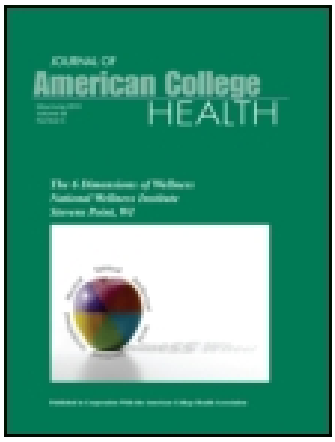

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Sleep Quality and Body Mass Index in College Students: The Role of Sleep Disturbances

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Major Article

Sleep Quality and Body Mass Index in College Students: The Role of Sleep Disturbances

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Abstract. Objective: Obesity and its comorbidities have emerged as a leading public health concern. The aim of this study was to explore the relationship between body mass index (BMI) and sleep patterns, including duration and disturbances. **Methods**: A convenience sample of 515 college students completed an online survey consisting of the Pittsburgh Sleep Quality Index (PSQI), and self-reported height and weight to calculate BMI. Univariate and multivariate logistic regression analyses were performed using components of the PSQI as predictors of overweight (BMI $\geq$ 25). **Results**: One-third of the participants had BMI $\geq$ 25, and 51% were poor-quality sleepers (PSQI $>$ 5). Controlling for age and sex, only sleep disturbances were associated with overweight (odds ratio = 1.66, 95% confidence interval [1.08, 2.57]). **Conclusions**: Sleep disturbances, rather than sleep duration, predicted overweight among young adults; this is consistent with the most recent evidence in the literature. These findings support expanding the scope of wellness programs to promote healthy sleep among students.

Keywords: body mass index (BMI), college students, habits, overweight, prevalence, sleep, sleep disturbance, sleep duration, sleep quality

College is a time marked by change, when many students experience autonomy and freedom from direct supervision for the first time, greater academic and social pressures, and erratic schedules. Major changes in lifestyle, such as unbalanced diets, alcohol intake, and lack of sleep, can be detrimental to the students' well-being.[1–3]

The prevalence of overweight and obesity, measured as body mass index (BMI $\geq$ 25), has increased dramatically over the past decade.[4–8] For example, in 2008, the prevalence of obesity (ie, BMI $\geq$ 30) among US adults 20 years or older was 26.7%, 6.9% greater than the estimate for 2000.[7] Furthermore, the combined estimated prevalence of overweight and obesity (BMI $\geq$ 25) for 2000 among adults was 68%.[7] This increase in BMI has been observed across all ages, with overweight and obesity in children and adolescents reaching 31.8% in 2010.[8] Similarly elevated rates have been estimated among college students, with over one third reporting BMI $\geq$ 25.[9–11]

Concurrent with the increase in overweight and obesity among the US population, there has been a change in sleeping patterns.[12,13] Insomnia and sleep difficulties have been widely studied in the general population.[14] Research shows that, on average, adults sleep less than the recommended 8 hours per night[9,15] Furthermore, the percentage of adults sleeping 6 hours or less each night increased from 22% in 1985 to nearly 28% in 2007.[16] Unfortunately, as Lund and colleagues[17] point out, research describing the changes in the sleeping patterns and needs of college-aged adolescents is limited. Most of the studies examining sleep patterns among college students have focused on the relationship between sleep habits and academic performance,[18–20] and mental health problems (ie, stress, depression, and suicidal ideation).[21–24] All the studies concede that college students experience frequent and sometimes severe sleep problems that negatively impact their health and well-being.[17–24] Overall, estimates of sleeping problems/disturbances among college students ranged between 13.8% and 68.6% depending on the definition and measurement used.[20,21] In a 2012 national survey of college students (N = 99,066), 26.4% reported sleep difficulties during the previous 12 months as being "traumatic or very difficult to handle," and 57.1% of the sample reported having enough sleep to feel rested on fewer than 4 days a week.[9] In a study examining sleep/wake patterns over the transition from high school to college, Carskadon and Davis[25] found a significant reduction in the number of hours of sleep, as well as delay in onset of nighttime sleep, as students transition to college. In

