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Effects of Sleep on Adolescents' Appetite, Dietary Intake, and Weight

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Abstract

Introduction: Several factors have been associated with excess weight gain in adolescents, including loss of sleep.

Objective: The purpose of this study is to examine the effects of sleep factors on appetite, dietary intake, and the body weights of adolescent youth.

Methods: A prospective correlational study design was used. Male and female adolescents (N = 76) ages 12–18 years completed a 5-night study. Sleep was assessed using Fitbits (88.5% accuracy) and the Pittsburgh Sleep Quality Index (PSQI) (test-retest reliability = .81); appetite was assessed by a Visual Analog Scale (α = 0.84); dietary intake was assessed by the Block Kids Food Screener (reliability up to .88); sleep hygiene was assessed using the Adolescent Sleep Hygiene Practice Scale (α = .67).

Results: Poor sleep quality was reported by 39.5% of participants, and 75% of participants had inadequate sleep time (7.33 h). Participants' age significantly correlated with PSQI scores (r = .28, $p < .05$) and BMI (r = .37, $p < .01$). Participants' PSQI scores significantly correlated with sleep hygiene (r = .45, $p = .05$) and appetite (r = .3 3, $p < .01$). Sleep latency significantly correlated with sleep hygiene (r = .32, $p < .05$). Several sleep hygiene factors correlated significantly with the participants' sleep quality, quantity and latency scores and dietary intakes.

Conclusion: These findings suggest that changes in sleep hygiene practices may improve adolescent sleep quality and quantity as well as appetite and dietary intake.

Keywords

sleep, appetite, weight, adolescents<workforce

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Introduction/Background

The 2017–2018 National Health and Nutrition Examination Survey indicated 19.3% obese U.S. youth aged 2–19 years, and 16.1% overweight adolescents with 6.1% severely obese adolescents (Fryar et al., 2020). Some behaviors associated with excess weight gain include eating high-calorie, low-nutrient foods and beverages and inconsistent sleep times and routines (Centers for Disease Control [CDC], 2021). The epidemic of adolescent obesity is concurrent with an increase in sleep disturbances and deprivation (He et al., 2015). Therefore, the association between sleep disturbances and adolescent obesity may be bidirectional (Bruce et al., 2019).

Adolescents may experience decreased sleep for a variety of reasons including work, family, hormones, stress, or cultural factors (CDC, 2021). Research has suggested that sleep quality, or self-reported data on how well an individual sleeps, is essential and may have more of an effect on physiological and behavioral factors than sleep quantity, or the number of hours an individual sleeps (Fatima et al., 2016; Hayes et al., 2018). Sleep hygiene practices, or sleep routines, may also influence sleep quality and quantity. Good sleep hygiene practices consist of elements such as limiting caffeine, consistent sleep and wake times, lack of screen time prior to sleep, and limiting environmental factors such as noise (Shimura et al., 2019). Sleep loss, either from poor sleep quality, decreased quantity, or poor sleep practices, may affect adolescents in numerous ways through a variety of biological and behavioral pathways (Fatima et al., 2016),

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and poor sleep practices have been associated with weight gain in adolescents (Hayes et al., 2018; He et al., 2015). While sleep quality, quantity, and latency (time needed to fall asleep) may influence adolescent obesity, sleep has received considerably less research attention than other modifiable behaviors such as nutrition and physical activity in maintaining ideal body weight (Chaput & Dutil, 2016; He et al., 2015).

Review of Literature

Sleep Factors

Adolescents are recommended to sleep for 8 to 10 h per night; however, over two-thirds of high school students in the U.S. have reported sleeping less than 8 h on school nights (Wheaton et al., 2016). Decreased sleep quantity has been associated with poor diet quality, and evidence suggests that food intakes may increase during periods of sleep restriction (Goldschmidt et al., 2020). Franckle et al. (2015) noted that students who slept less than 10 h per night consumed higher calorie intakes with more soda and less vegetable intakes in comparison to those who slept the recommended 8–10 h per night. Although studies on adolescents have noted that a lack of sleep quantity was associated with higher body mass index (BMI) levels and poor dietary habits (Chaput, 2016), study results are not consistent (Felso et al., 2017), often due to differing methods of measuring dietary habits.

