

Self-Reported Sleep Duration and Weight-Control Strategies Among US High School Students

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Study Objective: To determine if self-reported sleep duration was associated with weight-control behaviors among US high school students.

Design: National Youth Risk Behavior Survey.

Setting: United States, 2007.

Participants: US high school students (N = 12,087).

Measurements: Students were asked if they had engaged in several weight-control behaviors during the 30 days before the survey to lose or maintain weight. Self-reported sleep duration categories included very short (≤ 5 h), short (6 or 7 h), referent moderate (8 or 9 h), and long (≥ 10 h). Sex-specific logistic regression analyses with race/ethnicity, grade, and body mass index category as covariates were conducted using SUDAAN to account for complex study design.

Results: Approximately half the students reported short sleep duration (51.8% of males and 54.3% of females), whereas very short sleep durations were reported by another 14.8% of males and 16.9% of females. Among males, very short sleepers were significantly ($P < 0.05$) more likely than moderate sleepers to report dieting (36.3% versus 26.1%), fasting (14.2% versus 4.3%), and purging (4.3% versus 1.1%) to lose or maintain weight during the 30 days before the survey. Among females, the respective very short, short, and moderate sleepers varied ($P < 0.05$) in dieting (59.9%, 55.0%, and 47.5% respectively), fasting (28.3%, 15.2%, and 10.3%, respectively), and taking diet pills (13.3%, 6.8%, and 4.3%, respectively). Prevalence of purging was significantly higher only for very short sleepers (12.3%, 6.0%, and 3.9%, respectively).

Conclusion: Self-reported short sleep duration was associated with dieting and three unhealthy weight-control behaviors in this population. If our findings are confirmed, intervention studies should be conducted to examine the effect of educational interventions.

Keywords: Adolescence, sleep, weight management

Citation: Wheaton AG; Perry GS; Chapman DP; Croft JB. Self-reported sleep duration and weight-control strategies among US high school students. *SLEEP* 2013;36(8):1139-1145.

INTRODUCTION

At a time when adolescents need more than 9 h of sleep per night for optimal health and well-being,¹ social factors (such as 24-h access to cell phones and the Internet) and biological factors (such as delayed circadian rhythms) may combine to delay bedtimes,²⁻⁴ whereas school start times often advance wake-up times.⁵ As a result, adolescent students are often sleep deprived.⁶ Short sleep duration in adolescents has been associated with lowered academic performance, depressive mood, and behavioral problems.^{4,7-9} Shorter sleep duration has also been found to be associated with various risk behaviors, including smoking and alcohol use.^{8,10-12}

Eating disorders often present during adolescence¹³ and are associated with a variety of unhealthy behaviors that include purging behaviors (e.g., self-induced vomiting or misuse of laxatives), fasting, or otherwise restricting food intake. The lifetime prevalence of eating disorders (anorexia nervosa, bulimia nervosa, or binge eating disorder) in the United States is estimated to be approximately 6% for women and 3% for

men,¹⁴ but the prevalence of disordered weight-control behaviors and symptoms that do not meet the stringent criteria for an eating disorder diagnosis is likely much higher.¹⁵ Sleep complaints are common in young women with eating disorders and may predict the development of psychological disorders, such as depression or anxiety, that are frequently associated with eating disorders.¹⁶

To our knowledge, there is no literature on the possible association between sleep duration and weight-control strategies in the nonclinical adolescent population. Our objectives were to determine if self-reported short sleep duration was associated with perception of body weight or with the prevalence of several weight-control behaviors among US high school students.

