Patterns of Eating Associated with Sleep Characteristics: A Pilot Study Among Individuals of Mexican Descent at the US-Mexico Border.

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Abstract

INTRODUCTION: Previous studies have linked sleep to risk of diabetes and obesity, at least partially via alterations in food intake. Diabetes and obesity are common among Hispanics/Latinos, and studies are needed to better clarify the role of sleep in health among this group. Utilizing the revised TFEQ-R-18, this study will examine whether eating behaviors such as cognitive restraint, emotional eating and uncontrolled eating are related to self-reported sleep experiences. Specifically, we hypothesized that poor eating habits would be associated with (1) more insomnia symptoms, (2) overall worse sleep quality, (3) increased daytime sleepiness, and (4) shorter sleep duration. METHODS: Data were collected from N=100 adults (age 18-60, 47% female) of Mexican descent in the city of Nogales, AZ (34% not born in the US). Surveys were presented in English or Spanish. Eating Patterns were assessed with the Three-Factor Eating Questionnaire (TFEQ), which resulted in a total score and subscales for “cognitive restraint,” “uncontrolled eating,” “and “emotional eating.” Insomnia was assessed with the use of the Insomnia Severity Index (ISI), Sleepiness with the use of the Epworth Sleepiness Scale (ESS), Sleep quality with the use of the Pittsburgh Sleep Quality Index (PSQI), and weekday and weekend sleep duration with the use of the Sleep Timing Questionnaire (STQ). Covariates included: age, sex, Body Mass Index (BMI), education and immigrant status. RESULTS: Overall TFEQ score (problematic eating) was positively associated with greater insomnia, poorer sleep quality, more sleepiness, and less weekend (but not weekday) sleep. Mean TFEQ score in the sample was 18.7 (range 0-51). In adjusted analyses, every point on the TFEQ was associated with 0.6 ISI points, 0.8 PSQI points, 0.5 ESS points, and 1.1 minutes of less weekend sleep duration. Regarding subscale scores, relationships were generally seen between sleep and emotional eating and unrestricted eating, and not cognitive restraint. CONCLUSIONS: Greater insomnia, poorer sleep quality, increased daytime sleepiness and decreased weekend sleep duration were associated with eating patterns at the US Mexico border, particularly in the area of unrestricted eating and emotional eating. This suggests possible mechanisms linking sleep and obesity in Hispanic/Latinos.
Keywords: sleep health; three factor eating questionnaire; sleep duration; eating patterns; Mexican-Americans; border health, health disparities.

**Introduction**

Short sleep duration is associated with many health problems related to obesity (Patel & Hu, 2008), diabetes (Altman et al., 2012; Grandner et al., 2016), hypertension (Grandner & Perlis, 2013; Meng et al., 2013) cardiovascular disease (Altman et al., 2012; Sands et al., 2012) and mental health problems (Patel et al., 2015; Vgontzas et al., 2012). Sufficient evidence in the literature exists linking short sleep duration with obesity and weight gain (Nielsen et al., 2011; Patel & Hu, 2008) among both children and adults (Canuto et al., 2014; Liu et al., 2012). Other cross-sectional studies have shown associations between higher mean body mass index (BMI) in both short and long sleep durations (Grandner & Drummond, 2007; Grandner, Patel, et al., 2010; Markwald et al., 2013). Numerous mechanisms linking physiological, environmental, and behavioral factors have been explored elsewhere (Dashti et al., 2015; McNeil et al., 2013; Moller-Levet et al., 2013; Schmid et al., 2015; St-Onge et al., 2012; Taheri et al., 2004) that may provide some insight for the association between sleep and weight regulation.

All these possible mechanisms may at least partially work through changes in eating behaviors. Several studies have shown that insufficient and/or poor-quality sleep can be associated with unhealthy eating behaviors at the population level (Grandner, Jackson, et al., 2013; Grandner, Kripke, et al., 2010; Reid et al., 2019) and in the laboratory (Markwald et al., 2013; Spaeth et al., 2013; St-Onge et al., 2011). Further, extensive work shows that impaired sleep can lead to deficits in decision making (Harrison & Horne, 2000; Killgore, 2010; Killgore et al., 2006), which may also contribute to unhealthy eating behaviors.

