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Dietary Behaviors and Poor Sleep Quality among Young Adult Women: Watch that Sugary Caffeine!

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Abstract

Purpose: Associations of dietary patterns with sleep quality have not been sufficiently studied, particularly among young adults. Studying factors associated with sleep quality among young adults is especially important given the significant life changes they are experiencing, which can influence not only sleep quality but also dietary behaviors.

Methods: We examined the cross-sectional association of sleep quality among 462 women at age 23 years. We used the Pittsburg Sleep Quality Index (PSQI) to define sleep quality. Intake over the previous 7 days of fruits and vegetables, soda, sports drinks, other sweetened drinks, and coffee drinks were assessed by a self-report questionnaire. Linear regression analysis examined the association between PSQI scores and dietary intake.

Results: About 47% of participants were White, 25% Black, 10% Hispanic, and 18% Other. Almost ½ (45%) reported poor sleep quality. Compared with reporting consuming no energy drinks, participants who reported consuming any energy drinks had PSQI scores that were 0.84 points higher (7.08 ± 0.51 vs 6.24 ± 0.39; p=0.04) (indicating poorer sleep quality). Participants who reported drinking one or more high calorie coffee drinks had PSQI scores that were 1.00 points higher compared with those reporting drinking no high calorie coffee drinks (7.14 ± 0.51 vs 6.14 ± 0.42; p=0.02). Fruit or vegetable intake was not associated with PSQI score.

Conclusions: Poor sleep quality is prevalent among young women. Young women with poor sleep quality should consider their sugary caffeine use to determine if it may be associated with their sleep.

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Keywords

adolescents; emerging adults; dietary behaviors; sleep health

Introduction

Good sleep quality is recognized as important for overall well-being and physical and mental health (1, 2). However, in the US, more than 50 million adults report inadequate sleep (3). Poor sleep, defined as poor subjective sleep quality, short sleep duration, irregular sleep patterns, or insomnia complaints, is common among young adults (4, 5) and has a higher prevalence among young women than men(6–9). Of note, Jackson and colleagues reported that almost one-third of young women had sleeping difficulties in the last twelve months (10).

Poor dietary habits have been shown to be associated with poor sleep, but most published work focused on associations with sleep duration not sleep quality (11–13). Adolescents reporting short sleep duration were less likely to consume at least one fruit or vegetable a day and greater fast food consumption compared with adolescents reporting at least 8 hours per night of sleep (12). Among Korean adolescents, higher intake of soda, soft drinks, fast food and confectionaries was associated with shorter sleep duration (13). Waking up with fatigue (poor sleep quality) was associated with lower intake of fruits, vegetables, and milk and higher intake of soda, soft drinks, fast food, instant noodles, and confectionaries. Young adults who tended to go to bed late were more likely to skip breakfast, consume more fast food, and drink more sugar sweetened beverages than their peers who went to bed earlier (14). Among adults, Kant and colleagues found that short and long sleepers were more likely to skip breakfast and have fewer main meals during the day compared with adults sleeping 7 – 8 hours per night (11). In sum, poor dietary habits, characterized by various methods, is associated with poor sleep quality.

Associations of dietary patterns with sleep quality have not been sufficiently studied, particularly among young adults. The period of young adulthood is characterized by leaving home, becoming autonomous and developing a self-identity, and establishing long-term health behavior patterns (15). Dietary patterns may differ than during adolescence due to change in location that may influence food availability and cost, personal preferences, and meal preparation skills (16). Young adults may not be constricted by the school schedules of adolescents and their biological sleep patterns differ from that of adolescents (17). Associations with dietary patterns and sleep quality may differ from those of adolescents. For instance, one study of young adults found that poor sleep quality, defined by report of difficulty falling/staying asleep, was associated with skipping breakfast but not consumption of caffeinated beverages, sugar sweetened beverages, or fast food (14), results that contrast with studies on adolescents. Further study is needed to determine if observed associations of poor sleep and poor diet, including caffeinated beverages, in adolescence are also observed in young adulthood.

We sought to contribute to the extant literature by evaluating the association of dietary behaviors with sleep quality among young adult women. We hypothesized that less healthful dietary behaviors would be associated with poorer sleep quality.