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addition to the amount of sleep, the quality of sleep seems to be changing and impacting the well-being of college students.[17,19,26] Using the Pittsburgh Sleep Quality Index (PSQI), Lund et al identified 63.9% of college students in their sample ($N = 1,125$) as poor-quality sleepers, those who experience restricted total sleep, erratic sleep schedules, and/or sleep disturbances.[17] Along the same line, Gaultney[19] found that 27% of college students ($N = 1,845$) were at risk for sleep disorders likely to disturb sleep. When Pilcher and co-investigators[26] looked at the impact of sleep quantity and quality on the health of college students, they found sleep quality to be a better predictor than sleep quantity of several measures of health, including health complaints, depression, fatigue, and sleepiness. Results from these studies reveal an unquestionable problem of insufficient and poor-quality sleep among adolescents and young adults, as well as growing levels of sleep dissatisfaction.[27] The number of people reporting poor-quality sleep seems to be reaching "epidemic" proportions, with 73% of college students reporting occasional sleep problems that include insufficient sleep, difficulty falling asleep, sleep disturbances, and excessive daytime sleepiness.[20,28]

Although it is well established that an imbalance between caloric intake and physical activity are key factors responsible for the current obesity problem,[29,30] there is emerging evidence suggesting that other factors may be important contributors to the obesity problem.[30–32] One of the factors in question is sleep.[29–59]

Unlike other mammals, humans have consolidated sleep in periods of 7–9 hours. It has been shown that during normal sleep, glucose utilization and glucose production drop simultaneously during the first part of the night and raise simultaneously during the predawn hours.[60–62] Scheen et al found, however, that when subjects are maintained at rest but sleep deprived, the pattern of glucose utilization is altered, and glucose levels become constant throughout the night.[60] Following Scheen et al's landmark study,[60] a number of studies have shown that the metabolic changes associated with interference of normal sleep patterns may contribute to the development of obesity, cardiovascular disease, insulin resistance, and diabetes.[33–41,46,56,58–65] Cross-sectional research evaluating the relationship between obesity and sleeping patterns suggests a negative correlation between overweight/obesity and/or related metabolic markers, and sleep duration among children,[42–49] adolescents,[40,49–52] and adults.[53–59] Moreover, research studies exploring the association between sleep and BMI among adolescents suggest that the relationship might be multilayered.[66–68] For example, in a sample of American adolescents,[67] researchers found that the likelihood of obesity increased by 80% for each hour of lost sleep. Although sleep disturbances were not directly related to obesity; they were negatively correlated with level of physical activity, suggesting that sleep disturbances could indirectly impact body weight through a reduction in physical activity. On the other hand, no relationship between level of physical activity and sleep duration was found. Similarly, in a study of European adolescents, investigators found that short sleep duration was associated with obesity, increased food intake, and sedentary habits, but not with level of physical activity.[68] But not all the emerging evidence supports a relationship between short sleep duration and increased BMI; some studies have found no association between sleep duration and BMI,[69–73] whereas others have found a U-shaped relationship with the odds rising for those with shorter and longer sleep durations.[73–76] In many studies, however, the potential effects of sleep loss cannot be distinguished from the effects of sleep disturbances[77]; more recent laboratory studies have solved this problem by measuring metabolic changes while controlling for sleep duration and sleep disturbances.[36,37,41] For example, Tasali and collaborators[41] found that in young healthy adults, suppression of deep non–rapid eye movement (REM) sleep without concomitant changes in total sleep time resulted in decreases in insulin sensitivity, which lead to reduced glucose tolerance and increased risk of diabetes.[41] Additional evidence supporting the hypothesis that sleep fragmentation, independent of sleep duration, can alter glucose homeostasis was obtained by Stamatakis and Punjabi.[36] In their study with healthy adults, total sleep time was held within normal range (7–7.5 hours) while inducing fragmented sleep with auditory and mechanical stimuli across all stages of sleep. The study showed a reduction in insulin sensitivity and glucose effectiveness associated with sleep fragmentation, supporting the hypothesis regarding the negative effects of sleep disturbances on glucose metabolism. These findings are particularly relevant to college students due to the nature of *college culture*. Although there might be significant variations from campus to campus, college culture is characterized by social arrangements and behavior practices that negatively affect students' sleep, including communal living, frequent parties and drinking, poor time management, and high levels of stress and work.[78–80]