Emerging research suggests that sleep quality may be just as important as sleep quantity in relation to adolescent obesity (Arora et al., 2018). Research has also noted that sleep disturbances or poor sleep quality has resulted in increased snack consumption resulting in elevated calorie, fat, and carbohydrate intakes (He et al., 2015), lower intake of vegetables, fruits, and increase in obesity, and body fat percentages (Arora et al., 2018). Fatima et al. (2016) also noted that sleep quality had a considerable association to an individual being overweight or obese, and that sleep quality was perhaps independent of sleep duration in overweight and obesity sleep studies. Conversely, Agostini et al. (2018) found no association between poor sleep quality and increased higher calorie food (junk food) consumption.

Sleep hygiene practices (consistent routine) may influence sleep quality and quantity (Shimura et al., 2019), which subsequently could affect dietary intake and overall weight. A review article by Griggs et al. (2020) described several studies evaluating sleep promotion and healthy sleep habits in adolescents. The results indicated that sleep quality improved after good sleep hygiene practices (changes to behavior such as not gaming at bedtime) were implemented.

Purpose

While sleep quantity has been associated with dietary intake, appetite, and body weight levels, less is known about the role of sleep quality and hygiene on these factors. Therefore, the purpose of this study is to examine the effects of sleep factors on appetite, dietary intake, and the body weights of adolescent youth.

Methods

Design

Previous research is limited for a comprehensive approach to sleep quality, quantity, latency, and hygiene in relation to appetite, dietary intake, and BMI levels among adolescents. This prospective correlational study was designed to achieve the aforementioned study purpose.

Question

Does adolescents' sleep quality, sleep quantity, sleep latency, and sleep hygiene have a relationship to appetite, dietary intake, and BMI levels?

Measures

A Fitbit Charge 3 measured sleep quality, quantity, and latency by estimating a combination of movements and heart rate patterns. The Fitbit recorded the following data for this study: (1) sleep quality: the number of minutes slept per night divided by the total length of time spent in bed; (2) sleep quantity: the minutes slept in the five days and nights; (3) sleep latency: the time in minutes for each participant to achieve the transition from wakefulness to sleep. Researchers have found that Fitbits have a sleep/wake sensitivity of 95% when the sensitivity was set for high threshold. Researchers have also found the Fitbit to have an 88.5% of accuracy for total sleep time and efficiency (Lee et al., 2019).

The Pittsburgh Sleep Quality Index (PSQI) is a 19-item self-report Likert-scaled tool used to measure subjective sleep quality. The PSQI scale contains seven component scores with a range of 0 (good sleep efficiency) to 3 (poor sleep efficiency). Summing all seven scores provides a global sleep quality score. PSQI scores have a range of 0–21. A PSQI score of 5 of higher indicated poor sleep quality, and a score of less than 5 indicated good quality sleep. The PSQI has been validated in adolescents with acceptable internal consistency (Cronbach's $\alpha = .72$) and had a good test-retest reliability coefficient of .81 (De la Vega et al., 2015).

An Appetite Visual Analog Scale, which has been shown to relate food intake to feelings of hunger and fullness, was used to assess the adolescent's perceived appetite. The reliability coefficient for this scale was $\alpha = 0.84$ when used with young adult populations (Parker et al., 2004). The participants rated sensations of fullness and hunger by marking a "X" on the horizontal line. The sensations could range from 'not at all 'to 'a great deal' to indicate varying degrees of hunger and appetite related information. The response line of each participant was measured in millimeters with each line for a maximum answer measuring 55 millimeters. Sensations of 'not at all' were measured as a "0" and 'a great deal' measured at the 55-millimeter point.

The Block Kids Food Screener (NutritionQuest, 2019) was used to assess dietary intake. The screener provided information about recent food intake of adolescents. The questionnaire includes 42 items with a food list developed from the National Health and Nutrition Examination Survey database. The Block Kids Food Screener was used with children over 12 years of age and had reliability scores of up to .88 for most nutrients and food groups (Hunsberger et al., 2015). Directions stated to consider everything the participants ate or drank in the past week, including breakfast, lunch, dinner, as well as other times (CDC, 2020a).