Methods

Participants for this study were a cohort of adolescent girls originally participating in the Trial of Activity for Adolescent Girls (TAAG) multi-center field trial (18). Eligibility criteria included that the girls had to read and speak English, be eligible to participate in middle school physical education classes, and not have contraindications to participate in a submaximal exercise test. After the trial ended in 2006, follow-up studies were conducted in 2009 and 2015 with the girls originally recruited from the University of Maryland field center. This study focused on the 2015 follow-up when the girls were about age 23 years, the only follow-up period in which sleep quality was assessed. From girls who participated in the 2009 follow-up, 81.3% were re-recruited in 2015 (19). There was no difference in race/ethnicity, parent education, or participation in free or low-cost lunch program in high school between those who were re-recruited and those who were not. The study was approved by the Kaiser Permanente Southern California Institutional Review Board. Recruitment strategies were previously reported (20, 21). In 2015, follow-up contact and data collection occurred remotely through mail, email, and Facebook (19).

Sleep Quality – Dependent Variable

Participants completed the Pittsburgh Sleep Quality Index (PSQI), a widely used and well-validated self-report measure of sleep quality (22). The scale assesses sleep disturbances on the majority of days in the past month across seven domains: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, daytime dysfunction, and use of sleep medications. Scores are summed to create a global score, with higher scores indicating poorer sleep quality, which was the study's primary outcome. We also examined sleep quality, indicated by scores less than five (good sleep quality) and scores five and higher (poor sleep quality) (22).

Independent Variables

Demographics—Participants self-identified as non-Hispanic White, Black or African American, Hispanic or Latino, Asian/Pacific Islander, American Indian or Alaska Native, or Other. We classified race/ethnicity as White, Black, Hispanic, and Other. Height and weight were determined from self-report and body mass index (BMI; kg/m^2) was calculated. Relationship status was assessed and combined into single/divorced/separated and married/cohabitating. Educational status was assessed as high school graduate or less, some college/university, and 4-year college/university graduate. Employment status was categorized as student, employed, and unemployed. Hours worked for pay was categorized as 0 hours per week, 1 – 19 hours per week, 20 – 40 hours per week, and more than 40 hours per week. Personal annual income was assessed and, based on the sample distribution, was categorized as less than $10,000, $10,001 to $25,000, and greater than $25,000. Overall family socioeconomic status was determined by asking participants if they considered their family

as low income, lower-middle income, middle income, upper-middle income, or high income. Categories were combined into low, middle, and high income.

Dietary behaviors—The 2009 Youth Risk Behaviors Survey (YRBS) questions were used to assess the previous weeks' intake of fruits and vegetables. Items included intake of fruit, green salad, potatoes (not fried), carrots, other vegetables, and 100% fruit juice. Serving size was not assessed. Items on beverage intake were taken from an adolescent beverage consumption screener developed by Nelson and Lytle (23). Four items query on the past 7 days' frequency of consumption of soda, sports drinks, other sweetened drinks, and high calorie coffee drinks. Questions included "during the past 7 days, how often did you drink a can, bottle, or glass or soda or pop, such as Coke, Pepsi, or Sprite (Do not include diet soda or pop)? and "during the past 7 days how often did you drink coffee drinks such as lattes, mochas, Frappuccinos, and Macchiatos (please do not include regular coffee)? One to two-week test-retest reliability ranged from 0.66 to 0.84 and all items, except other sweetened drinks, were significantly associated with same-item beverage intake measured from 24-hr dietary recalls.(23) Beverages, fruits, and vegetables responses were categorized as none, less than one per day, or one or more per day. The number of days in the past week in which breakfast was eaten was assessed and categorized as never/do not know, 4 days or less, or 5 or more days.

Analysis: For descriptive purposes, we compared the associations between overall cohort categorical characteristics and dietary behaviors with sleep quality (categorized as good or poor) using the Pearson chi-square test or Fisher's exact test in cases of sparse data. We assessed continuous measures with the Wilcoxon rank test. First, we conducted linear regression to test the association between the PSQI score and dietary variables, controlling for race/ethnicity, education, annual income, family income, employment status, parenting role, and BMI. For significant associations between the PSQI score and dietary variables, follow-up linear regression analyses examined the association between the seven PSQI domains and dietary variables to determine which domain of sleep was most strongly associated with diet. All analyses were conducted using SAS version 9.4 (SAS Institute, Inc, Cary NC, USA).

