high negative affect scores denote distress and unpleasant emotions (Watson et al., 1988). The PANAS has been found to be a reliable ($\alpha$=0.84– 0.90) measure commonly utilized by researchers (Watson et al., 1988). The PANAS was used to assess the relationship of mood to weight and BMI.

### Procedures

Baseline data were collected from freshmen (in their initial year of college) during week 2 of an 11-wk fall term, using a series of self-report measures. One hundred and thirty-seven students participated in the initial assessment (approximately 12.45% of those who were approached during recruitment), with 54 participants returning for the follow-up, which occurred approximately 8 wks after the initial assessment. All of the original surveys were used in the follow-up, with the exception of the items sex, ethnicity, and age, which were asked only at baseline. The follow-up response rate was 39%. Therefore, baseline characteristics of those who presented at follow-up were compared with those who did not. All procedures conformed to the ethical standards provided by Portaluppi and colleagues (2010).

### Statistical analysis plan

**Preliminary analyses—**Reliability analyses for our primary variables of interest were undertaken. Then, frequencies and mean scores were calculated to describe our participant sample, as well as participant ratings on our primary variables of interest (rMEQ, weight, BMI, IPAQ, PSQI, PANAS, Gray-Donald Eating Patterns) for both baseline and follow-up. Third, bivariate relationships using *t* tests and Pearson correlations were conducted to examine the relationships among our primary variables of interest.

**Tests of hypotheses—**To examine the relationship between weight status and chronotype among a sample of college freshmen, we conducted two separate linear regressions with chronotype as our predictor variable and weight and BMI, respectively, as our outcome variables. To assess whether weight gain during the initial term of the freshman year in college differed by chronotype, we conducted two linear regressions with chronotype serving as our predictor variable and weight change and BMI change, respectively, serving as our two outcome variables. To assess whether behaviors and mood indicative of weight gain and BMI varied by chronotype over time, we examined the relationship between chronotype and changes on scores of the IPAQ, PSQI, Junk Food subscale, negative affect (using linear regressions), and alcohol and smoking status (using chisquare tests), from baseline to follow-up.

## RESULTS

### Sample characteristics

Mean scores on the rMEQ, IPAQ, PSQI, PANAS, and Gray-Donald Eating Patterns Questionnaire as well as ratings of weight and BMI are presented in Table 2 at both baseline

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and follow-up. Average BMI at baseline was 21.99 (SD = 3.24) and 22.89 (SD = 3.41) at follow-up. Weight ($t(134) = 5.97$, $p<0.01$) and BMI ($t(126) = 3.90$, $p<0.01$) were significantly different by sex. Average weight gain from baseline to follow-up for the entire sample was 1.13 (SD = 4.74) pounds, with males gaining an average of 2.73 (SD = 5.37) pounds and females gaining an average of 0.03 (SD = 3.98) pounds. Given this difference, the sample was examined for interaction effects; however, a repeated-measures analysis of covariance (ANCOVA) revealed that a time × chronotype × sex interaction was not significant ($F(1, 45) = 0.45$, $p>0.05$).

Analysis of chronotype at baseline categorized seven participants as morning types, 65 as neutral types, and 64 as evening types. Of those who completed the follow-up study, 4 were morning types, 25 were neutral types, and 25 were evening types. Because there were only four individuals who were characterized as "morning types" and did not significantly differ on any of the primary measures compared with neutral types, we collapsed morning and neutral into one chronotype grouping variable. All further analyses were conducted using two chronotype groups: evening types and morning/neutral types. Additionally, results from a paired *t* test demonstrated that chronotype did not change across the data collection period ($p = 0.742$). Sex, race/ethnicity, amount of credits per term, alcohol consumption, caffeine use, weighing habits, negative affect, positive affect, physical activity (IPAQ), junk food consumption, and sleep quality did not vary by chronotype at baseline. To determine covariates for analysis, we examined sex and negative affect (from the PANAS, assessed at time 1 or time 2) as potential covariates. If either variable demonstrated a trend towards a linear association ($p<0.2$) with initial weight, it was included as a covariate. Sex was significantly associated with initial weight ($p<0.0001$), whereas negative affect was not associated with initial weight ($p = 0.222$) or time 2 ($p = 0.365$). Therefore sex, but not negative affect, was included as a covariate in analyses.