In addition to the literature potentially linking sleep, obesity and eating behaviors, disparities in sleep have also been well documented in available literature and pertain to this issue. Sleep difficulties and racial/ethnic differences have been previously documented,
especially among Hispanic/Latinos (Grandner, Petrov, et al., 2013; Whinnery et al., 2014). Of note, recent evidence shows that habitual sleep durations are declining among Mexican-Americans at a rate that is more than double that of Non-Hispanic Whites (Sheehan et al., 2019). Many of the adverse outcomes of poor sleep, i.e. obesity, cardiovascular diseases and diabetes, are more prevalent among Mexican-Americans, when compared to non-Hispanic Whites and non-Hispanic Blacks (Ghani, 2020; Mozumdar & Liguori, 2011). Prior research has identified a number of potential mechanisms of these cardiovascular disparities including dietary, physical activities and other pathways (Mozaffarian, 2016). Sleep may represent another pathway which has been discussed less (Hale et al., 2014; Loredo et al., 2010). It has also been well documented that Mexican-Americans have difficulties with short sleep (Cespedes et al., 2016; Chen et al., 2015), insomnia (Cespedes et al., 2016; Kaufmann et al., 2016), and sleep apnea (Chen et al., 2015). However, there is minimal information available regarding the role of eating behavior patterns and sleep among the Hispanic/Latino population, therefore requiring further exploration. Give the important connections between sleep and dietary behavior, the important health implications of both sleep and dietary behavior for cardiometabolic risk, and the unique health disparities that exist in this population, it is important to understand how eating patterns are related to sleep health within this specific population. These results may illustrate unique relationships that exist in this group and may point the way towards future sleep and diet interventions in this community.

Utilizing the revised TFEQ-R-18, this study will examine whether eating behaviors such as cognitive restraint, emotional eating and uncontrolled eating are related to self-reported sleep experiences. Specifically, we hypothesized that poor eating habits would be associated with (1) more insomnia symptoms, (2) overall worse sleep quality, (3) increased daytime sleepiness, and (4) shorter sleep duration, based on previous studies that have shown that suboptimal diet is separately associated with each of these outcomes (Grandner et al., 2013, 2014). The present study evaluated these hypotheses among Mexican-Americans at the United States-Mexico border.

**Methods**

**Participants**
This was a pilot survey study of adults living at the US-Mexico border. A total of N=100 adults of Mexican descent were recruited from Nogales, Arizona (Santa Cruz county). Also, recruitment was capped at 100 for this pilot study, therefore after the 100th eligible participant completed the survey recruitment was ended. This number was chosen as the primary goal of this study was to preliminarily establish the presence of associations and feasibility of recruitment and data collection, so that larger studies could improve on and clarify the nature of these associations. Individuals were recruited through in-person solicitations via booths set up outside of well-trafficked areas including local shopping establishments, parks, and community buildings around town. Also, advertisements were placed in the local newspaper. The inclusion criteria were as follows: (1) must be fluent in English or Spanish, (2) must be over the age of 18 years, (3) must identify as Mexican or Mexican-American, (4) must reside in Santa Cruz county, AZ and (5) must be willing to complete a battery of surveys. Exclusion criteria were as follows: (1) unable to read or speak English or Spanish, (2) under the age of 18 years, (3) have a medical condition that would hinder their ability to provide consent and/or participate, (4) have a uncontrolled serious mental illness that may impede their ability to provide consent and/or participate and (5) does not reside in Santa Cruz county, AZ. Surveys were distributed in the language of participant choice, via a tablet administered by a fully bilingual research staff. This study was approved by the University of Arizona Institutional Review Board (protocol # 1608763580). All participants provided informed consent prior to engaging in the study and were compensated $20 for their participation and all data were collected in the summer.