Results

In 2015 there were 462 respondents (mean age 22.9 ± 0.45 years). The cohort was racially/ethnically diverse, with 25.3% African American, 10.2% Hispanic, 46.8% non-Hispanic white, with the remaining classified as Other race/ethnicity. As displayed in Table 1, 55.0% were college graduates, most were employed (58.0%) and had annual incomes less than $25,000 (66%).

Poor sleep quality was prevalent, with 45.2% of participants reporting poor sleep (PSQI ≥ 5). Participants categorized with poor sleep quality were more likely to be Black, have a higher BMI, have lower education and family income, be in a parenting role, and be unemployed (Table 1).

Dietary variables by sleep quality are displayed in Table 2. Daily consumption of fruit servings, vegetable servings, or fruit juice did not differ by sleep status category. Of participants reporting poor sleep quality, 29.7% reported drinking at least one sugar-sweetened beverage each day compared with 15.0% of participants with good sleep quality ($p<0.0001$). Participants with poor sleep quality were more likely to report consuming energy drinks ($p=0.008$) and high calorie coffee drinks ($p=0.0002$) compared with those reporting good sleep quality (Table 2). Poor sleep quality was also associated with fewer days per week of eating breakfast ($p=0.002$).

After adjusting for race/ethnicity, education, employment status, weekly work hours income, family socioeconomic status, parenting role, and BMI, some dietary variables were associated with PSQI score. Participants who reported consuming any energy drinks had higher PSQI scores (7.08 ± 0.51 vs 6.24 ± 0.39; $p=0.04$) compared with participants who did not report consuming any energy drinks (Table 3). Participants who reported drinking one or more high calorie coffee drinks had PSQI scores that were 1.00 points higher compared with those reporting drinking no high calorie coffee drinks ($7.14 + 0.51$ vs $6.14 + 0.42$; $p=0.02$). After adjustment for covariates, consuming at least one sugar-sweetened beverage a day was no longer significantly associated with poor sleep quality ($p=0.07$). Fruit intake, vegetable intake, fruit juice intake, and breakfast consumption were not associated with mean PSQI scores after covariate adjustment.

We explored how the individual PSQI domains may have differed by reported consumption of the beverage variables that met statistical significance from the primary model. In adjusted models, young women who drank at least one high calorie coffee drink per day had, on average, 8.7 minutes longer sleep latency compared with reporting no high calorie coffee drink consumption ($p=0.04$). The sleep disturbance and sleep quality domains were also significantly lower for those who consumed energy drinks or high calorie coffees. The other domains were not significantly associated with energy drink consumption or high calorie coffee consumption, although there was a trend for associations with energy drink consumption and sleep duration ($p=0.06$) and for high calorie coffee consumption and daytime dysfunction ($p=0.06$).

Discussion

Poor sleep quality was prevalent among emerging adult women, with 45% having poor sleep quality based on their PSQI scores. Poorer sleep quality scores were associated with consuming high energy drinks and high-calorie coffee drinks – products containing not only caffeine but also sugar. The PSQI domains of sleep disturbances and sleep quality were unfavorable for those consuming energy drinks and high calorie coffee drinks compared with participants reporting no consumption. Sleep latency was longer for participants who drank high calorie coffee drinks. Young women with poor sleep quality should consider their sugary caffeine use to determine its association with their sleep.

Our results extend prior research examining energy drink correlates of poor sleep with young adults, which was mostly conducted in college student populations. For instance, poor sleep quality assessed by the PSQI was associated consumption of alcohol, energy drinks,

caffeinated beverages, and other stimulant beverages among Thai college students (8). One stimulant drink per week was associated with 50% increased odds of being categorized with poor sleep quality. Others have reported lower sleep quality among energy drink users in college students (14, 24–26). In a non-college sample of young adults with an average age of 25.4 years, Larson et al. found inadequate sleep prevalence was higher among males, but not females, who reported more than one energy drink per week (27).