The Adolescent Sleep Hygiene Practice Scale, a self-report tool developed for youth over 12 years of age, has 33 items to assess sleep hygiene including questions regarding physiological, cognitive, behavioral, environmental, sleep stability, daytime sleep, substance factors, and sleep routines. The scale scores for the tool range from 1 to 6, with lower scores indicating the poor sleep hygiene behavior is practiced less frequently. Therefore, higher sleep hygiene scores indicate poor sleep hygiene practices are practiced more frequently. The internal consistency of the scale was reported as $\alpha = .84$; and subscale alphas were physiological $\alpha = .60$; behavioral $\alpha = .62$; cognitive $\alpha = .81$; environment $\alpha = .61$; sleep stability $\alpha = .68$; daytime sleep $\alpha = .68$. This scale also demonstrated acceptable internal consistency when used in adolescents, Cronbach's $\alpha = .67$ (de Bruin et al., 2014).

Sample

Eligible participants included both male and female adolescents recruited through upper midwestern religious groups of all denominations in the U.S. As this study took place during the height of the pandemic, schools were not in session; thus, the target population was accessible through churches.

Inclusion Criteria

Inclusion criteria included participants who: (1) had the ability to read and understand English at a 5th grade level (to ensure the participants were adequately informed about the research study and the potential risks and benefits of participation, both parents and/or legal guardians, as well as the participant, had to be able to read and understand English), (2) were 12–18 years of age, (3) had given parental and/or legal guardian consent and participant assent, (4) were not taking any medications that may affect sleep, (5) had no medical or psychiatric diagnosis, and (6) adolescents agreed to keep their usual sleep habits at their usual place of sleep.

Power analysis indicated that a sample of 77 adolescents was required to detect a medium correlation effect at 80% power when conducted using G*Power version 3.0.10 (UCLA Institute for Digital Research & Education, 2019). Considering a 10% oversampling to compensate for possible attrition, 84 participants were recruited for this study.

Procedures (Including IRB and Consent)

The University Human Subject's Review Board provided approval for this study. As this study took place during the global COVID-19 pandemic, a 'no contact' study took place, with no in person or virtual contact with the researcher, participants, or parents. As schools were not in session, participants were recruited through ads placed in church bulletins from various denominations in the summer between May 2020 and August 2020. Potential participants and/or their parent(s) responded to the ads. During initial informational discussions by phone, adolescents and parent(s) were informed of the study purpose and procedures, including proper use of the Fitbit, the importance of always wearing the Fitbit for the 5 study days and nights upon receiving the Fitbit, and the importance of completing all surveys at the morning after the 5th night of sleep. Participants and parents were informed to sleep where they spend most of their sleep time and were instructed to keep their usual sleep practices for the duration of the 5-night study. In addition, they were advised to consume their usual dietary intakes for the five days and nights of the study. Additional questions were addressed by the first author. Participants and their parent(s) were informed that participation was voluntary, and that they could withdraw at any time. Before being admitted into the study, participants and/or parent(s) verbally completed a demographic survey and health assessment questionnaire, which was also used as a screening tool to determine inclusion and exclusion criteria. Conditions, such as neurologic, endocrine, cardiac, respiratory, gastrointestinal, urinary, sensory, integumentary, psychiatric, and metabolic disorders that might affect study outcomes were assessed. Medication, allergy, and anthropometric information were also included. Due to the no contact nature of the study, height and weight were self-reported by the participant or parent. Weight and height measures were calculated into BMI using the BMI Percentile Calculator for Child and Teen (CDC, 2020b). The adolescent BMIs were underweight, healthy weight, overweight, and obese according to CDC guidelines (CDC, 2020b). Informed consent and assent forms from parents and participants were signed and returned to the PI by email or postal service. All study materials, including a Fitbit, written instructions, and questionnaires, were mailed to the participants via U.S. Postal Service. Following five days and nights of Fitbit sleep monitoring, participants completed the PSQI, Appetite Visual

Analog Scale, Block Kids Food Screener, and Adolescent Sleep Hygiene Practice Scale. Participants mailed the Fitbits and the completed questionnaires back to the researcher. Participant data were de-identified, including all Fitbit data and questionnaires. As appreciation, a $25.00 gift card was mailed to participants upon completion of the study.

