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Research Article

The Relationship between Sleep Quality and Eating Competence in A Sample of Canadian Post-Secondary Students

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Abstract

Background: Post-secondary students are at increased risk for sleep problems and poor eating behaviours that overtime may lead to negative health outcomes later in life. However, limited research has examined associations of sleep quality with eating behaviours and eating competence (e.g., being positive, flexible, and comfortable with eating and getting enough enjoyable and nutritious foods) among Canadian post-secondary students.

Methods: Using a cross-sectional study design, participants completed an online survey with valid and reliable measures that assessed sleep quality (Pittsburgh Sleep Quality Index [PSQI]), eating competence (Satter Eating Competence Inventory [ecSI]) and select eating behaviours (i.e., daily fruit and vegetable intake; weekly caffeine and alcohol intake). Participants were dichotomized into poor- and good-quality sleepers using the PSQI cut-off score (>5 = poor-quality sleeper). Independent t-tests examined sociodemographic (e.g., year in college) and health (e.g., Body Mass Index [BMI]) differences by sleep quality group.

Binary logistic regression analyses controlling for BMI examined significant differences between quality sleep (good vs. poor) with eating behaviours. Significance level was set at $p<0.05$.

Results: Participants (n=184) were mostly female (86%) and pursuing full-time studies (93%) in the Faculty of Health Sciences. Most participants were categorized as poor-quality sleepers (69%, n=127), were not meeting the minimum of 7 hours of recommended hours of sleep per night (6.75±1.44SD) and had daily intakes of fruits and vegetables that fell below the recommended minimum. Good quality sleepers had higher eating attitudes (OR=1.23; 95% CI=1.10, 1.39; $p<0.001$), internal regulation (OR=1.24, 95% CI=1.05, 1.48; $p=0.015$), contextual skills (OR=1.13; 95% CI=1.03, 1.25; $p=0.010$), and overall eating competence (OR=1.07, 95% CI=1.03, 1.12; $p=0.002$) compared to poor-quality sleepers.

Conclusion: Campus health services should consider screening students for inadequate sleep behaviours, and when warranted, provide nutrition education that focus on skills to improve eating competence.

Keywords

Sleep quality; eating behaviours; eating competence; post-secondary students; college/university students; young adults

1. Introduction

A growing body of research has linked sleep quality and duration with dietary intake and eating habits [1]. In particular, individuals with poor sleep quality report lower intakes of fruits and vegetables and higher intakes of added sugars compared to good quality sleepers [2]. Furthermore, poor quality sleepers report skipping breakfast and irregular eating patterns [2, 3]. Irregular eating patterns contribute to obesity and dysmetabolism [4] and has been associated with factors for cardio-metabolic disease risk [5].

Students pursuing post-secondary education such as university or college are a population described as vulnerable for both sleep problems [6] and poor dietary habits [7]. In U.S. college students, inadequate sleep duration (<7hours/night) was associated with negative eating attitudes, poor internal regulation of food, and binge eating behaviours [8]. Poor sleep has been linked to increased appetites and the desire to choose sugary foods [9]. Sugar-sweetened beverage consumption represents a significant source of energy consumption in college students that may contribute to weight gain, obesity and other negative health outcomes [10, 11]. Pathways through which lack of sleep might adversely effect energy balance and lead to weight gain include factors such as alterations in appetite and glucose regulation, increased food intake, and reduced energy expenditure [12].

Irregular sleep-wake patterns and poor sleep quality are associated with increased daytime sleepiness and can have significant effects on endocrinology and metabolism status [13]. In a systematic review and meta-analysis, poor sleep duration resulted in increased energy intake, leading to a net positive energy balance of 385 kcal per day, which in the long term may implicate weight gain [14]. Previous work suggests sleep deprivation may cause dysregulation of the

metabolic hormones leptin and grehlin, which are key regulators of hunger and satiety [15, 16] and executive function [17] that reflect internal regulation of food [18] and subsequently an increase in energy intake. Evidence suggests a more plausible explanation for the observed increase in energy intake after poor sleep duration is hedonically driven [19]. That is, short sleep heightens the motivation to seek food for reward. For instance, a study among U.S. university students reported short sleep duration to be associated with poor internal regulation of food intake and binge eating [18] which may explain the hedonic drive for food with lack of sleep.