Bivariate relationships between our primary variables of interest at baseline are presented in Table 3. Total rMEQ scores were negatively correlated with total PSQI scores ($r = -0.241$, $p=0.01$) (eveningness was inversely related to sleep quality). Weight was positively correlated with positive affect ($r = 0.271$, $p=0.01$) and negatively correlated with junk food consumption ($r=-0.188$, $p=0.05$), whereas BMI was correlated with junk food ($r = -0.188$, $p = 0.05$). (It should be noted that higher ratings on the Junk Food subscale are indicative of *less* junk food consumption.)

**Completers versus noncompleters—**Morning, neutral, and evening types did not vary by completion status (those who participated in both study sessions versus those who participated in just the initial session), $\chi^2(1, n = 135) = 0.001$ $p>0.05$. Additionally, completers and noncompleters did not differ on weight ($t(133) = 0.435$, $p>0.05$) or BMI ($t(125) = 0.154$, $p>0.05$) at baseline. Completers versus noncompleters *did not* significantly differ on PANAS, IPAQ, PSQI, or Junk Food subscales.

### Tests of Hypotheses

A cross-sectional linear regression, with initial weight or BMI as outcome, chronotype as predictor, and sex as covariate, found no significant relationship between chronotype and initial weight (unstandardized B = −1.701, $p = 0.645$) or initial BMI (unstandardized B = −0.260, $p = 0.635$). A linear regression analysis, with BMI change as the outcome variable and chronotype as the predictor variable, demonstrated that chronotype was significantly associated with BMI change (unstandardized B = 0.495 BMI points, 95% confidence interval [CI]: [0.039, 0.950], $p = 0.034$), after adjustment for sex. This indicates that being an evening type at baseline was associated with an increase of 0.50 BMI points during the course of the study. Second, a linear regression analysis, with weight change as the outcome variable and chronotype as the predictor variable, approached significance (unstandardized B = 2.354 pounds, 95% CI: [−1.62, 4.869], $p = 0.066$), after adjustment for gender. This indicates that being an evening type at baseline was associated with an increase of 2.35 pounds during the course of the study (Table 4).

A linear regression revealed that chronotype was not significantly associated with change in scores on the PSQI, IPAQ, Junk Food subscale, or negative affect scale (all $p>0.05$). Only 8 of 135 students identified as smokers, and all 8 were evening types. Only 3 smokers completed the follow-up, thereby limiting further analysis. Drinking status did not differ by chronotype at baseline; however, at follow-up, significantly more evening types reported drinking, $\chi^2(1, n = 54) = 5.94$, $p<0.05$. Evening types were not more likely to change drinking status throughout the duration of the study, $\chi^2(1, n=54) = 3.19$, $p>0.05$.

## DISCUSSION

To our knowledge, this was the first study to prospectively examine the relationship between chronotype and weight or BMI among a sample of college freshmen. Findings indicated that chronotype was not significantly associated with weight or BMI at baseline. However, as expected, evening chronotypes experienced a significant increase of BMI over time, whereas morning/neutral types' BMI remained stable. Similarly, weight gain among evening chronotypes approached significance. These findings suggest that evening types may be prone to significant increases in BMI during their freshman year of college.

Interestingly, the average weight gain of the sample was only 1.13 pounds, which is much lower than the 5–9 pounds most current studies report during the initial college term (Gropper et al., 2009; Kasparek et al., 2008; Racette et al., 2005). This may be due to the study's time frame of 8 wks, which is much shorter than the typical length of a semester. Regardless, this gain still represents a disconcerting trend. If this rate of weight gain was maintained, participants would gain an average of 8.39 pounds per year.

Contrary to our hypothesis, evening types did not have a significantly higher BMI when compared with morning/neutral types at baseline. One explanation for this could be that late adolescents may not begin to fully exhibit maladaptive health behaviors that are correlated with eveningness until they leave home and become autonomous in their decision-making. For instance, if the relationship between chronotype and BMI exists due to maladaptive health behaviors, one would only expect to see evening-type adolescents gaining greater amounts of weight *over time* when compared with their morning/neutral counterparts, but these subtle changes may not manifest in overt baseline differences until adulthood. Therefore, this gain would eventually result in a significantly higher BMI for evening types when compared with morning or neutral types, as we found.