Measures

Eating patterns were assessed with the TFEQ Revised-18 version (Karlsson et al., 2000). The TFEQ-R-18 is a well-validated, standard measure of eating behavior (Karlsson et al., 2000). It consists of 18 items and measures three aspects of eating behavior: cognitive restraint, uncontrolled eating and emotional eating. Cognitive restraint is comprised of six items (e.g. “I consciously hold back at meals in order not to gain weight”), uncontrolled eating is comprised of three items (e.g. “when I see a real delicacy, I often get so hungry that I have to eat right away”), and emotional eating is comprised of nine items (e.g. “when I feel blue, I often overeat”). Responses are scored on a 4-point scale, and answers can vary across items (definitely true/mostly true/mostly false/definitely false). Mean scores are computed for each subscale and
transformed to correspond to a 0-100 scale score for cognitive restraint, uncontrolled eating and emotional eating, respectively. The internal consistency has been previously reported as Cronbach’s alpha >0.8 (Cappelleri et al., 2009; Mostafavi et al., 2017). In this study, the Cronbach’s coefficient alpha was 0.88 for the TFEQ-R-18.

The Insomnia Severity Index (ISI) (Bastien et al., 2001) was utilized to assess insomnia symptom severity. The ISI was originally developed in English (Bastien et al., 2001) and has been translated into Spanish and validated (Fernandez-Mendoza et al., 2012). The internal consistency of the ISI has been previously reported as 0.74 (Bastien et al., 2001), similar to the Cronbach alpha of this study, which was 0.77.

Daytime sleepiness was measured using the Epworth Sleepiness Scale (ESS) (Johns, 1991). The ESS is a standard clinical and research tool that is well-validated (Lapin et al., 2018) and has been previously translated into Spanish. The ESS has been described in detail elsewhere (Ghani, 2020). Although the ESS has been reported to have an internal consistency of 0.88 (Johns, 1991), our study found a Cronbach alpha of 0.78, which is adequate.

Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989). Details of the PSQI are described elsewhere (Ghani, 2020). The PSQI has been previously translated into Spanish (Tomfohr et al., 2013).

The Sleep Timing Questionnaire (STQ) has been validated against a prospective sleep diary (Monk et al., 2003) and was used to assess habitual computed weekday and weekend sleep duration (Monk et al., 2003). The STQ has been discussed previously (Ghani, 2020). The Cronbach alpha reliability coefficient for the STQ scale ranged from 0.71 to 0.83 (Monk et al., 2003), similar to the Cronbach alpha of 0.78, we found in this study.

Translation of Measures into Spanish.

Wherever possible, previously developed Spanish versions of questionnaires were used. English-only measures were translated for the purposes of this study. The translation process followed Guideline-based translation procedures (Hilton & Skrutkowski, 2002; Van de Vijver & Hambleton, 1996) and have been described previously regarding the STQ and ISI (Ghani, 2020). The translation of the TFEQ followed the same process, which included translation, back-translation, and focus-group feedback. See Ghani et al (Ghani, 2020) for the complete procedure.
All participants were given the opportunity to complete assessment battery in either English or Spanish. They were presented with the battery in the language of their choice.

**Statistical Analysis.**

Descriptive statistics for the sample were reported in terms of percent for categorical data and means and standard deviations for continuous data. To determine whether sleep variables were related to TFEQ subscales, linear regression analyses examined each TFEQ subscale separately as continuous outcome and each sleep variable continuously as an independent variable (ISI scale score, PSQI global score, ESS total score, STQ weekday TST minutes, and STQ weekend TST minutes). In all analyses, covariates included age, sex, and immigrant status. Additional models included adjustment for education level and Body Mass Index (BMI); based on self-reported \([weight/height^2]*703\), though due to some individuals not reporting either height or weight, N=6 records were missing for BMI analyses, reducing power. Results are reported as unstandardized regression coefficients (B), with 95% Confidence Intervals (CI) and p values (p<0.05) considered statistically significant. All analyses were performed in STATA 14.0 (STATACORP, College Station, TX).