Various internal (e.g., stress, anxiety) and external (e.g., shift-based work, jetlag) factors may influence sleep and eating behaviours, and eating competence of university students [20]. Eating competence, as defined by the Satter Eating Competence Model (ecSatter) is an intra-individual approach to eating, and food-related attitudes and behaviours that encompass positive bio-psychosocial outcomes [21]. Eating competence is defined as being positive, comfortable, and flexible with eating as well as getting enough to eat of enjoyable and nourishing food [22]. Competent eaters have healthier diets [23, 24] and body weights [25], and are more joyful and positive about eating [26], and sleep better [27] compared to non-competent eaters.

Prior research examining the relationship between sleep and eating competence among post-secondary student populations has focused on sleep duration (i.e., number of hours slept at night) rather than sleep quality [28]. Sleep quality, as defined by the National Sleep Foundation, includes the following key determinants: 1) sleep more time in bed (at least 85% of total time), 2) falling asleep in 30-minutes or less, 3) waking up no more than once per night, and 4) being awake for 20-minutes or less after initially falling asleep [29].

Examining associations of sleep quality with eating competence and eating behaviours in university students is imperative given that early adulthood represents a time of transition for many young people, and habits established at this time can effect both their current health and risk for developing chronic diseases in the future [30, 31]. Therefore, the purpose of this exploratory study was to: 1) describe sleep quality and eating competence and behaviours in a sample of Canadian post-secondary students; and 2) assess the associations of sleep quality with eating competence and behaviours. Findings may help to inform health promotion and nutrition education/interventions for post-secondary students.

2. Methods

We conducted a cross-sectional study investigating sleep characteristics, eating competence and select eating behaviours among health sciences undergraduate students attending a small university located in Oshawa, Ontario, in Canada. The Faculty of Health Sciences (FHS) provides diverse undergraduate programs such as Nursing Science, Allied Health Sciences, Kinesiology, Health Sciences, and Medical Laboratory Science. Once research ethics approval was obtained, students were invited to complete an on-line questionnaire via LimeSurvey™, about their sleep and eating behaviours in the Winter of 2018. Students enrolled in any health sciences program (n=1829 in the 2017/2018 academic year) were recruited via e-mail invitations from a central research e-mail account. As an incentive, students could enter into a drawing to win one of five gift cards valued at $50 CAD. This research complies with the research ethics guidelines and was approved by the research ethics board (REB) at Ontario Tech University in Oshawa, Ontario, Canada (REB No. 14370).

2.1 Outcome Measures

The online survey included valid and reliable measures that assessed sleep quality, eating competence and eating behaviours along with sociodemographic and health characteristics.

2.2 Sleep Quality

Sleep quality was measured using the validated Pittsburgh Sleep Quality Index (PSQI) [32], which assesses patterns of sleep dysfunction over a previous 1-month period. The 19-item, PSQI provides a global sleep quality score and the following 7 subscales: Subjective sleep quality (i.e., self-perception of one's sleep quality), Sleep Latency (i.e., usual time it takes to fall asleep at night), Sleep Duration (i.e., average hours of actual nightly sleep), Habitual Sleep Efficiency (i.e., actual hours of sleep compared to hours spent in bed), Sleep Disturbances (i.e., factors that cause wakening during the night or early morning), Sleep Medication Use (i.e., "over the counter" or prescribed), and Daytime Dysfunction (i.e., difficulty staying awake during the day). Each item is scored on a 0-3 Likert scale, where 3 reflects the negative extreme. The scores of the seven scales are summed to generate a global index score. A global score > 5 is indicative of a poor-quality sleeper, while a score of ≤ 5 is indicative of a good-quality sleeper. The PSQI is a reliable and valid tool [33] and has been used in college students [6, 28].

2.3 Eating Behaviours

Eating behaviours assessed were eating competence, daily fruit and vegetable intake, and weekly alcohol and caffeine intake.