### Potential mechanisms

The potential mechanisms of the chronotype-BMI relationship have yet to be determined. Related studies, Pabst et al. (2009) and Ronneberg et al. (2012), have implicated depression and social jet lag (respectively) as contributors to the chronotype-BMI relationship. Pabst and colleagues (2009) found a relationship between eveningness and depression, which was more pronounced in overweight participants. Depression may contribute to the chronotype-BMI relationship, as evening types endorse higher levels of depression (Hidalgo et al., 2009), and prospective relationships between depression and obesity have been found in adolescent samples (Anderson et al., 2007; Goodman & Whitaker, 2002; Stice et al., 2005). Alternatively, Roenneberg and colleagues (2012) found that social jetlag (the deviation of sleep timings between workdays and free days) accounted for the variance of BMI in the overweight group, whereas chronotype and sleep duration accounted for the variance in the normal-weight group. Social jetlag is associated with chronotype in that many evening types shift their sleep schedules between work and free days in an attempt to resolve sleep debt that accumulates throughout their work/school week (Wittmann et al., 2006). Social jetlag may contribute to overweight and obesity by shifting circadian rhythms. This chronodisruption may misalign the metabolic pathways and hormones, and, therefore, is posited to lead to weight gain and the observance of high BMIs (Garaulet & Madrid, 2009). Neither of these studies were prospective, thus future research is necessary to parse out the temporal nature of these relationships.

We focused on potential pathways involving health behaviors that are hypothesized to vary with eveningness (e.g., junk food consumption, sleep quality, caffeine and alcohol). Although we did not detect any differences in the levels of these behaviors between chronotype groups, our findings may have been limited by the study's short time frame and the homogeneity of the sample at baseline. For instance, if evening types are engaging in greater junk food consumption or alcohol use, it may require more than 8 wks of follow-up for either of these variables to yield significance. More so, with greater variance in BMI and/or weight variables, we may have been better able to clarify these relationships.

## Implications

Previous research has demonstrated that eveningness is a risk factor for a number of unhealthy habits (Fleig & Randler, 2009; Gianotti et al., 2002). Our finding that evening types experienced a significant increase in BMI over time when compared with morning/neutral types adds to the extant literature on the adverse health correlates of eveningness, such as physical inactivity (Monk et al., 2004) and substance use (Gianotti et al., 2002). Freshmen may be particularly vulnerable to BMI increases. Others have noted that individuals of college age are an ideal group to target for lifestyle interventions, given that, for many, this transitional time represents the first instance in which they are encouraged to develop their own health habits and behaviors (Nelson et al., 2008). Taken together, it may be beneficial to tailor psychoeducational interventions to evening types, as this may improve the health of and quality of life of a majority of college students. For instance, educating evening-type students about how to best regulate their sleep in concert with their social and academic schedules might partially ameliorate the freshmen weight gain phenomenon. This might also allow their health behaviors, for example, caffeine use (Fleig & Randler, 2009) and lowered physical activity (Schaal et al., 2010), to normalize or mirror those of morning and neutral types. Additionally, more extreme levels of eveningness might be indicative of delayed sleep phase disorder (DSPD). Therefore, as an additional precaution, these individuals might benefit from education regarding therapies such as exogenous melatonin administration, phototherapy, and consistent sleep scheduling (Wyatt, 2011). These therapies may prove to not only promote healthier sleep, but also to prevent weight gain in individuals susceptible to DSPD. Future studies should seek to examine these variables in order to further elucidate the relationship between chronotype and weight.

## Limitations

Self-selection for participation may have resulted in the study's truncated range of BMIs. Those who were overweight may have chosen not to participate due to the sensitivity and stigma that accompanies obesity (Latner et al., 2005). This may have been especially relevant for women, as the women who participated in this study gained almost no weight, whereas the men gained an average of 2.73 pounds. Based on this, we hypothesize that men may be more sensitive to the chronotype weight relationship when compared with women. However, this hypothesis was not statistically significant, perhaps due to our small sample size. Additionally, the study's small sample size and low response rate may limit generalizability. This smaller range of BMIs and small sample size may have made it more difficult to observe relationships between health behaviors and weight/BMI. Therefore, future studies should use larger samples in order to examine the association of sex with this relationship (Guidolin & Gradisar, 2012). Lastly, the study's abbreviated time frame may have led to underestimation of effects. For example, the participants in this 8-wk study gained less weight than is typically gained during a semester-long study. Our results showed a trend towards significance for change in weight over time by chronotype group. Therefore, we might expect to find significance with a longer follow-up. Future prospective studies might consider using an additional follow-up period to extend the time in which participants are followed. In addition, use of objective sleep measures, such as actigraphy, and/or daily food and activity diaries could potentially help describe and clarify the nature of these relationships even more accurately.