**Results**

**Characteristics of sample**

Sample characteristics are reported in Table 1. The sample consisted of adults with a mean age of 36.5 years (SD=19.1) and 34% were born in Mexico. The mean BMI was 30.2 kg/m² (SD= 6.1). There were fewer females than male participants and among the participants, only one-fourth of the sample had a college degree. The sample was representative of the US Census data for Santa Cruz County, AZ.

Overall, in the sample population, the average score on the ISI was indicative of mild insomnia, the average score on the ESS was not indicative of excessive sleepiness, and the average score on the PSQI was indicative of overall poor sleep quality. Although the ISI and PSQI are correlated, they do measure different constructs. The ISI measures insomnia severity and is more of a clinically specific measure (as ISI is used as an outcome measure in clinical trials) and the PSQI is more of a global indicator of overall sleep health across multiple domains. In the present study, the two were correlated, as expected (r=0.52), but thus far from collinear.
Computed weekday sleep duration and weekend sleep duration from the STQ were reported as 7 hours and 16 minutes and 7 hours and 49 minutes, respectively. This indicates participants slept on average, an additional 33 minutes over the weekend. The average total score of the TFEQ was 18.7 (SD=11.1, range 0-51), and average score for the subscales uncontrolled eating, cognitive restraint and emotional eating are 7.6 (SD=6.5, range 0-26), 9.1 (SD=4.7, range 0-19), and 2.0 (SD=2.4, range 0-9), respectively.

Eating behavior and Sleep Related Outcomes

Results of analyses examining relationships between eating behaviors and sleep outcomes are reported in Table 2. We found that unhealthy eating patterns were associated with greater insomnia, (B=0.6, p<0.05), poorer sleep quality (B=0.8, p <0.05), greater sleepiness (B=0.5, p<0.05) and decreased weekend sleep duration (B=0.02, p<0.05). No association was found for weekday sleep duration.

Furthermore, our analysis showed that, primarily, the uncontrolled eating and emotional eating subscales of the TFEQ-R-18 drove these relationships. Uncontrolled eating and emotional eating were strongly associated with both greater insomnia severity (Uncontrolled Eating B=0.447, p<0.05; Emotional Eating B=0.149, p<0.05) and daytime sleepiness (Uncontrolled Eating B=0.438, p<0.05; Emotional Eating B=0.158, p<0.05), respectively, but these were not significantly associated with cognitive restraint. Poor sleep quality was associated with uncontrolled eating (B=0.475, p<0.05), and associated with emotional eating (B=0.204, p<0.05), but not associated with cognitive restraint. Uncontrolled eating (B=-0.009, p<0.05), and emotional eating (B-0.003, p<0.05) were also associated with reduced sleep duration on the weekend, but this was not the case for cognitive restraint. Weekday sleep duration was not associated with any of the measured subscales.

After adjustment for education level (Table 2), all relationships remained significant. After further adjustment for BMI, nearly all relationships remained significant (see Table 2). Specifically, overall score of the TFEQ-R-18 was still associated with sleep quality and weekend sleep duration, and both uncontrolled eating and emotional eating were still associated with insomnia severity, daytime sleepiness, sleep quality, and weekend sleep duration. Also, after adjusting for BMI, there was a statistically significant association between cognitive restraint and weekend sleep duration.
Discussion

This study provides evidence that there is a relationship between sleep duration and quality and food behavioral patterns, such as uncontrolled eating and emotional eating, among Mexican-Americans at the United States-Mexico border. Overall, our findings demonstrated that diet intake patterns were related to sleep. In this study, we observed that worse insomnia, reduced subjective sleep quality, more daytime sleepiness and reduced weekend sleep duration was associated with greater levels of unhealthy eating behaviors identified, through the use of the TFEQ-R-18 score. These results indicate that poor eating habits do indeed impact sleep, specifically among individuals who identify as of Mexican descent at the US-Mexico border.

The main finding of this study was that eating patterns among adults at the US-Mexico border, especially uncontrolled eating and emotional eating, were associated with a variety of sleep health measures including insomnia, daytime sleepiness, poor sleep quality, and weekend sleep duration.