2.3.1 Eating Competence

The Satter Eating Competence Inventory (ecSI) assesses eating competence using 4 scales: Eating Attitudes (i.e., ability to be positive and flexible towards eating), Food Acceptance (i.e., ability to try new foods and learn one's own unique food preferences), Internal Regulation (i.e., attention and responsiveness to cycles of hunger, appetite and satiety), and Contextual Skills (i.e., ability to buy and prepare meals and eat at predictable times, even if that means suspending other activities) [34]. Respondents select from five response options (never, rarely, sometimes, often, always), which are scored on a 4-point scale from 0 (never/rarely) to 3 (always), then summed for a total score (possible range, 0-48). A score ≥ 32 is defined as being eating competent. The ecSI is a valid and reliable measure of eating competence and has been used in college students ($\alpha = 0.81$) [8]. The Ellyn Satter Institute website provides more details on the ecSI [22].

2.3.2 Dietary Intake

Fruit and vegetable intakes over the past month (cups/day) were assessed using the 19-item National Cancer Institute Daily Fruit and Vegetable Screener. This valid and reliable instrument [35, 36] assessed the frequency and portion size of servings of fruits and vegetables, and provided an algorithm that estimates the frequency of cups of fruits and vegetables eaten daily.

Total caffeine intake (servings/week) was determined from five questions that asked participants to report how many servings-per-week they consumed of coffee, espresso, tea,

caffeinated soft drinks and energy drinks. Responses were summed to determine an average intake-per-week of caffeinated beverages. Total alcohol intake was determined from 4 questions that asked participants to report how many servings per week they consumed beer, wine, liquor and mixed drinks. Responses were summed to determine an average intake per week of alcoholic beverages.

2.3.3 Sociodemographic and Lifestyle Characteristics and Weight Status

A range of questions focusing on demographics such as gender, race, age, year in academic program were collected. To determine weight status, participants were asked for their self-reported height and weight used in calculating their Body Mass Index (BMI) [height (m^2)/weight (kg)] [37].

2.4 Data Analysis

Quantitative data from the online survey was exported from LimeSurvey™ to Microsoft Excel (Microsoft Corp. 2010) and then imported and analyzed using SPSS 25 (IBM Corporation, Chicago, IL, USA). Only participants that completed all items on the Pittsburgh Sleep Quality Index (PSQI) and Satter Eating Competence Inventory (ecSI) measures were included in the data analyses (n=184). Internal consistency using Cronbach's alpha were conducted to determine PSQI and ecSI measure reliability. Descriptive statistics of all sociodemographic and health characteristics of participants that completed the survey were performed. All study measures were normally distributed, except for the PSQI and the NCI Fruit and Vegetable Screener. Thus, using the PSQI global cut-off score of >5, the type of quality sleeper was dichotomized into poor- (n=127) and good-quality (n=57) sleeper categories, while total fruit and vegetable intake (servings/week) were transformed by taking the square root.

Independent *t*-tests for continuous variables and Chi-square/Fisher's Exact tests for categorical variables were performed to determine significant ($p<0.05$) sociodemographic and health characteristic differences between poor- and good-quality sleepers. Lastly, binary logistic regression analyses controlling for body mass index examined significant differences between quality sleeper (good vs. poor) with eating behaviours (i.e., eating attitudes, food acceptance, internal regulation, contextual skills, eating competence total score, and fruit & vegetable, caffeine and alcohol intake). Good quality sleepers were dummy coded in the binary logistic regression analyses. Beta standard errors, odds ratios (OR), and 95% confidence interval (CI) for each independent variable in regression analyses examining associations with a good-quality sleeper were computed. To detect a medium effect size ($\delta=0.5$) between poor and good-quality sleepers, with 80% power at the 5% significance level, a minimum sample size of n=102 participants (n=51 per group) was needed for independent t-test; however, for logistic regression analyses, a larger minimum sample size was needed (n=4260) at 80% power and 5% significant level. Estimated sample size was calculated using G*Power (version 3.1; Heinrich Heine University, Dusseldorf, Germany). Statistical significance was set at $P<0.05$.