Statistical Analysis

Upon receiving the questionnaires and Fitbits, data were downloaded for analysis. Sleep quality, quantity, and latency data recorded on the Fitbit (Fitbit, 2020) were downloaded and entered in the SPSS Version 26 and confirmed with a double entry procedure. The statistical significance was set at $p < .05$. Frequency and explorative techniques were used to evaluate data for accuracy, missing data, and outliers. Missing data was calculated by default pairwise deletion. All outliers were within two standard deviations.

Frequency distributions were determined for the demographic, anthropometric, health assessment, sleep quantity, quality, latency, and hygiene, appetite indices, dietary intake, and BMI levels. Bivariate correlational analyses were used to examine the relationships of the independent variables (sleep quality, quantity, latency, and sleep hygiene scores) and dependent variables (appetite scores, dietary intake, and BMI indices) of the adolescents.

Results

Sample Characteristics

Fifty-two churches of various denominations were contacted with 37 churches of various denominations agreeing to participate. Church ads for 1–2 weeks and one-time emails were placed in the summer of 2020 with various churches responding at staggered times. A total of 123 potential participants or parents contacted the PI by either phone, text, or email. Four potential participants were excluded for medical reasons. Thirty-two potential participants lacked parental consent; but 84 participants consented to be in the study. Attrition occurred among 8 (11.6%) participants for the following reasons: (1) the Fitbits being returned with no data ($N = 6$), (2) taking prescription sleep medication ($N = 1$), and (3) other medical reasons ($N = 1$). Over the 12-week study, six Fitbits were lost. Therefore, 76 participants' surveys and Fitbits were returned and completed with 5 days and nights of data and used for analysis.

Among study participants, self-reported BMIs ranged from 15.6 to 31.0 with a mean BMI of 22.12 ($SD = 2.95$). Self-reported BMIs indicated two participants (2.6%) were underweight; 3 participants (3.9%) were obese; 17 participants (22.3%) were overweight, and 54 (71.1%) of participants were a healthy weight. See Table 1 for participant demographic information.

Participants self-reported 8.49 ($SD = 1.39$) hours of sleep; Fitbit results revealed 6.09 ($SD = 3.26$) hours of sleep. Participants self-reported 20.45 ($SD = 17.38$) sleep latency minutes; Fitbit results revealed 6.09 ($SD = 3.26$) sleep latency minutes. Of study participants, 88.2% self-reported good sleep quality; Fitbit results revealed 60.5% of participants with good sleep quality. Results from the Fitbit and PSQI sleep data are presented in Table 2.

Using the Visual Analog Scale, appetite scores ranged from 0 to 55; with a mean score of 32.60 (SD = 13.47). No other appetite factors, such as food cravings, increased desire to eat, or hunger pains, had a mean score above the median point. The participants' carbohydrate intakes ranged from 11.39 to 334.95 grams per day; mean carbohydrates consumed per day were 154.38 grams ($SD = 57.57$). The protein intakes ranged from 6.8 to 338.78 grams per day and the mean protein intakes reported per day was

Table 1. Participant Demographic Information.

Demographic	Mean	SD	Range	Frequency of responses	Valid percent
Age	15.22	1.91	(12–18)		
Gender					
Male				31	40.8
Female				45	59.2
Ethnicity					
White, not Hispanic				66	86.8
Native American				3	3.9
Black, not Hispanic				3	3.9
Other				4	5.3
BMI	22.12	2.95	(15.6–31.0)		
Underweight				2	2.6
Healthy Weight				54	71.1
Overweight				17	22.3
Obese				3	3.9

Note. $N = 76$.