Caffeine is a well-recognized contributor to poor sleep (28). We are not aware of prior studies that have examined associations between high-calorie coffee drinks with sleep quality. Over 13% of the young women reported consuming at least one of these coffee drinks each day in the past week. The behavior was associated with higher PSQI scores, and the domains of sleep latency, sleep disturbance, and sleep quality. With the popularity of coffee drinks and the ubiquitous nature of food outlets serving high calorie coffee drinks, it may be difficult for young women with poor sleep quality to reduce consumption of sugar-sweetened coffee drinks.

In addition to caffeine, energy drinks and high-calorie coffee drinks both contain sugar and can be identified as sugar-sweetened beverages. In light of other studies that have reported associations of poor sleep with soda and other sugar-sweetened beverages that are usually caffeinated (13),(29), it is possible that the combination of sugar and caffeine may promote poor sleep. There is some evidence that combining sugar with caffeine prolongs alertness (30). Caffeine and simple sugars interact with circadian rhythms. Chronic caffeine intake may lengthen the circadian period, which can lead to disturbances in the daily rhythm of glucose metabolism. People who consume caffeinated sugary beverages late in the day may be less tolerant of the sleep-inducing effects of carbohydrates (sugar) (30), ultimately leading to poor sleep quality. Alternatively, there may be a bidirectional association in which young women with poor sleep quality consume sugary caffeinated beverages in order to maintain alertness.

Unlike some previous studies, we did not find associations with sleep quality and more healthful dietary behaviors, like eating fruits and vegetables. Among Korean adolescents, poor sleep quality was associated with lower intake of fruit and vegetables (13). Our assessment of fruits and vegetable intake only included six items and did not include serving size. A more precise assessment method might have detected poor dietary habits and poor sleep quality. Oglivie et al. reported fewer days per week of breakfast consumption for young adults who reported low sleep quality (14), also conflicting with our results.

An advantage of studying factors associated with sleep characteristics among young adults not in college is that there is greater variation among socioeconomic factors than would be found among college students. Our bivariate results indicated that those reporting poor sleep quality were more likely to be Black, have lower education, report a lower family income, be unemployed, and report being in a parenting role. Given that socioeconomic status is associated with sleep quality (31–33), it is important to control for such characteristics when examining associations among young adults. However, we were able to locate only one set of studies that included socioeconomic factors as covariates in their analysis (14, 27).

Controlling for socioeconomic status, energy drink consumption (14, 27), sports drink consumption (14), and skipping breakfast (14) were associated with trouble sleeping.

The present study had limitations. The study design was cross-sectional and all data were self-reported. Actigraphy is the gold standard method to assess sleep quality. We can only report associations, rather than examine potential exposures to poor sleep quality. Diet was assessed using a brief screener instead dietary recalls or food frequency questionnaires. We did not collect information on shift work, which can influence sleep quality, dietary behaviors, and caffeine intake. The study only included females and our results cannot be generalized to males. The cohort was derived from girls living in the Baltimore, MD/Washington, DC metropolitan region and may not be representative of young adult women living in other areas. However, the cohort was racial/ethnically and socioeconomically diverse and included women who had not attended college. Sleep quality was assessed with a validated and commonly-used self-report instrument.

In conclusion, among racial and ethnically diverse young adult women, poor sleep quality was common. While eating behaviors were not associated with poor sleep, sugary caffeinated beverage drinks were. Although the study was cross-sectional and causality cannot be determined, young women with poor sleep quality should consider their sugary caffeine use to determine if it may be associated with their sleep. It is possible that sleep problems may lead to sugary caffeine consumption, which may lead to more sleep problems.

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Abbreviations:

BMI	Body mass index
CI	Confidence Interval
OR	Odds ratio
PSQI	Pittsburgh Sleep Quality Index
TAAG	Trial of Activity for Adolescent Girls
YRBS	Youth Risk Behaviors Survey

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Implications and Contribution

Associations of dietary patterns with sleep quality have not been sufficiently studied, particularly among young adults. We found poorer sleep quality was associated with consuming high energy drinks and high-calorie coffee drinks. Young women with poor sleep quality should consider their sugary caffeine use to determine if it may be associated with their sleep.