Previous work examining sleep health and eating habits have reported mixed results. Kilkus and colleagues assessed sleep quality using Pittsburgh Sleep Quality Index and eating behavior using the original 51-item and revised 18 item TFEQ, in adults at risk for Type 2 diabetes (Kilkus et al., 2012). They found that, among N=53 healthy adults, lower subjective sleep quality was associated with increased hunger and more disinhibition, uncontrolled eating, and emotional eating, but also higher cognitive restraint. However, no significant associations between sleep duration and any of these eating behavior factors were reported. Our findings showed a relationship with sleep duration, but only for weekend sleep -- uncontrolled eating and emotional eating were associated with weekend sleep duration. It is possible that these divergent findings were due to a different population, or a different version of the TFEQ, or a different method for estimating sleep duration (based on timing, versus actigraphy), or the separate assessment of weekday and weekend sleep.

The main drivers for the relationship between poor sleep and eating behaviors seemed to be uncontrolled eating and emotional eating, but not cognitive restraint. This identification is important, as both uncontrolled eating and emotional eating have been previously reported to be associated with depression (Kilkus et al., 2012). Sleep disturbances and depression have been previously reported among adults and older Mexican-Americans (Pedraza et al., 2012; Roane et
al., 2014) and understanding eating behaviors may play a role in both of these conditions. These eating patterns seem to be related to sleep characteristics, representing sleep as a potential modifiable avenue for intervention. Addressing these eating behaviors may help reduce risk for developing obesity and other cardiometabolic disorders, as well as proving benefits for mental health and improve sleep outcomes.

An established link between cardiometabolic risk factors and sleep relates to diet and nutrition, which also entails dietary and eating patterns. Cognitive restraint, uncontrolled eating and emotional eating have been previously associated with certain food intakes. A comprehensive study by De Lauzon and colleagues (de Lauzon-Guillain et al., 2006) focused on food intake, revealing that cognitively restrained eaters were more likely to consume healthy foods. On the contrary, emotional eaters were more likely to consume more desserts/sugary foods, whereas uncontrolled eaters tend to consume more energy-dense foods. Those with greater degree of uncontrolled eating, disinhibition and emotional eating are more likely to overeat and gain weight (Chaput et al., 2011). Of note, previous studies have shown that nutritional profiles of individuals that report short or long sleep duration and/or poor sleep quality have reported that healthier eating patterns are associated with greater likelihood of sufficient and/or good quality sleep (Grandner, Jackson, et al., 2013; Mossavar-Rahmani et al., 2017). Laboratory studies suggest that extended wake hours may especially drive the consumption of calorie-dense food at night (Markwald et al., 2013; Spaeth et al., 2013; St-Onge et al., 2011). Understanding the relationship between eating behaviors and sleep may help prevent overeating therefore reducing the risk of developing cardiometabolic disorders. Our study did not investigate specific types of food consumed nor timing of food consumption in relation to sleep, however, both these factors may have an impact on eating patterns and sleep. In future studies, assessing specific types of food and timing of food intake in a larger sample size, may be beneficial. Furthermore, food insecurity has been previously shown to be associated with sleep health, as well as eating patterns. The role of food insecurity in these relationships, in the border population, should be explored in future studies. The present study found that, specifically, emotional eating and uncontrolled eating subscales were most strongly associated with sleep health. Future health and wellness interventions may specifically target these eating patterns, to see if improving sleep health can improve eating habits which would, then improve cardiometabolic health.
It is important to point out that previous studies have not assessed weekday-weekend differences in relationships between sleep and diet. A study by Spaeth and colleagues (Spaeth et al., 2013) showed that following a simulated sleep-deprived work week (5 nights at 4 hours), diet significantly improved during the simulated weekend when sleep opportunity was increased. Eating behavior assessed by the TFEQ-R-18 in this study was associated with weekend sleep duration however not weekday sleep duration. This may be the case for a few reasons. During the week, participants may have a typical work week schedule, allowing for consistency. This consistency may allow for scheduled breakfast, lunch and dinner times, not leaving much room for variation (deviation). Another possibility may be that on weekends, people are engaged in more social events including hanging out with friends and family, socializing at bars, or going out to dinner. These weekend activities may introduce social pressures and expectations which affect eating habits, or simply the act of delaying bedtime may play a role. Engagement in these activities brings its own pressures and stressors, that may be managed by highly palatable foods. Our study did not analyze specific food types or caloric restriction as previous studies have indicated a relationship between TFEQ restraint scale and caloric intake (Stice et al., 2010).