METHODS

We used data from the 2007 National Youth Risk Behavior Survey (YRBS). The Youth Risk Behavior Surveillance System was developed by the Division of Adolescent and School Health, Centers for Disease Control and Prevention (CDC), to monitor the prevalence of youth health-risk behaviors, including unintentional injuries and violence, tobacco use, alcohol and other drug use, sexual behaviors that result in sexually transmitted diseases, dietary behaviors, and physical activity behaviors. Students complete the anonymous, self-administered questionnaires during a single class period. Because the national YRBS is a public-use dataset, this research was exempt from review by an institutional review board. The National YRBS uses a three-stage cluster design to obtain a representative sample of high school students (9th through 12th grades, predominantly

Submitted for publication August, 2012

Submitted in final revised form January, 2013

Accepted for publication February, 2013

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14-18 y of age). Hispanic and black youth were oversampled in 2007. Sampling strategies have been reported elsewhere.¹⁷ Of 195 schools sampled, 157 (81%) participated; 84% of the students sampled at the participating schools submitted useable questionnaires. The overall response rate for the 2007 YRBS was 68%.

Usable data were available from 14,041 respondents to the 2007 National YRBS. Respondents who were not in grades 9 through 12 or for whom grade data were missing ($n = 83$), who did not identify their sex ($n = 13$), or who did not respond to the sleep duration question ($n = 1,887$) were excluded from the analysis. The final sample size for data analysis included 12,087 study respondents (85.8%).

Measures

Self-reported sleep duration was ascertained by the question, "On an average school night, how many h of sleep do you get?" Possible responses were "4 or less h," "5 h," "6 h," "7 h," "8 h," "9 h," or "10 or more h." We formed four sleep duration categories: very short sleep (≤ 5 h), short sleep (6 or 7 h), moderate sleep (8 or 9 h), and long sleep (≥ 10 h). Although 9.25 h is often identified as the usual sleep need for adolescents,¹ this sleep duration was obtained using polysomnographic data. At least one study, however, has found that adolescents using sleep diaries tend to underestimate the sleep they actually obtain as measured by actigraphy.¹⁸ Due to the uncertainty surrounding this issue, we chose 8 or 9 h as our referent group and labeled it as moderate rather than optimal.

Students were asked, "Which of the following are you trying to do about your weight?" Possible responses were "lose weight", "gain weight", "stay the same weight", or "I am not trying to do anything about my weight." Students were then asked if they had engaged in various behaviors to lose weight or keep from gaining weight during the 30 days before the survey. These behaviors included exercising; "eating less food, fewer calories, or foods low in fat" (dieting); and unhealthy weight-control behaviors such as "going without eating for 24 h or more (also called fasting)"; "taking diet pills, powders, or liquids without a doctor's advice"; and "vomiting or taking laxatives" (purging).

Because body image may affect weight-control behaviors, we compared students' objective weight status (based on body mass index, BMI) to their perceived weight status to assess how accurately they perceived their own weight status. BMI (kg/m^2) was calculated based on self-reported weight in pounds and height in inches. BMI percentile was generated for age and sex based on the 2000 CDC Growth Charts.¹⁹ We defined BMI categories, which were based on the following BMI percentiles: underweight (or at risk for underweight) ($\leq 15^{\text{th}}$ percentile), normal weight ($> 15^{\text{th}}$ percentile and $< 85^{\text{th}}$ percentile), overweight ($\geq 85^{\text{th}}$ percentile and $< 95^{\text{th}}$ percentile), and obese ($\geq 95^{\text{th}}$ percentile).²⁰ BMI percentiles were set to missing if weight, height, sex, or age were not reported. BMI percentiles were also set to missing if weight, height, or BMI were outside the biologically plausible limits defined by the Division of Nutrition and Physical Activity, CDC.¹⁹

Participants were also asked, "How do you describe your weight?" Possible responses were "very underweight"; "slightly underweight"; "about the right weight"; "slightly overweight";

or "very overweight". For our analysis, "very underweight" and "slightly underweight" were combined in one perceived weight category labeled "underweight", whereas "slightly overweight" and "very overweight" were combined in another perceived weight category labeled "overweight." Students who perceived themselves as thinner than their objective weight status (BMI category) were defined as underestimators. Underestimators included students who described themselves as underweight but were in the normal weight, overweight, or obese BMI categories and students who described themselves as normal weight but were in the overweight or obese BMI categories. Students who perceived themselves as heavier than their objective weight status were defined as overestimators. Overestimators included students who described themselves as overweight but were in the normal weight or underweight BMI categories and students who described themselves as normal weight but were in the underweight BMI category. Students whose perceived weight status was comparable to their BMI category were defined as accurate estimators.