The present study was designed to evaluate the relationship between parameters of sleep, including sleep duration and disturbance, and BMI. Based on the evidence that sleep fragmentation alters metabolic functions involved in appetite control, our hypothesis was that sleep disturbances, rather than sleep duration, would be associated with BMI $\geq$ 25 among college students attending a public university.

METHODS

Participants

The sample consisted of 536 college students from a large university in the southwestern United States who completed the study to satisfy a class requirement. Data were collected between October 22, 2010, and May 6, 2011. Twenty-one nontraditional students over 34 years of age were excluded, yielding a sample of 515 participants between 18 and 34 years, mostly females (73.2%). The study was approved by the University Committee on Human Subjects. No personal identifiers were collected

and, after reading a description of the study, participants gave passive consent by proceeding to complete the survey.

Materials

The PSQI was utilized to assess sleeping patterns. The PSQI is a standardized, quantitative measure of sleep quality with demonstrated high levels of consistency, reliability, and validity.[81–84] It is composed of 19 self-reported questions grouped into 7 component scores. The 7 components were scored following the algorithm proposed by Buysse et al.[81] Accordingly, each component score is weighted equally on a 0–3 scale, with lower scores indicating no problems and higher scores indicating progressively worsening problems as follows: (1) subjective sleep quality (very good to very bad), (2) sleep latency ($\leq$ 15 to $>$ 60 minutes), (3) sleep duration ($\geq$ 7 to $<$ 5 hours), (4) sleep efficiency ($\geq$ 85% to $<$ 65% hours sleep/hours in bed), (5) sleep disturbances (not during the past month to $\geq$ 3 times per week), (6) use of sleeping medications (none to $\geq$ 3 times a week), and (7) daytime dysfunction (not a problem to a very big problem). The 7 component scores were added to yield a global score ranging from 0 to 21 that was treated as a continuous variable. The reliability of the PSQI global score was satisfactory in our sample, yielding a Cronbach's α of .702. For clinical use, Buysse and colleagues proposed a cutoff score of $\leq$ 5 to indicate good quality sleep and $>$ 5 to indicate poor sleep quality.[81] Overweight and obesity were defined as recommended by the Clinical Guidelines for the Identification, Evaluation and Treatment of Overweight and Obesity in adults.[85] BMI was calculated using self-reported height and weight as: weight (lb)/[height (in)]^2 $\times$ 703. A dichotomous variable was created using BMI $\geq$ 25 as cutoff to identify those exceeding the recommended weight (overweight and obese). Self-reported and clinically measured height and weight have been found to be highly correlated, but with an underreporting bias of about 1 unit.[86,87] Although self-reported BMI is not recommended as a clinical tool, it is considered an important health surveillance tool that is valid for epidemiologic research,[87] in particular with younger adults.[88] Specifically, self-reported height and weight are currently used in the National Health and Nutrition Examination Survey to estimate rates of overweight and obesity for the US population.[88]

Procedure

All data were collected online. Participants were directed to complete the College Student's Health Profile Questionnaire. This survey consisted of questions addressing demographics, self-reported height and weight, and several standardized health-related measures, including the PSQI. Seventy-three students missed at least 1 question from the PSQI and were excluded from some analyses. As a result, the number of subjects included in the calculations of the descriptive estimates varied, ranging from 442 in the calculations of the PSQI global score and 498–506 subjects included in the calculations of all other components of the PSQI. Descriptive statistics, chi-square, and logistic regression analyses were performed using IBM SPSS 20 (IBM SPSS Statistics for Windows, version 20.0; IBM Corp., Armonk, New York). We use the odds ratio (OR) and 95% confidence interval (CI) to show the estimated effect of the PSQI global score and each one of the 7 components on BMI; ORs greater than 1 indicate increased risk.