Table 2. Fitbit and PSQI Sleep Data.

Variable	Mean	SD	Range	Frequency of responses	Valid percent
Fitbit sleep quality score	87.01	2.55	(70.8–90.8)		
Poor sleep (score < 85)				9	11.8
Adequate (≥85)				67	88.2
Fitbit sleep quantity hours	7.33	.81	(5.74–9.62)		
Less than 8 h				57	75
8–10 h				19	25
Greater than 10 h				0	0
Fitbit sleep latency minutes per night	6.09	3.26	(1–15.8)		
Less than 8 min				56	73.7
8–20 min				20	26.3
Greater than 20 min				0	0
PSQI sleep quality score	3.87	2.19	(0–10)		
<5 (good sleep quality)				46	60.5
≥5 (poor sleep quality)				30	39.5
PSQI reported sleep quantity hours	8.49	1.39	(5–12)		
PSQI reported sleep latency minutes	20.45	17.38	(2–90)		

Note. $N = 76$.

Table 3. Intercorrelations for Demographics, Sleep Quality, Quantity, Latency, Hygiene, and Dietary Intake, Appetite, and BMI.

Variable	Age	Sleep quality (PSQI)	Fitbit sleep quantity	Sleep latency	Sleep hygiene	Appetite scale	Dietary intake	BMI
Age	1							
Sleep quality (PSQI)	.28*	1						
Fitbit sleep quantity	−.07	−.12	1					
Sleep latency	−.09	.12	.11	1				
Sleep hygiene	.19	.45**	−.02	.32*	1			
Appetite scale	.07	.33**	.12	−.08	.15	1		
Dietary intake	.18	.05	.06	−.10	.18	.18	1	
BMI	.37**	.12	.02	−.08	.18	−.03	.02	1

Note. $N = 76$.
Significance: *$p \le .05$; **$p \le .01$; ***$p \le .001$.

81.31 ($SD = 65.53$) grams. The participants' fat intakes ranged from 6.23 to 50.68 grams per day; and the mean fat intakes per day were 20.36 ($SD = 9.36$) grams. The adolescent self-reported dietary energy intakes ranged from 333.32 to 2711.96 kilocalories per day with a mean daily intake of 1126.07 kilocalories ($SD = 485.70$).

Research Question Results

The participants ages were significantly associated with their PSQI scores ($r = .28$, $p < .05$) indicating as age increased, poor sleep quality also increased. Increased age was significantly associated with increased BMI ($r = .37$, $p < .01$). In addition, PSQI scores were associated with increased sleep hygiene scores ($r = .45$, $p = .05$) and increased appetite scale scores ($r = .3\ 3$, $p < .01$); therefore, as poor sleep quality scores increased, poor sleep hygiene practices increased, and appetite scores also increased. Lastly, participants' sleep latency scores were significantly positively associated with higher sleep hygiene scores ($r = .32$, $p < .05$); therefore, as the participants time to fall asleep increased, the participants' sleep hygiene scores, indicating poor sleep practices, also increased. See Table 3.