Statistical Analysis

All analyses were conducted using SAS-callable SUDAAN (version 10.0.0, RTI International, Research Triangle Park, NC) to account for the complex sampling design. Records were weighted based on student sex, race/ethnicity, and grade in school to adjust for student nonresponse and oversampling.¹⁷ Male and female students were analyzed separately due to expected sex-based differences in weight-control behaviors. Prevalence of weight overestimators or underestimators, attempting to lose or maintain weight, and the weight-control behaviors (exercising, dieting, fasting, taking diet pills, and purging) were assessed within sleep duration categories. Odds ratios (OR) and 95% confidence intervals (CI) adjusted for race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and other/multi-racial [non-Hispanic]) and grade were calculated in multivariable logistic regression models for the likelihood of each outcome for each sleep duration category. Logistic regression models for the weight-control behaviors were also adjusted for BMI category. We used the moderate sleep duration category (8 or 9 h per night) as the referent. We also tested for linear trends across sleep duration categories using the Wald F-statistic. A P value < 0.05 was considered statistically significant for all tests.

RESULTS

Study Population

Students were predominantly white (63.2% of males, 62.3% of females), with approximately 15% black and 15% Hispanic students (Table 1). Only 31.4% of male students and 27.4% of female students reported sleeping 8 or 9 h (moderate sleep) on an average school night. Approximately half of students (51.8% of males and 54.3% of females) were short sleepers (6 or 7 h). Five h or less (very short sleep) was reported by 14.8% of males and 16.9% of females. Ten or more h (long sleep) was reported by a very small proportion of our sample (2.0% of male students and 1.3% of female students). Self-reported sleep duration varied by race/ethnicity and school grade. Among male students, non-Hispanic blacks (25.5%) were less likely to report moderate sleep duration than non-Hispanic whites (32.7%; pair-

Table 1—Characteristics of US high school students who responded to sleep duration question in the 2007 National Youth Risk Behavior Survey (YRBS)

Characteristic	Male (N = 5,969)			Female (N = 6,118)		
	n ^a	% ^b	95% CI	n	%	95% CI
Race/ethnicity						
White, non-Hispanic	2,538	63.2	56.4-69.4	2,605	62.3	55.6-68.5
Black, non-Hispanic	1,165	14.3	11.0-18.2	1,343	15.2	12.0-18.9
Hispanic	1,650	15.7	12.4-19.6	1,643	15.9	12.4-20.0
Other/multiracial	524	6.9	4.9-9.7	471	6.7	4.8-9.3
Grade						
9th grade	1,492	28.7	27.0-30.4	1,437	27.4	26.2-28.7
10th grade	1,464	26.3	25.3-27.3	1,474	26.0	25.0-27.1
11th grade	1,439	23.9	22.8-25.0	1,618	24.4	23.1-25.8
12th grade	1,574	21.2	20.3-22.1	1,589	22.2	21.1-23.3
Self-reported sleep duration						
≤ 5 h (very short)	929	14.8	13.5-16.1	1,059	16.9	15.7-18.3
6 or 7 h (short)	3,083	51.8	49.5-54.2	3,249	54.3	52.5-56.1
8 or 9 h (moderate)	1,817	31.4	29.1-33.9	1,703	27.4	25.5-29.5
≥ 10 h (long)	140	2.0	1.5-2.6	107	1.3	1.0-1.9
BMI category^c						
Underweight	361	6.9	6.0-7.9	318	6.2	5.4-7.2
Normal weight	3,298	59.9	58.0-61.7	3,750	68.3	65.6-70.9
Overweight	965	16.7	15.7-17.9	961	15.7	14.1-17.3
Obese	1,018	16.5	15.2-17.9	657	9.9	8.5-11.4
Weight estimation^d						
Overestimator	411	7.6	6.7-8.6	981	18.6	17.1-20.2
Accurate estimator	3,790	68.9	67.3-70.4	3,975	70.4	68.4-72.2
Underestimator	1,364	23.5	22.2-24.9	670	11.0	9.7-12.6
Trying to change weight?						
Lose weight	1,890	30.7	28.9-32.5	3,656	60.9	59.0-62.8
Gain weight	1,599	26.6	24.8-28.5	424	5.6	4.7-6.5
Maintain weight	1,293	21.7	20.4-23.2	1,107	18.2	16.9-19.6
Not trying to do anything about weight	1,160	21.0	19.2-22.9	914	15.3	14.2-16.5
Weight-control behavior						
Exercised	3,382	55.2	53.7-56.7	3,939	67.2	65.5-69.0
Dieted	1,714	28.7	27.5-30.0	3,102	53.6	51.6-55.6
Fasted	440	6.9	5.8-8.1	963	16.1	15.1-17.3
Took diet pills	254	4.0	3.4-4.7	413	7.2	6.4-8.1
Purged	139	1.9	1.4-2.5	371	6.5	5.6-7.5
≥ 1 unhealthy behavior ^e	644	10.0	8.7-11.5	1,265	21.3	19.9-22.7