## Conclusions

College students typically experience weight and BMI gain, which has often been associated with a number of unhealthy behaviors (Kasparek et al., 2008; Nelson et al., 2009; Racette et al., 2005). Our novel finding is the first to temporally suggest that eveningness may be an additional contributor to BMI gain during the freshman year. What remain unclear are the mechanisms by which chronotype leads to increases in BMI. Once these relationships have been clarified, evening types could be provided with strategies on how to efficiently function within their sleep preference and prevent adverse weight outcomes.

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## TABLE 1

Frequency distributions of descriptives

| Variable | Totals | % |
|---|---|---|
| Gender | | |
| Male | 56 | 40.9 |
| Female | 79 | 57.7 |
| Ethnicity | | |
| Non-Hispanic White | 81 | 60 |
| Black/African American | 4 | 3 |
| Hispanic/Latino | 4 | 3 |
| Asian American | 18 | 13.3 |
| Other | 28 | 20.7 |
| Living situation | | |
| In dorms | 129 | 94.2 |
| Off campus | 3 | 2.2 |
| At home | 5 | 3.6 |
| Smoke | | |
| No | 127 | 94.1 |
| Yes | 8 | 5.9 |
| Drink | | |
| No | 75 | 55.1 |
| Yes | 61 | 44.9 |
| Caffeine | | |
| No | 27 | 19.7 |
| Yes | 110 | 80.3 |
| Meal plan | | |
| No | 9 | 6.6 |
| Yes | 127 | 93.4 |
| Weigh habits | | |
| Never | 8 | 5.9 |
| Only at doctors | 39 | 28.7 |
| Once a month | 35 | 25.7 |
| Once a week | 28 | 20.6 |
| Daily | 8 | 5.9 |
| Other | 18 | 13.2 |

$N = 137$

## TABLE 2

Means and standard deviations of measures.

| | Baseline | | Post | |
|---|---|---|---|---|
| **Variable** | **M** | **SD** | **M** | **SD** |
| IPAQ | 4577.70 | 3105.76 | 3874.53 | 3523.95 |
| PSQI | 5.53 | 2.42 | 5.72 | 2.72 |
| Gray-Donald Eating Patterns | | | | |
| Junk Food | 18.68 | 3.78 | 16.74 | 2.86 |
| PANAS | | | | |
| Positive Affect | 30.41 | 7.30 | 31.05 | 6.93 |
| Negative Affect | 15.30 | 4.55 | 16.38 | 5.50 |
| Weight | 139.21 | 28.81 | 143.04 | 29.46 |
| BMI | 21.99 | 3.26 | 22.89 | 3.41 |

## TABLE 3

Baseline correlations.

| Measure | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| 1. Weight | – | 0.807** | 0.108 | 0.271** | −0.029 | 0.155 | 0.094 | −0.188* |
| 2. BMI | – | – | 0.077 | 0.168 | −0.003 | 0.146 | 0.011 | −0.188* |
| 3. Negative PANAS | – | – | – | −0.094 | 0.080 | 0.162 | 0.027 | −0.121 |
| 4. Positive PANAS | – | – | – | – | 0.037 | −0.128 | 0.131 | 0.155 |
| 5. rMEQ | – | – | – | – | – | −0.241** | −0.035 | −0.024 |
| 6. PSQI | – | – | – | – | – | – | −0.108 | −0.077 |
| 7. IPAQ | – | – | – | – | – | – | – | −0.033 |
| 8. Junk Food | – | – | – | – | – | – | – | – |

* $p<0.05$;

** $p<0.01$.

## TABLE 4

Linear regressions.

| | Chronotype | |
|---|---|---|
| **Variable** | **B** | **95% CI** |
| Initial BMI | −0.260 | −1.344–0.823 |
| BMI change | 0.495* | 0.039–0.950 |
| Initial weight | −1.701 | −8.980–5.578 |
| Weight change | 2.354 | −0.162–4.869 |

*$p<0.05$.