The participants' physiological sleep hygiene scores were significantly associated with the global PSQI score ($r = .28$, $p < .05$). Therefore, the participants' physiological sleep hygiene factors, such as increased caffeine intake late in the evening, resulted higher global PSQI scores, indicating poor sleep quality. The participants' behavioral sleep hygiene scores were significantly associated with increased global PSQI scores ($r = .36$, $p < .01$), and increased Fitbit mean sleep latency scores ($r = .29$, $p < .05$), thus indicating increased behavioral sleep hygiene scores, such as increased gaming at bedtime, were significantly associated with poorer sleep quality and increased time to fall asleep. The participants' behavioral sleep hygiene scores, or increased gaming at bedtime, were also significantly associated with less sleep minutes ($r = -.28$, $p < .05$). The participants' cognitive sleep hygiene scores were significantly associated with the global PSQI scores ($r = .47$, $p < .01$), and the participants' ages ($r = .27$, $p < .05$). Therefore, as the participants' cognitive sleep hygiene factors, such as worrying, increased, sleep quality decreased. The participants' increased cognitive sleep hygiene factors such as increased worrying at bedtime were also associated with participants' increased ages. The participants' environmental sleep hygiene factors were significantly associated with their global PSQI scores ($r = .23$, $p < .05$), and their total caloric intakes ($r = .31$, $p < .05$); as environmental sleep hygiene factors, such as warm or cold room temperatures increased, the participants' total caloric intakes also increased as well as the global PSQI scores, indicating poor sleep quality. The participants' stability sleep hygiene scores were also associated with sleep latency ($r = .23$, $p < .05$); therefore, as the participants' stability sleep hygiene factors, indicating inconsistent weekend and weekday sleep and wake times, increased, the participants' Fitbit mean sleep latency, or number of minutes that it took the participants to fall asleep, also increased. The participants' daytime sleep hygiene factors were significantly related to their global PSQI scores ($r = .28$, $p < .05$) and the participants' total calorie intakes ($r = .36$, $p < .01$). As the participants' daytime sleep hygiene factors, such as napping increased, the participant's total calorie intake also increased as well as the global PSQI score, indicating poor sleep quality. Finally, the participants' total sleep hygiene factor scores were significantly associated with the global PSQI score ($r = .44$, $p < .01$). As the participants' total sleep hygiene scores increased, indicating increased poor sleep practices, the participants' global PSQI scores also increased. See Table 4 for sleep hygiene correlations and related sleep quality, quantity, and latency measures.

Discussion

This study noted an association between poor sleep hygiene practices and poor sleep quality and longer sleep latency. Specific factors from participants' sleep hygiene scores (physiologic, behavior, cognitive, environment, daytime sleep, and the overall poor sleep hygiene practices) were associated with poor sleep quality. Behavioral sleep hygiene factors were also associated with poor sleep quantity and longer sleep latency. Daytime sleep was associated with poor sleep quality as well as dietary intake.

Anthropometrics and Sleep Data of the Adolescents

Only 26.4% of the participants in this study self-reported a height and weight that yielded a BMI meeting criterion for being overweight. This was a lower percentage of overweight or obese adolescent youth as compared to the national average of 33% (Fryar et al., 2020). As noted in a previous study, self-reporting by youth may contribute to over reported heights and under reported weights with subsequent miscalculation of BMIs for 4%–8% of participants (Opichka & Smith, 2017). The participant's age in this study was significantly associated with their BMI's. As participant ages increased, BMIs increased. These findings are consistent with information on adolescent overweight and obesity rates in the U.S. as well as previous research (Grander et al., 2015). According to the CDC (2021), 20.3% of 6–11-year-old youth are obese as compared to 21.1% of youth ages 12–19 years. Research also suggests that older adolescents spend more time away from home; hence, fewer family meals and more fast-food meals (Kracht et al., 2019), and older adolescents tend to spend more time gaming and less time engaging in physical activity (Quante et al., 2019a).

The adolescents in this study slept an average of 7.33 h per night; therefore, 77.6% of the adolescents slept less than the recommended amount of sleep per night. The findings from this study coincide with previous studies which note that adolescents average approximately 7 h of sleep each night (Wheaton et al., 2016). This study took place in the summer months during a pandemic; and research has noted that adolescents sleep even less in the summer months (Quante et al., 2019b) and would benefit from regulated summer sleep schedules (Brazendale et al., 2017).

According to the calculated PSQI, 60.5% of the participants had good sleep quality; and the Fitbit data showed 88.2% of participants had a good sleep quality. The PSQI data showed the participants had a mean of 8.49 h of sleep

Table 4. Intercorrelations for Sleep Hygiene Factors and Demographics, Sleep Quality, Quantity, Latency, Dietary Intake, Appetite, and BMI.