^aUnweighted N's. ^bWeighted percentage (95% CI). ^cBMI categories were based on BMI percentiles generated for age and sex (2000 CDC Growth Charts): underweight (≤ 15th percentile), normal weight (> 15th percentile and < 85th percentile), overweight (≥ 85th percentile and < 95th percentile), and obese (≥ 95th percentile). ^dOverestimators included students who described themselves as overweight but were in the normal weight or underweight BMI categories and students who described themselves as normal weight but were in the underweight BMI category. Underestimators included students who described themselves as underweight but were in the normal weight, overweight, or obese BMI categories and students who described themselves as normal weight but were in the overweight or obese BMI categories. ^eUnhealthy weight-control behaviors defined as fasting, taking diet pills, or purging behaviors. BMI, body mass index; CI, confidence interval.

wise *t*-value = 3.3, *P* = 0.002) or Hispanics (32.8%; pairwise *t*-value = 2.7, *P* = 0.011). There was no significant difference in prevalence of moderate sleep duration by race/ethnicity among female students. Among male students, the proportion reporting moderate sleep duration was strongly associated with grade in school (9th: 42.5%, 10th: 33.3%, 11th: 25.9%, 12th: 20.3%). All between-grade differences were statistically significant (*t*-value > 2.6, *P* < 0.011). Among female students, the proportion was also strongly associated with grade in school (9th: 37.7%, 10th: 27.6%, 11th: 21.9%, 12th: 20.6%), although the difference between 11th and 12th grades was not statistically significant.

More than half of the students were in the normal weight category (59.9% of males and 68.3% of females), and approximately one in three were overweight or obese (33.2% of males and 25.5% of females) (Table 1). Most students were accurate estimators of their weight status (68.9% of males and 70.4% of females); however, females were more likely to be overestimators of their weight status than males (18.6% versus 7.6%, respectively). Only 21.0% of males and 15.3% of females were not trying to do anything about their weight. There were 60.9% of female students and 30.7% of male students who were trying to lose weight; another 18.2% of females and 21.7% of males

Table 2—Prevalence and odds ratio of weight-estimation status and weight-control behaviors by sleep duration category