3. Results

Participants (N=184) were mostly female (86%) and attended university on a full-time basis (93%) (Table 1). Participant demographics reflected the university's demographics with most reportedly being White (54%) or Asian (32%), and a relatively proportional number of participants in each class year (see Table 1). On average, participants were in the higher end of acceptable weight status (BMI: 24.39±5.05SD) and fell slightly short of the National Sleep Foundation's recommended 7 to 9 hours of sleep per night (6.75±1.44SD hrs/night). Internal consistency scores for PSQI (α=0.60) and ecSI (eating attitudes, α = 0.85; food acceptance, α = 0.71; internal regulation, α = 0.76; contextual skills, α = 0.79; esCI total, α = 0.91) were acceptable (α>0.70 for most scales except for the PSQI being undesirable [α=0.60]) [38].

Most participants were categorized as poor-quality sleepers (69%, n=127) as determined by the PSQI cut-off score of greater than five. Independent *t*-tests revealed no statistically significant differences between poor and good-quality sleepers on any sociodemographic or health characteristics (see Table 1). As anticipated, poor-quality sleepers slept significantly less hours per night compared to good-quality sleepers (6.35±0.12SE vs. 7.65±0.15SE, $p<0.001$).

Binary logistic regression analyses, adjusting for body mass index revealed significant differences between poor- and good-quality sleepers on all ecSI subscales and total score, except for the food acceptance scale (Table 2). That is, good-quality sleepers were more likely to have higher eating attitudes (i.e., ability to be positive and flexible towards eating), internal regulation (i.e., attention and responsiveness to cycles of hunger, appetite and satiety), contextual skills (i.e., ability to buy and prepare meals and eat at predictable times, even if that means suspending other activities), and overall eating competence compared to poor-quality sleepers. Binary logistic regression analysis did not show any other eating behaviour significant differences between poor- and good-quality sleepers, except there was a trend towards significance ($p=0.066$) in poor-quality sleepers consuming more caffeinated beverages per week compared to good-quality sleepers (3.09±2.63SD vs. 2.26±2.48SD, respectively).

Table 1 Sociodemographic & health characteristics among Canadian university students (N=184).

	All participants		Sleep Quality Category*				
			Poor Sleepers (n=127)		Good Sleepers (n=57)		
Characteristic	**N**	**%**	**N**	**%**	**N**	**%**	***P*-value‡**
Gender[a]							0.643
Female	159	86.4	111	87.4	48	84.2	
Male	25	13.6	16	12.6	9	15.8	
Race/ethnicity[b]							0.085
White	97	54.2	61	48.8	36	66.7	
Asian	57	31.8	46	36.8	11	20.4	
Black	10	5.6	6	4.8	4	7.4	
Mixed/Other	15	8.4	12	9.6	3	5.6	
Enrollment Status[c]							0.114
Part-time	12	6.6	6	4.7	6	10.9	
Full-time	170	93.4	121	95.3	49	89.1	
Program Year							0.194
First year	36	19.7	21	16.5	15	26.8	
Second year	51	27.9	41	32.3	10	17.9	
Third year	53	29.0	35	27.6	18	32.1	
Fourth year	39	21.3	28	22.0	11	19.6	
Part-time or off track	4	2.2	2	1.6	2	3.6	
	Mean	**SD**	**Mean**	**SE**	**Mean**	**SE**	***P*-value†**
Mean age (years)[a]	23.06	7.41	23.27	0.66	22.59	0.99	0.569
Body Mass Index (kg/m^2)	24.39	5.05	24.71	0.47	23.69	0.60	0.209
Self-report Sleep (hours/night)	6.75	1.44	6.35	0.12	7.65	0.15	<0.001

*Sleep quality category was determined from the PSQI global cut-off score of poor sleeper (>5) indicating significant sleep disturbance.

‡Chi-square or Fisher's Exact tests for categorical values.

† Independent t-tests for continuous values.

[a] 1 participant preferred not to disclose their gender, age, or year in program.

[b] 5 participants chose not to disclose their race/ethnicity.

[c] Missing data for 2 participants.

Table 2 Binary logistic regression analyses examining associations of quality sleeper with eating behaviours among Canadian university students (N=184).