RESULTS

Participants were mostly females (73.2%), with a mean age of 21.68 years ($SD = 3.49$). Most participants identified themselves as Caucasian (63.9%) or Hispanic (18.4%). Over 30% (33.3%) of the participants had a BMI $\geq$ 25. Of these participants, 102 were classified as overweight (BMI = 25.0–29.9) and 67 as obese (BMI $\geq$ 30). BMI rates varied by sex, with more males reporting BMI $\geq$ 25 than females (41.9% vs 30.1%; $p < .05$).

Sleep Pattern

Results of the PSQI are presented in Table 1. The mean global PSQI score was 5.9 $\pm$ 2.8 ($Mdn = 5.78$, range = 0.89–16.36), with 51% of the participants experiencing poor sleep quality ($>$ 5) and 19% reporting extremely poor sleep quality ($\geq$ 8). However, when asked to subjectively rate their quality of sleep, only 30.7% rated it as fairly bad or very bad. The most important components contributing to poor sleep quality included restricted sleep time, long sleep latency, poor sleep efficiency, and daytime dysfunction. Overall, most students reported restricted sleep; only 30.11% of students reported the recommended 8 or more hours of sleep, and 40.6% reported 6 hours or less per night ($M = 6.8$, $SD = 1.39$). Almost 40% of participants (39.6%) reported taking more than 30 minutes to fall asleep (M = 29.5, $SD = 42$ minutes), with one-third (33.07%) reporting sleep efficiency below 85% (ie, percent of the time asleep from the moment they go to bed until they get up). Perhaps as a consequence of the poor quality of sleep, 27.9% of the students reported daytime dysfunction at least once a week. Nearly one-fourth of the students (24.3%) reported taking sleep medication in the previous month, and 13.2% reported taking sleep medication at least once a week. Most participants reported some sleep disturbances (93.0%), and 16.1% were classified as experiencing high levels of sleep disturbances according to the PSQI algorithm (Table 1). Some of the students' responses to specific questions on the PSQI are worth mentioning (Table 1): 55.03% reported *waking up in the middle of night or early morning* at least once a week, 32.7% reported *lacking enthusiasm to get things done* at least once a week, and 28% reported *experiencing bad dreams* at least once a week. Of the students who reported "other" reasons for sleep disturbances at least once a month, the most common was "stress-related" (eg, stress, racing thoughts, worried).

TABLE 1. Frequency Distributions of Sleep Quality and Sleep Disturbance Scores as Measured by Components and Individual Questions of the PSQI