Table 1.

Overall cohort characteristics by Pittsburgh Sleep Quality Index (PSQI) categories of good and poor sleep quality.

	Good Sleep Quality (N=253)	Poor Sleep Quality (N=209)	Total (N=462)	p value**
Age *	22.9 (0.45)	22.9 (0.45)	22.9 (0.45)	0.16
Race/ethnicity				0.03
Black	50 (19.8)	67 (32.1)	117 (25.3)	
Other	48 (19.0)	34 (16.3)	82 (17.7)	
Hispanic	29 (11.5)	18 (8.6)	47 (10.2)	
White	126 (49.8)	90 (43.1)	216 (46.8)	
Body mass index *	25.2 (5.89)	26.9 (7.21)	26.0 (6.57)	0.01
Education				0.007
High school graduate or less	25 (9.9)	39 (18.7)	64 (13.9)	
Some college	75 (29.6)	69 (33.0)	144 (31.2)	
College graduate	153 (60.5)	101 (48.3)	254 (55.0)	
Participant annual income				0.25
Less than $10,000	77 (30.4)	79 (37.8)	156 (33.8)	
$10,000 – $25,000	85 (33.6)	64 (30.6)	149 (32.3)	
More than $25,000	91 (36.0)	66 (31.6)	157 (34.0)	
Family income				0.006
Low	74 (29.2)	85 (40.7)	159 (34.4)	
Middle	116 (45.8)	93 (44.5)	209 (45.2)	
High	63 (24.9)	31 (14.8)	94 (20.3)	
Parenting role, yes	37 (14.6)	68 (32.5)	105 (22.7)	<0.0001
Employment status,				0.0003
Student	89 (35.2)	73 (34.9)	162 (35.1)	
Employed	158 (62.5)	110 (52.6)	268 (58.0)	
Unemployed	6 (2.4)	26 (12.4)	32 (6.9)	
Hours worked for pay				0.132
0 hours	33 (13.0)	41 (19.6)	74 (16.0)	
1–19 hours	36 (14.2)	36 (17.2)	72 (15.6)	
20–40 hours	154 (60.9)	107 (51.2)	261 (56.5)	
More than 40 hours	30 (11.9)	25 (12)	55 (11.9)	
PSQI Total, mean	3.6 (1.23)	8.2 (2.29)	5.7 (2.88)	<0.0001

Good sleep quality is defined as PSQI total score < 5; poor sleep quality is defined as PSQI ≥ 5.

* Categorical variables are n (column %); continuous variables are mean (SD).

** P values calculated using Chi squared test or Fisher's exact test in cases of sparse data. Continuous measures were assessed using the Wilcoxon rank sum test.

Table 2.

Dietary behaviors* of the Pittsburgh Sleep Quality Index categories of good and poor sleep quality.

	Good Sleep Quality (N=253)	Poor Sleep Quality (N=209)	Total (N=462)	p value**
Fruits per day				0.30
None	19 (7.5)	21 (10)	40 (8.7)	
Less than 1	132 (52.2)	117 (56)	249 (53.9)	
1 or more	102 (40.3)	71 (34)	173 (37.4)	
Vegetables per day				0.64
None	9 (3.6)	5 (2.4)	14 (3)	
Less than 1	127 (50.2)	112 (53.6)	239 (51.7)	
1 or more	117 (46.2)	92 (44)	209 (45.2)	
Fruit juice per day				0.10
None	114 (45.1)	74 (35.4)	188 (40.7)	
Less than 1	109 (43.1)	108 (51.7)	217 (47)	
1 or more	30 (11.9)	27 (12.9)	57 (12.3)	
Sugar beverages per day				0.0001
None	70 (27.7)	33 (15.8)	103 (22.3)	
Less than 1	145 (57.3)	114 (54.5)	259 (56.1)	
1 or more	38 (15)	62 (29.7)	100 (21.6)	
Energy drinks per day				0.008
None	231 (91.3)	175 (83.7)	406 (87.9)	
Some	22 (8.7)	34 (16.3)	56 (12.1)	
High-calorie coffees per day				0.0002
None	161 (63.6)	97 (46.4)	258 (55.8)	
Less than 1	70 (27.7)	72 (34.4)	142 (30.7)	
1 or more	22 (8.7)	40 (19.1)	62 (13.4)	
Breakfast per week				0.002
Never/do not know	15 (5.9)	18 (8.6)	33 (7.1)	
4 days or less	89 (35.2)	102 (48.8)	191 (41.3)	
5 or more	149 (58.9)	89 (42.6)	238 (51.5)	

Good sleep quality is defined as PSQI total score < 5; poor sleep quality is defined as PSQI ≥ 5.