Scale (possible score range)		**Sleep Quality Category***						
Subscale		**Poor Sleepers (n=127)**		**Good Sleepers (n=57)**				
	Cron-bach's α	**Mean**	**SD**	**Mean**	**SD**	**B (S.E)‡**	**OR (95% CI)†**	***p-value***
Satter Eating Competence Inventory								
Eating Attitudes (0 to 15)	0.85	10.66	3.46	12.68	2.69	0.21 (0.06)	1.23 (1.10, 1.39)	<0.001
Food Acceptance (0 to 9)	0.71	5.24	2.32	5.42	2.50	0.02 (0.07)	1.02 (0.89, 1.17)	0.740
Internal Regulation (0 to 9)	0.76	6.40	1.99	7.21	1.79	0.22 (0.09)	1.24 (1.05, 1.48)	0.015
Contextual Skills (0 to 15)	0.79	7.76	3.44	9.32	3.25	0.13 (0.05)	1.13 (1.03, 1.25)	0.010
Eating Competence Total (0 to 48)	0.91	30.06	8.33	34.63	7.62	0.07 (0.02)	1.07 (1.03, 1.12)	0.002
Total Fruit and Vegetable Servings/day (n=167)	n/a	2.46	1.80	2.28	1.76	-0.20 (0.33)	0.82 (0.43, 1.55)	0.538
Total Caffeinated Intake[a] (servings/week)	n/a	3.09	2.63	2.26	2.48	-0.13 (0.07)	0.88 (0.76, 1.01)	0.066
Total Alcohol Intake[b] (servings/week) (n=181)	n/a	1.41	2.27	2.02	2.95	0.11 (0.06)	1.11 (0.98, 1.26)	0.096

*Sleep quality category was determined from the PSQI global cut-off score of poor sleeper (>5) indicating significant sleep disturbance. Good-quality sleeper is coded as 1 while poor-quality sleeper is coded as zero in these analyses.

‡Beta coefficient and standard error.

†Odds ratio and 95% confidence intervals were calculated using binary logistic regression analysis controlling for body mass index for each outcome.

[a]Total caffeine intake was sum of coffee, expresso, tea, soft drinks and energy drinks servings per week (possible score range 0 to 25).

[b] Total Alcohol intake was sum of beer, wine, liquor and mixed drinks per week (possible score range 0 to 20).

4. Discussion

Our study explored relationships of sleep quality with eating competence and behaviours in a sample of Canadian post-secondary health sciences students. More than two-thirds of students were poor quality sleepers and slept significantly less hours per night compared to good quality sleepers. This is consistent with studies conducted in the United States and Europe which continue to find poor sleep quality at alarming levels among the post-secondary student population [6, 28, 39]. The mean sleep duration for the entire sample was 6.75 hours (SD 1.44) which is just under the minimum National Sleep Foundation's recommended sleep duration of 7 to 9 hours per day for young adults [40]. A substantial proportion of students fail to obtain the recommended hours of sleep each night, and thus, may function at less than optimal levels [41].

Sleep duration has been linked with being overweight and poor overall eating competence in U.S. college students [28]. Similarly, in our study, good quality sleepers were significantly more likely to have higher eating attitudes (ability to be positive and flexible towards eating), internal regulation (attention and responsiveness to cycles of hunger, appetite and satiety), contextual skills (ability to buy and prepare meals and eat at predictable times even if that means suspending other activities), and a higher overall eating competence score compared to poor quality sleepers. These findings are not surprising given that the release of key metabolic regulators are partly dependent on sleep time, sleep duration, and sleep quality [42]. Adequate sleep quality is important to the normal functioning of daily metabolic and hormonal processes and appetite regulation. Poor sleep quality and duration may cause dysregulation of the metabolic hormones grehlin and leptin, which are key regulators of hunger and satiety respectively [15, 16]. In particular, slow wave sleep (SWS) or delta sleep is the deepest stage of sleep and considered the most restorative sleep stage where the regulation of leptin and ghrelin occurs. Inadequate sleep has been associated with decreased leptin and increased ghrelin, changes that have also been observed in reaction to food restriction and weight loss, and are typically associated with increased appetite [43]. Given that poor sleep quality is associated with characteristics of low eating competence and health issues, health care providers may want to consider screening college students for inadequate sleep behaviours, and when warranted, provide nutrition education and counseling that focus on skills to improve eating competence.