Characteristic	Male Students								
	≤ 5 h (N = 929) ^a		6 or 7 h (N = 3,083)		8 or 9 h (N = 1,817)		≥ 10 h (N = 140)		Linear trend P value ^d
	% ^b	OR ^c (95% CI)	% ^b	OR ^c (95% CI)	% ^b	OR ^c (95% CI)	% ^b	OR ^c (95% CI)	
Overweight/obese	37.1	1.3 (1.0-1.7)	33.4	1.1 (1.0-1.3)	31.0	Referent	35.4	1.1 (0.7-1.9)	0.067
Overestimators	8.8	1.3 (0.8-2.0)	7.2	1.0 (0.7-1.4)	7.4	Referent	14.5	2.3 (1.1-5.1)	0.249
Underestimators	26.2	1.2 (0.9-1.6)	23.5	1.1 (0.8-1.3)	22.4	Referent	21.9	1.0 (0.6-1.6)	0.233
Attempting to lose/maintain weight	54.8	1.0 (0.8-1.2)	51.7	0.9 (0.8-1.1)	52.8	Referent	48.1	0.8 (0.5-1.4)	0.780
Weight-control behavior									
Exercised	58.2	1.1 (0.9-1.4)	55.4	1.1 (0.9-1.3)	53.9	Referent	51.6	1.0 (0.6-1.5)	0.245
Dieted	36.3	1.6 (1.3-2.0)	28.1	1.1 (0.9-1.4)	26.1	Referent	28.1	1.2 (0.7-1.9)	< 0.001
Fasted	14.2	3.0 (1.8-4.8)	6.1	1.3 (0.9-1.9)	4.3	Referent	14.8	3.9 (1.9-7.9)	< 0.001
Took diet pills	6.6	1.4 (0.8-2.5)	3.2	0.7 (0.5-1.0)	3.7	Referent	^e	–	0.252
Purged	4.3	3.9 (2.1-7.5)	1.5	1.4 (0.7-2.8)	1.1	Referent	^e	–	< 0.001
≥ 1 unhealthy behaviors ^f	18.6	2.4 (1.6-3.6)	9.0	1.1 (0.9-1.3)	7.2	Referent	18.6	3.0 (1.6-5.6)	< 0.001

Characteristic	Female Students								
	≤ 5 h (N = 1,059)		6 or 7 h (N = 3,249)		8 or 9 h (N = 1,703)		≥ 10 h (N = 107)		Linear trend P value ^d
	% ^b	OR ^c (95% CI)	% ^b	OR ^c (95% CI)	% ^b	OR ^c (95% CI)	% ^b	OR ^c (95% CI)	
Overweight/obese	29.5	1.1 (0.9-1.5)	23.1	0.8 (0.7-1.0)	27.7	Referent	32.1	1.0 (0.6-1.9)	0.377
Overestimators	20.8	1.4 (0.9-2.0)	19.3	1.2 (0.9-1.5)	16.0	Referent	14.7	1.0 (0.5-2.3)	0.092
Underestimators	12.1	1.0 (0.8-1.3)	9.6	0.8 (0.7-1.1)	12.5	Referent	28.0	2.2 (1.1-4.6)	0.849
Attempting to lose/maintain weight	78.4	1.2 (0.9-1.5)	81.0	1.4 (1.1-1.7)	76.2	Referent	74.2	1.0 (0.6-1.6)	0.128
Weight-control behavior									
Exercised	64.6	1.1 (0.9-1.4)	69.3	1.2 (1.1-1.5)	65.2	Referent	59.0	0.9 (0.6-1.3)	0.381
Dieted	59.9	1.7 (1.3-2.2)	55.0	1.3 (1.0-1.6)	47.5	Referent	45.1	1.0 (0.6-1.7)	< 0.001
Fasted	28.3	3.7 (2.6-5.2)	15.2	1.7 (1.3-2.2)	10.3	Referent	20.5	2.4 (1.2-4.8)	< 0.001
Took diet pills	13.3	3.4 (2.1-5.3)	6.8	1.6 (1.1-2.4)	4.3	Referent	^e	–	< 0.001
Purged	12.3	3.5 (2.4-5.2)	6.0	1.6 (1.0-2.6)	3.9	Referent	^e	–	< 0.001
≥ 1 unhealthy behaviors ^f	35.3	3.3 (2.5-4.3)	20.3	1.6 (1.2-2.0)	14.4	Referent	22.5	1.8 (0.9-3.6)	< 0.001