Variable	Physiologic	Behavior	Cognitive	Environment	Stability	Daytime	Substance	Total
Age	.07	.14	.27*	.11	−.06	.15	−.19	.21
Sleep quality (PSQI)	.28*	.36**	.47**	.23*	.13	.28*	.06	.44**
Fitbit sleep quantity	.09	−.28*	−.11	.02	.03	.49	−.21	−.06
Sleep latency	.06	.29*	.07	.15	.23*	.05	.01	.19
Appetite scale	.17	−.02	.21	.09	.13	−.02	−.03	.15
Dietary intake (kcal)	.12	.03	.13	.31*	.22	.36**	−.03	.22
BMI	−.05	.14	.09	.06	.21	.01	−.13	.14

Note. $N = 76$.
Significance: *$p \le .05$; **$p \le .01$; ***$p \le .001$.

each night; however, the Fitbit data showed the participants experienced a mean sleep quantity of 7.33 h per night. The PSQI data noted the participants self-reported a mean sleep latency of 20.45 min; however, the Fitbit data revealed the participants had a mean sleep latency of 6.09 min. These inconsistencies are not uncommon in studies with self-reported data (such as the PSQI and dietary intake) from adolescents since these individuals tend to report their 'best selves' (Opichka & Smith, 2017). The sleep latency captured by the Fitbit showed that 73.7% of the participants had short sleep latency, or less than 8 min to fall asleep, and no participants had a long sleep latency. These findings contradict those of other studies which indicate that 6%–37% of adolescents report problems related to prolonged sleep latency (Wheaton et al., 2016).

Relationships among Demographics, Sleep, Appetite, Dietary Intake, and BMI

As the participant's age in this study increased, the global PSQI score, indicating poor sleep quality, also increased. Research has suggested that use of electronics at bedtime can affect sleep quality, and older adolescents engage in more electronic use at bedtime as compared to younger adolescents (Caumo et al., 2020; Quante et al., 2019a). Overall, short sleep quantity has been associated with an increased risk of adolescent obesity (Chaput, 2016). However, these results are not consistent with this study results. In a systematic review of 17 studies, 11 studies revealed an association between short sleep and obesity; however, six of those studies found no association between adolescent sleep quantity and obesity (Felso et al., 2017).

Correlation results indicated that sleep quantity, latency, and hygiene scores were not statistically associated $p > .05$ with the appetite scores of the participants. A higher global PSQI sleep quality score (poor sleep quality) was correlated with an increased mean appetite score ($r = .33$, $p < .01$) of the adolescents; hence, improving sleep quality may be used to decrease appetite. These findings are not consistent with adolescent studies that have found no association between eating control and sleep quality (Goldschmidt et al., 2020; Kracht et al., 2019). Broussard et al. (2016) noted the importance of appetite-regulating hormones, ghrelin (increases hunger), and leptin (decreases hunger), as well as the relationship between fluctuations in these hormones and sleep. Insufficient sleep for any reason, such as poor sleep quality, stresses the body in ways that science continues to work to explain (Chaput & Dutil, 2016).

No associations between the global PSQI and reported dietary intake were noted in this study. These findings are not consistent with a study that noted an increase in calories, fat, and carbohydrate consumption was associated with poor sleep quality (He et al., 2015). As noted, the self-reported dietary intake by the participants in this study was low. In addition, no associations between the global PSQI and BMI were noted in this study. As research has suggested sleep quality may be just as important as sleep quantity for adolescent obesity (Arora et al., 2018), these results were unexpected. Since most participants in this study had a calculated mean global PSQI of 3.87, with greater than five indicating poor sleep quality, the participants self-reported good sleep quality, which may partially explain this lack of association. Research has hypothesized that adolescents with less sleep will be less active; hence, there will be less demand for food (Felso et al., 2017). This hypothesis could help explain the decreased caloric intakes in this study. The participants had low sleep hours ($N = 7.33$) possibly resulting in increased tiredness with less physical activity and less demand for food. This study found no association between sleep quantity and dietary intake or BMI. These findings contrast with studies that have indicated increased BMI's to be associated with shorter sleep duration (Arora et al., 2018).

Relationships among Adolescents' Sleep Hygiene Scores

The overall Sleep Hygiene scores in this study were significantly associated with the global PSQI scores of the adolescents. As the mean Sleep Hygiene scores increased (poor sleep hygiene practices more frequent), the participants' scores on the PSQI increased, indicating poor sleep quality. No associations were noted between the reported sleep hygiene practices in this study and appetite scores, dietary intake, and BMI levels among the adolescent participants. As sleep patterns disrupt the balance of physiological and hormonal responses within the body (Price, 2016), this lack of association was surprising.