Psychosocial and acculturative stress has been previously reported to affect sleep outcomes, specifically daytime sleepiness and insomnia, among the Hispanic/Latino population (Alcantara et al., 2017). Our study was not powered to analyze the role stress may play on eating behaviors and sleep outcomes. Furthermore, those living at the border may differ from those living in more urban areas. In addition, Mexican-Americans living at the US-Mexico border may experience societal stressors (i.e., both parents or single parent working full-times jobs, managing everyday tasks as a single parent) that may contribute to unhealthy eating habits and poor nutritional decisions that lead to poor sleep. The convenience of not cooking healthy meals at home may lead to ordering fast foods, picking up quick meals via drive-through or convenient prepackaged meal kits that are high in calories and low in nutritional value. Adapting to the fast-paced western culture may also lead to poor sleep as acculturation previously reported in this population may impact sleep (Ghani, 2020). For future studies, behavioral aspects and time use patterns should be examined as well as psychosocial and acculturative stress, to explain the differences between weekday and weekend eating behaviors. Furthermore, the present study focused on relationships between eating and broad sleep characteristics, including sleep duration,
nighttime sleep quality, and daytime sleepiness. Future studies could examine more subtle characteristics such as perceived control, stress reactivity, hypervigilance, etc.

**Strengths**

There are several strengths in this study. One strength of this study is that the participants in this study were recruited from the US-Mexico border in Arizona, an underserved region. Current sleep epidemiological studies focus on urban areas and may miss the problems that are experienced by those living in more rural areas. The demographic region this study was conducted is considered suitable to understand border health disparities better, particularly dietary habits and sleep among Mexican-Americans.

Another strength was the use of the Three Factor Eating questionnaire, which is considered a reliable method to measure dietary restraint. The TFEQ R-18 provides three subscales and helps identify which eating patterns may be related to sleep impairments. This helps narrow down specific areas for improvement by clinicians and sleep health providers.

**Limitations**

There are few limitations worth mentioning. The sample size was small, since this was designed to be a pilot study of these relationships. Despite being one of the largest studies conducted assessing eating behaviors in this specific population, the sample size is small, relative to the effects observed. This study will need to be replicated in a larger sample size to get a clearer picture of associations and prevalence, as well as the influence of confounders, mediators/moderators, and other factors. Another limitation is that sleep measures were retrospectively self-reported, and future studies should use prospective and/or objective measures.

Because of the cross-sectional nature of this study, any causal relationships between eating behavior patterns and sleep impairments cannot be inferred. However, understanding what characterizes individual high scores of these eating behavior traits and its impact on sleep is important. Insight into eating behavior patterns and its impact on sleep could potentially serve to improve interventions for weight loss and for improving eating disorders symptomology. A longitudinal, prospective study in a larger sample size is necessary to obtain a clearer picture of prevalence estimates and associations.
Given that this was a pilot study that aimed to explore the presence of relationships in a novel setting, we did not use any Type-1 error adjustment. However, by reporting confidence intervals and p values, we allow for post-hoc determinations of precision of the estimates and reliability of findings. For example, a Bonferroni correction for analyses across 5 outcomes would be \( \frac{0.05}{5} = 0.01 \), and further correction across 3 models would be 0.003. Post-hoc application of these cutoffs may alter interpretation of these preliminary results.