Duration categories: ≤ 5 h, very short sleep duration; 6 or 7 h, short sleep duration; 8 or 9 h, moderate sleep duration; ≥ 10 h, long sleep duration. ^aUnweighted N's. ^bWeighted prevalence of weight-estimation status and weight-control behaviors among students within sleep duration categories. ^cFor weight estimation, OR adjusted for race/ethnicity and school grade. For remaining characteristics, OR also adjusted for BMI category. Sleep duration of 8 or 9 h was the referent group. ^dP value for Wald F-statistic shown for linear trend across three sleep categories: very short, short, and moderate. ^ePrevalence estimates unreliable (relative standard error > 0.3). ^fUnhealthy weight control behaviors defined as fasting, taking diet pills, or purging. CI, confidence interval; OR, odds ratio.

were trying to maintain their current weight. For each of the five weight-control behaviors evaluated, females were more likely to report engaging in the behavior than their male counterparts. The most common weight loss or maintenance behaviors were exercising (67.2% of females and 55.2% of males) and dieting (53.6% of females and 28.7% of males). At least one unhealthy weight-control behavior (fasting, taking diet pills, or purging) was reported by 10.0% of males and 21.3% of females.

Self-Reported Sleep Duration, Weight Status Estimation, and Weight-Control Behaviors

The sex-specific prevalence of overweight/obesity, weight status estimation, and various weight-control behaviors by sleep duration category are presented in Table 2. Among male students, overweight/obesity did not differ significantly by sleep duration. However, female students who were short sleepers (6 or 7 h) were less likely to be overweight/obese compared with the referent group (OR = 0.8; 95% CI = 0.7-1.0). Although unadjusted prevalences of overestimating weight status, underestimating

weight status, and attempting to lose or maintain weight generally declined as sleep duration increased to the referent (8 or 9 h) in both males and females, these relationships failed to reach statistical significance among male students after adjustment for race/ethnicity and grade in multivariable logistic regression models. Long sleepers were more likely to be weight overestimators among male students (OR = 2.3; 95% CI = 1.1-5.1) and weight underestimators among female students (OR = 2.2; 95% CI = 1.1-4.6). Among female students, the odds of attempting to lose or maintain weight was higher among short sleepers compared to the referent, although there was no difference between the very short sleepers (≤ 5 h) and the referent group.

Among male students, self-reported sleep duration was inversely associated with dieting, fasting, and purging. Very short sleepers were significantly more likely than moderate sleepers to report dieting (OR = 1.6; 95% CI = 1.3-2.0), fasting (OR = 3.0; 95% CI = 1.8-4.8), and purging (OR = 3.9; 95% CI = 2.1-7.5) to lose or maintain weight during the 30 days before the survey. Short sleepers were less likely to report taking diet pills

than moderate sleepers (OR = 0.7; 95% CI = 0.5-1.0). Among males, 18.6% of very short sleepers reported at least one of the unhealthy weight-control behaviors (fasting, taking diet pills, or purging) during the 30 days before the survey compared with 7.2% of moderate sleepers (OR = 2.4; 95% CI = 1.6-3.6). Long sleepers were also more likely to report fasting (OR = 3.9; 95% CI = 1.9-7.9) or at least one of the unhealthy weight-control behaviors (OR = 3.0; 95% CI = 1.6-5.6) compared with moderate sleepers.

Among female students, self-reported sleep duration was inversely associated (linear trend) with all weight-control behaviors except exercising (Table 2). Short sleepers were more likely to report exercising to lose or maintain weight than moderate sleepers (OR = 1.2; 95% CI = 1.1-1.5), but very short sleepers were no more likely to report this behavior than the moderate sleepers. Very short sleepers and short sleepers were significantly more likely than moderate sleepers to report dieting (OR = 1.7; 95% CI = 1.3-2.2 and OR = 1.3; 95% CI = 1.0-1.6, respectively), fasting (OR = 3.7; 95% CI = 2.6-5.2 and OR = 1.7; 95% CI = 1.3-2.2, respectively), and taking diet pills (OR = 3.4; 95% CI = 2.1-5.3 and OR = 1.6; 95% CI = 1.1-2.4, respectively). Prevalence of purging was significantly higher only for very short sleepers (OR = 3.5; 95% CI = 2.4-5.2). Long sleepers were more likely to report fasting (OR = 2.4; 95% CI = 1.2-4.8) compared to moderate sleepers. More than a third (35.3%; OR = 3.3; 95% CI = 2.5-4.3) of very short sleepers and 20.3% (OR = 1.6; 95% CI = 1.2-2.0) of short sleepers reported at least one of the three unhealthy weight-control behaviors during the 30 days before the survey, compared with 14.4% of moderate sleepers.