Component	Question	Component score 0	1	2	3
1	Rate overall quality of sleep	Very good	*Fairly good*	*Fairly bad*	*Very bad*
		11.4%	57.9%	27.6%	3.1%
2	How long does it take you to fall sleep	*≤15 minutes*	*16–30 minutes*	*31–60 minutes*	*>60 minutes*
		24.4%	36.0%	25.0%	14.6%
3	Hours do you actually sleep	*≥7 hours*	*6 hours*	*5 hours*	*<5 hours*
		58.6%	25.6%	10.1%	4.3%
4	% Time in bed sleeping	*>85%*	*75–84%*	*65–74%*	*<65%*
		67.0%	20.8%	7.7%	4.6%
5	Overall sleep disturbances score	*0*	*1–9*	*10–18*	*19—27*
		6.8%	77.1%	15.1%	1.0%
6	Taken medicine to aid in sleep?	*Not in past month*	*<Once a week*	*1–2 times a week*	*≥3 times a week*
		75.7%	11.1%	5.3%	7.9%
7	Daytime dysfunction	*0*	*1–2*	*3–4*	*5—6*
		18.3%	54.9%	23.7%	3.2%
	Individual questions				
	Q5. How often have you had trouble sleeping because:	*Not in past month*	*<Once a week*	*1–2 times a week*	*≥3 times a week*
	Q5b. Wake up middle of night/ early AM	19.1%	25.8%	25.8%	29.2%
	Q5c. Wake up to use the bathroom	36.4%	29.2%	14.8%	19.5%
	Q5d. Cannot breathe comfortably	77.8%	13.0%	5.5%	3.7%
	Q5e. Cough or snore loudly	80.4%	11.4%	4.7%	3.4%
	Q5f. Feel too cold	50.4%	23.0%	18.3%	8.3%
	Q5g Feel too hot	46.6%	24.6%	19.3%	9.3%
	Q5h. Have bad dreams	43.1%	28.7%	20.7%	7.5%
	Q5i. Have pain	64.1%	17.8%	10.7%	7.5%
	Q5j. Other reasons	68.7%	9.1%	10.2%	12.0%
	Q8. Had trouble staying awake during social activities?	63.4%	22.8%	10.5%	3.2%
	Q9. Problem getting enthusiasm	20.1%	47.2%	23.4%	9.3%

Note. PSQI = Pittsburgh Sleep Quality Index.

Relationship Between BMI and PSQI

Univariate logistic regression analyses were performed to examine the relationship between increased BMI (≥ 25) and PSQI global score, as well as the 7 individual components as predictor variables. Table 2 shows that, of all the possible components entered, only the sleep disturbance component was a significant ($p < .05$) predictor of overweight/obesity (BMI ≥ 25). After controlling for age and

TABLE 2. Univariate Logistic Regression With Overweight/Obesity (BMI ≥ 25) as Outcome Variable and Sleep Quality, PSQI Global Score, and the 7 Components of the PSQI as Predictor Variables

PSQI components (4-point scale, range = 0–3)	OR	95% CI	*p* value
Poor sleep quality (PSQI >5)	1.106	0.740, 1.654	0.623
PSQI global score (0–21)	1.029	0.958, 1.105	0.436
1. Subjective quality	1.060	0.806, 1.394	0.675
2. Latency	1.000	0.830, 1.205	1.000
3. Duration	1.151	0.924, 1.435	0.209
4. Efficiency	0.999	0.784, 1.274	0.997
5. Disturbances	1.701	1.164, 2.485	0.006
6. Medication	0.979	0.797, 1.324	0.838
7. Daytime dysfunction	1.026	0.795, 1.324	0.846

Note. BMI = body mass index; PSQI = Pittsburgh Sleep Quality Index; OR = odds ratio; CI = confidence interval.

sex, a multivariate logistic regression analysis revealed a 66% increase in the probability of being overweight as sleep disturbances increased (OR = 1.66, 95% CI [1.08, 2.57]). However, there was a small interaction effect between age and sleep disturbance (OR = 1.03, 95% CI [1.00, 1.05]), suggesting that sleep disturbances may become more serious with age (3% increase per year of age), even within the narrow range of the sample.