Lastly, there may be concern for residual confounding, such as comorbid medical and psychiatric conditions, that may not have been accounted for. Our study was unable to obtain detailed, verified medical histories. However, the availability of this information may also provide useful to better understand sleep habits and how it relates to risk of obesity and other cardiometabolic risk factors.

**Conclusion**

Our study found eating behaviors in this group were associated with sleep parameters including insomnia, sleep quality, sleepiness and weekend sleep duration (but not weekday sleep duration). Uncontrolled eating and emotional eating subscales from the TFEQ-R-18 drove this association, while the cognitive restraint subscale did not. When adjusted for BMI, cognitive restraint was associated with weekend sleep duration. This observation is of high clinical relevance because the relationship between eating habits and sleep health play an important role in obesity, cardiometabolic disorders and psychiatric illnesses. This study identified the association of eating behavior traits among a population identified at being higher risk of developing such health problems. Sleep health can be an avenue for intervention to possibly modify dietary patterns. This relationship provides an additional line of approach to intervene on a more individually tailored approach, likely providing increased compliance by patients and willingness to change behavior, especially for approaches that address emotional eating and uncontrolled eating.

**Acknowledgments**

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Disclosure Statement

In accordance with Taylor & Francis policy and my ethical obligation as a researcher, I am reporting that MAG received grants from Jazz Pharmaceuticals and Kemin Foods, and consulting from Fitbit, Natrol, Merck, Casper, SPV, Merck, Sunovion, University of Maryland, and New York University. The sponsors had no role in the design, execution, interpretation, or writing of the study. SP has received grant support from Bayer Pharmaceuticals, Philips Respironics, and Respica. The sponsors had no role in the design, execution, interpretation, or writing of the study. OMB discloses that he received subcontract grants to Penn State from Mobile Sleep Technologies / Proactive Life LLC (NSF/STTR #1622766, NIH/NIA SBIR R43-AG056250, R44-AG056250), received honoraria/travel support for lectures from Boston University, Boston College, Tufts School of Dental Medicine, New York University and Allstate, and receives an honorarium for his role as the Editor in Chief of Sleep Health (sleephealthjournal.org). The sponsors had no role in the design, execution, interpretation, or writing of the study. SP has received grant funding through his institution from Bayer Pharmaceuticals, Philips Respironics, and Respica. The sponsors had no role in the design, execution, interpretation, or writing of the study.

References


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Table 1: Characteristics of sample

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category/Units</th>
<th>Distribution*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age</strong></td>
<td>Years</td>
<td>36.5 ± 19.1</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td>Male</td>
<td>53%</td>
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<tr>
<td></td>
<td>Female</td>
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<tr>
<td><strong>Immigrant Status</strong></td>
<td>Born in Mexico</td>
<td>34%</td>
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<tr>
<td><strong>Education</strong></td>
<td>College Graduate</td>
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<tr>
<td></td>
<td>Some College</td>
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<tr>
<td></td>
<td>High School</td>
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<tr>
<td></td>
<td>Less than High School</td>
<td>27%</td>
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<tr>
<td></td>
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<tr>
<td>--------------------------------</td>
<td>------------------</td>
<td>-----------</td>
</tr>
<tr>
<td><strong>Body Mass Index</strong></td>
<td>kg/m²</td>
<td>30.2 ± 6.1</td>
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<tr>
<td><strong>ISI</strong></td>
<td>Points</td>
<td>9.1 ± 4.2</td>
</tr>
<tr>
<td><strong>ESS</strong></td>
<td>Points</td>
<td>6.4 ± 4.3</td>
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<tr>
<td><strong>PSQI</strong></td>
<td>Points</td>
<td>7.7 ± 3.5</td>
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<tr>
<td><strong>STQ Weekday Sleep Duration</strong></td>
<td>Minutes</td>
<td>436 ± 144</td>
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<tr>
<td><strong>STQ Weekend Sleep Duration</strong></td>
<td>Minutes</td>
<td>469 ± 162</td>
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<tr>
<td><strong>TFEQ Total Score</strong></td>
<td>Points</td>
<td>18.7 ± 11.1</td>
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<tr>
<td><strong>Uncontrolled Eating</strong></td>
<td>Points</td>
<td>7.6 ± 6.5</td>
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<tr>
<td><strong>Cognitive Restraint</strong></td>
<td>Points</td>
<td>9.1 ± 4.7</td>
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<tr>
<td><strong>Emotional Eating</strong></td>
<td>Points</td>
<td>2.0 ± 2.4</td>
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</tbody>
</table>