DISCUSSION

Obesity is a growing problem among adolescents. A substantial proportion of adolescents are attempting to lose or control their weight through healthy and unhealthy means. Fifty percent of the male students and four in five female students in our study were attempting to lose or maintain their weight, whereas 10.0% of male and 21.3% of female students reported that they had engaged in one of the unhealthy weight-control behaviors in the past mo. So that effective interventions to protect adolescent health can be implemented, possible targets for such interventions must first be identified. Lack of sleep may be one of those targets.

Two-thirds of high school students (66.6% of males and 71.2% of females) reported getting less than 8 h of sleep on school nights. This is comparable to the findings of the 2006 Sleep in America Poll conducted by the National Sleep Foundation.²¹ We found that very short sleep duration was associated with an increased prevalence of weight-control behaviors, especially unhealthy weight-control behaviors, in both male and female high school students. Among female students, a self-reported sleep duration of 6 to 7 h was also associated with an increased prevalence of most weight-control behaviors, even though this group was the least likely to be overweight or obese. We did not, however, find that sleep duration was associated with how students perceived their weight. Our results are in contrast with those of a study of Japanese adolescent girls that found that girls who overestimated their weight were more likely to sleep less than 7 h per night and to go to bed after 11:00

than girls whose perceived weight was more in line with their actual BMI.²²

We are not aware of any previous investigations of the relationship of sleep with weight-control behaviors in the general population. Past studies have investigated the prevalence of sleep complaints, primarily insomnia, in patients with eating disorders. Sleep complaints are common in patients with anorexia nervosa.²³ Although several polysomnographic studies have observed reduced overall sleep duration, reduced slow wave and rapid eye movement sleep, and low sleep efficiency in patients with anorexia compared with control patients, others have found no difference in sleep patterns.²⁴⁻²⁷ In a small Israeli study using actigraphy to measure sleep parameters, no difference in actigraphy measurements was found between patients with anorexia and control patients, although individuals with anorexia reported more difficulty falling asleep, more midsleep awakenings, and excessive daytime sleepiness.²³ A similar study in women with bulimia nervosa (binge eating, followed by purging) found that the patients with bulimia were more likely to report difficulty falling asleep and waking up too early, as well as more excessive daytime sleepiness. In contrast with the nonsignificant actigraphy findings in individuals with anorexia, that study found that patients with bulimia fell asleep more than 1 h later and woke up about 1 h later than control patients, possibly due to the increased likelihood of bulimic behaviors during the evening hours.²⁸ In a study of 400 women in whom an eating disorder had been diagnosed, half (50.3%) reported sleep disturbances, with a higher prevalence in patients exhibiting binge eating/purging behavior.¹⁶ A novel finding in our study was that long sleepers were more likely to report fasting among both male and female students. Long sleep duration has been linked to many health risks among adults, however, and may be a sign of depression.

Various mechanisms could contribute to the strong association we saw between self-reported short sleep duration and unhealthy weight-control behaviors. First, the weight-control behaviors could lead to shorter sleep. Chronic weight loss may cause biochemical changes that promote wakefulness. Hyperactivity is common in patients with anorexia, characterized by prolonged weight loss.²⁹ Starvation results in sleep fragmentation and reduced slow wave sleep, possibly by alteration of levels of peptides involved in sleep regulation, such as leptin, orexin, and cholecystokinin. Weight restoration in patients with restricting anorexia results in deeper sleep.³⁰ Further, a common adverse effect of many appetite suppressants is insomnia. Ephedrine and phentermine have been widely used as appetite suppressants and are both closely related to amphetamine, a stimulant with wake-promoting effects. Caffeine, a known stimulant, is also an ingredient in some preparations.