COMMENT

Conclusions

Although it is well established that an imbalance between caloric intake and physical activity are key factors responsible for the current obesity problem,[29,30] there is growing interest in studying the environmental and behavioral factors that may be contributing to the problem.[31,32] Emerging evidence suggests an association between body weight and problems in sleeping patterns, particularly its duration and quality.[39,42,47–51,54,57,67,68] Furthermore, research studies exploring the association between sleep and BMI among adolescents suggest that the relationship is complex.[66–68] As discussed by Pilcher et al,[26] in many studies sleep duration and disturbances are combined to estimate sleep quality, making it difficult to evaluate their independent effects on BMI. We used the PSQI global score and its 7 individual components (ie, subjective quality, latency, duration, efficiency, disturbances, medication, and daytime dysfunction) to examine the sleep patterns of college students and to evaluate the relationship between the different components of sleep quality and overweight/obesity. Overall, the data revealed a major problem with the sleep pattern of college students. In addition to short sleep duration, college students experienced fragmented sleep, as well as poor sleep quality as measured by the PSQI. Consistent with the hypothesis that sleep fragmentation may be responsible for increased body weight, our results show that after controlling for age and sex, sleep duration was not a significant predictor for BMI, but sleep disturbances were. Probing further, we also found an interaction between sleep disturbances and age suggesting that as students age, sleep disturbances may have a larger effect on BMI. That is, regardless of the amount of time spent sleeping, sleep disruptions may have a significant influence on weight, and this influence may be augmented by age. These findings are consistent with the hypothesis that sleep restrictions alter the circulating levels of metabolically relevant hormones such as leptin and ghrelin, resulting in alterations of glucose homeostasis and appetite regulation.[6,33–37,40,41] On the other hand, the interaction effect of age and sleep disturbances is congruent with evidence showing age-related changes in sleep timing and structure.[89–91] In a meta-analysis conducted to derive normative data on the effects of aging on sleep, Ohayon et al[92] found that as we age, total sleep time, sleep efficiency, percentage of slow-wave sleep, percentage of REM sleep, and REM latency significantly decrease, whereas sleep latency and wake after sleep onset significantly increase.

Our results suggest a need to attend to the quality of sleep, particularly in young adults. Furthermore, there is evidence that sleeping problems for many adult insomniacs begins early in life.[93–95] In addition to effects on grades and daily activities, poor-quality sleep puts college students at risk for health problems of long-lasting consequences, including excessive body weight. In turn, excessive body weight brings with it an increased risk for diabetes, cardiovascular disease, and some cancers. For example, in a recent meta-analysis, researchers identified 18 comorbidities associated with excess body weight. Of these, type 2 diabetes was estimated to have the greatest burden, followed by cardiovascular diseases and several forms of cancer (eg, esophageal, colon, endometrial, gall bladder, and breast cancers).[96] Excess body weight has also been associated with nonfatal disorders that impact the patients' quality of life, such as osteoarthritis and asthma.[97] In the near future, the increased morbidity associated with excess body weight may have a negative impact on life expectancy, as suggested by Calle et al.[98] Calle et al's study of more than 1 million American adults found that among people who never smoked, heavier men and women had a higher mortality risk from all causes, whereas those with a BMI < 25 had the lowest mortality risk.[95] Estimates based on current trends in the age of onset of excess body weight suggest that chronic conditions and disabilities associated with excess weight may increase dramatically in the younger generations, with negative consequences to their quality of life and life expectancy.[99]

A large proportion of college students experience sleep disturbances. This study shows that sleep disturbances are significantly linked to overweight and obesity. Our findings suggest the need to expand efforts of wellness programs and health initiatives to promote healthy sleeping habits among college students. These initiatives ought to also include educational components supporting healthy eating and physical activity among college students, emphasizing their intricate relationship, as well as the health benefits associated with undisturbed sleep.

Limitations

Several limitations should be noted. The current study was designed as an exploratory study based on relatively limited evidence showing that disruption of sleep continuity can produce increased body weight by altering metabolic functions. However, our analysis was based on self-reported data, including height and weight, rather than direct measurements. In addition, we did not measure students' level of physical activity or dietary intake. The characteristics of the study participants, college students, limit the generalizability of our findings to the general population of college-aged adults. The cross-sectional nature of the study precludes conclusions about the causal

relationship between sleep disturbances and BMI. Finally, we cannot rule out the possibility that our findings are due to other extraneous variables not measured, or to chance. Future studies would benefit from collecting multiple data points prospectively, using objective measurements of obesity and sleep, and exploring potential causal mechanisms between these variables.

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CONFLICT OF INTEREST DISCLOSURE

The authors have no conflicts of interest to report. The authors confirm that the research presented in this article met the ethical guidelines, including adherence to the legal requirements, of the United States and received approval from the Institutional Review Board of Arizona State University.

NOTE

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