* Values represented as percentage or mean ± SD.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1: Age, Sex, Immigrant Status</th>
<th>Model 2: Model 1 + Education</th>
<th>Model 3: Model 2 + BMI</th>
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<tbody>
<tr>
<td></td>
<td>B</td>
<td>95% CI*</td>
<td>p*</td>
</tr>
<tr>
<td>INSOMNIA</td>
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<td></td>
<td></td>
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<tr>
<td>Total Score</td>
<td>0.581</td>
<td>(0.066, 1.095)</td>
<td>0.027</td>
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<tr>
<td>Cognitive Restraint</td>
<td>-0.026</td>
<td>(-0.251, 0.198)</td>
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</tr>
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<td>Uncontrolled Eating</td>
<td>0.447</td>
<td>(0.146, 0.749)</td>
<td>0.004</td>
</tr>
<tr>
<td>Emotional Eating</td>
<td>0.159</td>
<td>(0.052, 0.267)</td>
<td>0.004</td>
</tr>
<tr>
<td>SLEEP QUALITY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>0.813</td>
<td>(0.170, 1.456)</td>
<td>0.014</td>
</tr>
<tr>
<td>Cognitive Restraint</td>
<td>0.134</td>
<td>(-0.147, 0.415)</td>
<td>0.346</td>
</tr>
<tr>
<td>Uncontrolled Eating</td>
<td>0.475</td>
<td>(0.091, 0.860)</td>
<td>0.016</td>
</tr>
<tr>
<td>Emotional Eating</td>
<td>0.204</td>
<td>(0.069, 0.338)</td>
<td>0.003</td>
</tr>
<tr>
<td>DAYTIME SLEEPINESS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>0.529</td>
<td>(0.032, 1.026)</td>
<td>0.037</td>
</tr>
<tr>
<td>Cognitive Restraint</td>
<td>-0.068</td>
<td>(-0.284, 0.148)</td>
<td>0.534</td>
</tr>
<tr>
<td>Uncontrolled Eating</td>
<td>0.438</td>
<td>(0.148, 0.728)</td>
<td>0.003</td>
</tr>
<tr>
<td>Emotional Eating</td>
<td>0.158</td>
<td>(0.056, 0.261)</td>
<td>0.003</td>
</tr>
<tr>
<td>SLEEP DURATION (WEEKDAY)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>-0.008</td>
<td>(-0.023, 0.008)</td>
<td>0.330</td>
</tr>
<tr>
<td>Cognitive Restraint</td>
<td>-0.002</td>
<td>(-0.008, 0.005)</td>
<td>0.581</td>
</tr>
<tr>
<td>Uncontrolled Eating</td>
<td>-0.004</td>
<td>(-0.014, 0.005)</td>
<td>0.331</td>
</tr>
<tr>
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<td>-0.001</td>
<td>(-0.004, 0.002)</td>
<td>0.453</td>
</tr>
<tr>
<td>SLEEP DURATION (WEEKEND)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Total Score</td>
<td>-0.017</td>
<td>(-0.031, 0.003)</td>
<td>0.015</td>
</tr>
<tr>
<td>Cognitive Restraint</td>
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<td>(-0.011, 0.001)</td>
<td>0.104</td>
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<tr>
<td>Uncontrolled Eating</td>
<td>-0.009</td>
<td>(-0.017, 0.001)</td>
<td>0.031</td>
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<tr>
<td>Emotional Eating</td>
<td>-0.003</td>
<td>(-0.006, 0.000)</td>
<td>0.042</td>
</tr>
</tbody>
</table>

+Confidence Interval

*P<0.05 is considered statistically significant