Despite observing no comparative differences in fruit and vegetable consumption among good and poor quality sleepers, both groups are not meeting the 7-10 servings per day recommendation by the Canadian Food Guide for adults, nor the 5 or more servings recommended by the Dietary Guidelines for Americans 2015-2020 [44]. Health Canada has unveiled the new Canada Food Guide, which no longer emphasizes food groups and recommended servings, but rather proportions of vegetables and fruits, whole grain foods and protein foods [45]. Given the low portions of fruits and vegetables consumption in the student

population, health and wellness programs should target the post-secondary student population with promoting better eating behaviours such as improved daily fruit and vegetable intake.

This study is not without limitations. A notable limitation of the present study is the small sample size with limited power, therefore caution should be taken when generalizing these findings to the Canadian post-secondary student population. The low response rate could be attributed to a labour disruption occurring at the time of the launch of the study. However, there were no differences noted between responders and non-responders. Furthermore, no causal inferences can be made without more longitudinal studies. Future research would benefit from examining sleep quality and eating competence among a larger cohort of university students in a longitudinal study design that also explores potential mediators or moderators of this relationship such as student's level of stress (e.g., emotional, social, financial, academic performance). As with all human research, study participants self-selected themselves to participate so biases in self-reports of sleep and eating behaviours is possible. However, prior research has found these instruments to be reliable in U.S. college populations [27, 28]. Despite these study limitations, this exploratory, cross-sectional study is the first, to our knowledge, to examine associations of sleep quality with eating competence and behaviours among Canadian post-secondary students.

Future studies should consider circadian preference also referred to as chronotype. Chronotype has been associated with sleep, eating behaviours, cognitive performance, and depressive and/or anxiety symptomatology in university students [46, 47]. Circadian preference differs among individuals and is typically classified into three chronotypes: Morning-type (M-type), Evening-type (E-type) – both divided into extreme and moderate types, and Neither-type (N-type), which subsumes intermediate characteristics and include about 60% of the population [46, 48]. M-types prefer to wake up early in the morning and go to be early in the evening and achieve peak mental and physical performance in the first part of the day. In contrast, E-types prefer to stay up late at night, rise at a later time in the morning, and reach their best performance during the second half of the day [48].

Chronotype influences attitudes, lifestyle, cognitive functions, motor skills and personality traits [46]. M-types tend to be more conscientious, agreeable and achievement oriented, whereas E-types show marginally more extroversion and some neurotic traits that may pre-dispose them to mental or psychiatric, mood and personality disturbances, and eating disorders [46]. Evening types experience social jetlag during their high school and university years, and accumulate a sleep debt given that classes and exams take place mainly in the morning [49]. This sleep debt and fatigue by E-types can lead to sleep disorders that reduce attention, concentration, and motivation during the day [50]. Conversely, M-types, being more aligned with their daily high school or university schedule, may be more advantage in their mental performance [46].

5. Conclusion

In conclusion, findings from this study suggest that a majority of Canadian post-secondary students are not obtaining adequate sleep quality or meeting the daily fruit and vegetable intake recommendations. Additionally, poor-quality sleepers are more likely to have lower eating competence characteristics compared to good-quality sleepers. Post-secondary students are at risk for both sleep and eating issues, with an interrelationship between the two that requires additional investigation. Creating healthy academic environments is a high priority focus on campuses around the world. Results suggest there is an important role for campus health/student services to promote health self-care behaviours in relation to sleeping and eating. Supportive programs focusing on healthy sleep behaviours and nutrition education should target students who self-identify with these issues, as well as the entire student community. Additionally, exploring the impact of contextual factors (e.g., time, finances, workload) on sleep and eating behaviours amongst post-secondary students is essential moving forward.

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Author Contribution

All authors were involved in the study design and contributed to the development and implementation of the study. VQ conducted the analyses and interpretation of the data. EP and VQ were involved in drafting the manuscript and all authors were involved in contributing to editing and reviewing the final manuscript. All authors have read and approved the final manuscript.

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Competing Interests

The authors have declared that no competing interests exist.

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