Sleep deprivation may contribute to impaired cognition and depressed mood, and thereby increase susceptibility to engaging in risky behaviors. Rather than merely being a consequence of depression, insomnia predicts depressive disorders.³¹ Among adolescents, shorter weekday sleep duration has been found to be associated with increased depressive symptoms and overall poor mental health.^{8,32} As a result of reduced cognition and mood, sleep-deprived adolescents may not consider the possible consequences of their risky behavior. Diagnoses of depression and anxiety are common in patients with

an eating disorder. Spindler and Milos found that frequency of binge eating, purging, and dieting was associated with anxiety disorders.³³ Studies have shown that anxiety is associated with sleep complaints.^{34,35}

The association between sleep and eating-disordered behaviors may not be a causal one; rather, a common factor may contribute to the development of both conditions. One such factor may be personality. A large cross-sectional study found that short sleep duration (≤ 6 h) was associated with high neuroticism and high self-criticism, after controlling for sociodemographic variables, psychiatric conditions, medical conditions, sedating medications, and broad personality dimensions.³⁶ In a meta-analysis evaluating the association between personality and eating disorders, anorexia nervosa and bulimia nervosa were consistently characterized by perfectionism, obsessive-compulsiveness, and neuroticism, with differences in constraint/impulsivity (high constraint in anorexia, high impulsivity in bulimia) and novelty seeking (low in anorexia, high in bulimia).³⁷ Individuals with insomnia tend to display similar personality traits, including high neuroticism, perfectionism, and internalization.³⁸

It is not possible to determine causality due to the cross-sectional nature of the survey. Another drawback is that self-reported sleep duration was the only sleep-related question asked of the high school students. Future investigations should include questions related to sleep quality and sleep disorders, especially insomnia, as well as asking about sleep duration on weekend nights, circadian disorders, or circadian rhythm type (morningness-eveningness). A limitation of the study was the necessary reliance on self-reported sleep duration, height and weight for BMI calculation, and weight-control behaviors. Adults generally overestimate sleep duration,^{39,40} but one study comparing sleep duration from sleep diaries and actigraphy among adolescents found that the study participants underestimated their sleep duration.¹⁸ However, the difference was on the order of 30 min. Adolescents tend to underestimate weight and overestimate height, with weight being underestimated more by overweight adolescents.^{41,42} Although the questions assessing weight-control behaviors have not been validated, the test-retest reliability is moderate.⁴³ Kappa values ranged from approximately 40% for the unhealthy weight-control behaviors to almost 60% for the more general questions (e.g., trying to lose weight).⁴³

CONCLUSION

We observed a relationship between self-reported short sleep duration and several weight-control behaviors. Although an association was found between sleep duration and dieting, which may be considered a relatively healthy weight-control behavior, the association with the unhealthy weight-control behaviors was even stronger. These results provide further evidence that inadequate sleep may contribute to increased risky behaviors among adolescents. Because this is the first study to document an association between short sleep duration and weight-control behaviors in the general adolescent population, more studies to confirm these results are warranted. If our findings are confirmed, intervention studies should be conducted to examine the effect of educational interventions that target sleep hygiene.

ACKNOWLEDGMENTS

Dr. Wheaton was supported through a cooperative agreement between the Association for Prevention Teaching and Research (APTR) and the Centers for Disease Control and Prevention (CDC), award number 3U50CD300860. The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention. Parts of this manuscript were presented at the American Public Health Association's 138th Annual Meeting and Exposition in Denver, CO on November 10, 2010.

DISCLOSURE STATEMENT

This was not an industry supported study. The authors have indicated no financial conflicts of interest.

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