*Categorical variables are n (column %).

**P values calculated using chi squared test or fisher's exact test in cases of sparse data.

Table 3.

Mean Pittsburgh Sleep Quality Index scores and dietary behaviors, controlling for race/ethnicity, education, annual income, family income, employment status, parenting role, and body mass index

Parameter	Mean score (SD)	P value
Eat breakfast 5 days or more	6.26 (0.43)	0.50
Eat breakfast 4 days or less	7.11 (0.42)	0.35
Eat breakfast Never/Do not know	6.61 (0.58)	referent
Eat one or more servings of fruit per day	6.69 (0.45)	0.95
Eat less than one serving of fruit per day	6.64 (0.43)	0.99
Eat no fruit servings per day	6.65 (0.56)	referent
Eat one or more servings of vegetables per day	6.85 (0.38*	0.35
Eat less than one serving of vegetables per day	7.04 (0.39)	0.23
Eat no servings of vegetables per day	6.09 (0.80)	referent
Drink one or more servings of juice per day	6.62 (0.54)	0.89
Drink less than one serving of juice per day	6.80 (0.44)	0.41
Drink no servings of juice per day	6.56 (0.41)	Referent
Sugar-sweetened beverages, average 1 or more per day	7.09 (0.45)	0.07
Sugar sweetened beverages, average less than 1 per day	6.61 (0.42)	0.35
Sugar sweetened beverages, never	6.28 (0.51)	referent
Energy drink, average 1 or more per day	7.08 (0.51)	0.04
Energy drink, none	6.24 (0.39)	Referent
High calorie coffee drink, average 1 or more per day	7.14 (0.51)	0.02
High calorie coffee drinks, less than 1 per day	6.70 (0.45)	0.06
High calorie coffee drinks, none	6.14 (0.42)	referent

Table 4.

Mean Pittsburgh Sleep Quality Index (PSQI) domains by energy drink consumption and high calorie coffee consumption, controlling for race/ethnicity, education, annual income, family income, employment status, parenting role, and body mass index.

	Energy Drink Consumption			High Calorie Coffee Consumption			
PSQI Domain	**None**	**1 or more per week**	**p value**	**None**	**Less than 1 per day**	**1 or more per week**	**p value**
Duration (hrs) (range 1–11)	7.0 (1.13)	6.6 (1.41)	0.06	7.0 (1.18)	6.9 (1.14)	6.8 (1.22)	0.28
Latency (min) (range 0–240)	22.7 (23.58)	27.3 (22.8)	0.11	21.1 (22.37)	24.4 (22.49)	29.8 (28.88)	0.04
Efficiency (range 16.7–600)	89.1 (30.10)	88.2 (23.62)	0.56	90.5 (36.20)	87.0 (15.18)	86.9 (20.82)	0.80
Disturbance (range 0–27)	8.0 (5.10)	9.7 (5.56)	0.05	7.6 (5.07)	8.5 (5.06)	10.4 (5.33)	0.0004
Daytime dysfunction (range 0–6)	1.4 (5.10)	1.6 (1.22)	0.16	1.3 (1.25)	1.6 (1.27)	1.5 (1.30)	0.06
Quality (range 0–3)	1.1 (0.64)	1.3 (0.67)	0.02	1.0 (0.64)	1.1 (0.62)	1.3 (0.70)	0.02
Meds (range 0–3)	0.2 (0.67)	0.3 (0.66)	0.27	0.2 (0.67)	0.2 (0.61)	0.3 (0.76)	0.35

Continuous measures were assessed using the Kruskal Wallis test for high calorie coffee consumption and the Wilcoxon rank sum test for energy drink consumption.