In this study, as the participant's Sleep Hygiene scores increased, the sleep latency time also increased; thus, suggesting that poor sleep hygiene practices resulted in an individual taking more time to fall asleep. In previous studies, activities such as gaming or late-night activities have been shown to increase sleep latency times (Caumo et al., 2020). Research indicated that adolescents are aware of the importance of a good sleep routine; however, adolescents also reported social pressures tend to defer or waive the routine; furthermore, bedtime routines are usually instigated by parents (Godsell & White, 2019); hence, the importance of parental involvement in an adolescent's health remains. Interventions focused on interrupting one element of the poor sleep hygiene practice could potentially affect numerous other areas and promote positive sleep hygiene and ultimately better, longer, adequate sleep (Arora & Taheri, 2017).

Strengths and Limitations

Having participants self-report heights, weights, and questionnaires were limitations of this study; however, due to the 'no-contact' nature of the study, heights and weights could not be verified. Respondents may be embarrassed to reveal private information; thus, self-reported data responses may be exaggerated. As this study was 'no contact', the researcher had no way to confirm who wore the Fitbits or completed the surveys or when the surveys were completed. The summer sleep schedule posed a unique situation as a lack of structure was apparent for several of the participants; therefore, possibly not only affecting their sleep schedules, but also their eating schedules (Quante et al., 2019b). Since this study took place during a global pandemic stress levels in families and participants were possibly elevated and affecting data responses and outcomes. Since school was not in session, participants may have missed breakfast and/or lunch as part of their usual meal and food intake routines. The use of churches as a venue for recruitment limits the generalizability of the results and may explain the lower rate of overweight and obese adolescents as well as the lack of racial and ethnic diversity for this study.

Using the Block Kids Food Screener to obtain a more comprehensive view of adolescent dietary intake was a strength of this study. Examining sleep factors not only by self-reported data, such as the PSQI and Adolescent Sleep Hygiene Practice Scale, but also by more objective data such as the Fitbit were also strengths of this study.

Implications for Practice

Previous studies have noted improvement in adolescent sleep quality (Arora & Taheri, 2017) as well as improvement with total sleep times following sleep interventions. Given the noted health benefits of sleep, a sleep intervention study geared towards improved sleep for improved overall health or weight loss would be indicated. Intervention areas such as later wake times, earlier bedtimes, and improved sleep practices are warranted. In addition, school programs on sleep education have been discussed. The bidirectional relationship between sleep and health increases the complexity of the relationship. Early, and frequent education on the benefits of sleep along with sleep interventions are essential. Nursing research has suggested that health professionals should routinely question sleep and promote sleep during routine physical examinations, but little evidence exists to suggest that this is practiced (Chaput, 2016); thus, health professionals implementing routine questions and promotion of sleep to improve adolescent health and weight should be explored.

Conclusions

Although studies have noted that sleep factors influence adolescent obesity, sleep has received considerably less research attention than other modifiable behaviors such as nutrition and physical activity (Chaput & Dutil, 2016; He et al., 2015). This study contributed to current literature on sleep in adolescents. This study found that as poor sleep hygiene practices increased, poor sleep quality scores and appetite scores also increased. In addition, several sleep hygiene factors correlated significantly with the participants' sleep quality, quantity, and latency scores and dietary intakes. The importance of sleep is acknowledged; however, school, life, and the balance of sleep is not always a priority, particularly for adolescents (Price, 2016), and adolescents often view sleep as a waste of time (Chaput & Dutil, 2016). In conclusion, changes in sleep hygiene practices may improve adolescent sleep quality and quantity as well as appetite and dietary intake. Additional research is needed to better understand sleep practices and effectiveness of interventions to improve sleep amongst adolescents. Thus, promotion of better sleep is an important nursing goal when seeking to optimize adolescent health.

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