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Shortened Sleep Duration does not Predict Obesity in Adolescents

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Abstract

Obesity continues to be a major public health issue. In adolescents, there are limited studies on the relationship between obesity and sleep duration. We hypothesied that average sleep duration of less than 6 hours in adolescents was associated with obesity. Data was from the National Longitudinal Study of Adolescent Health (ADD Health); survey of 90,000 youths, ages 12 – 18 years; surveyed in several waves. The sample population for our study was 13,568. Weighted multiple logistic regression was used to identify relationship between obesity at Wave II and sleep duration, having adjusted for skipping breakfast ≥ 2/week; race, gender, parental income, TV ≥ 2hrs/day, depression, and obesity at Wave I. At Wave I, mean age 15.96±0.11 yrs; mean sleep hours 7.91±0.04. 10.6% and 11.2% of adolescents were obese at Waves I and II, respectively. Adjusted analyses suggest that effect of shortened sleep duration in Wave I was not significantly predictive of obesity in Wave II (p<0.218).Longitudinally, depression and TV ≥ 2hrs/day at Wave I was associated with higher risk of obesity at Wave II in adjusted analyses. Depressed adolescents were almost twice as likely to be obese (OR=1.84, 95% CI=1.25–2.72); adolescents who watched TV ≥ 2hrs/day were 37% more likely to be obese (OR=1.37, 95% CI=1.09–1.72).Environmental factors including TV ≥ 2hrs/day and depression were significantly associated with obesity; shortened sleep duration was not. Future longitudinal studies in adolescents are needed to determine whether timing of television watching directly influences sleep patterns, and ultimately obesity.

Keywords

Adolescents; Obesity; Sleep; Television; Fast Food; ADD Health

INTRODUCTION

Obesity continues to be a major health problem (Lee et al., 2009) because of increasing prevalence and relation to medical consequences such as increased risk for diabetes mellitus, hypertension, heart disease, and cancer (Freedman et al., 2001, Dietz, 2001, Weiss et al.,

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2004). The effectiveness of weight management programs is limited (Anderson et al., 2001). Therefore, the identification of risk factors for obesity, such as sleep duration, is important as it could lead to additional preventative strategies. Prior research has identified a range of risk factors for obesity including low levels of physical activity, sedentary behaviour, and easy access to energy dense foods (Epstein et al., 2008, Fisher et al., 2007, Briefel et al., 2009, Robinson, 1999). However, evidence continues to accumulate that short sleep duration may also play a critical role. One explanation for this link could be that being awake longer potentially gives children and adolescents more time to eat and engage in a sedentary lifestyle (Nelson et al., 2006, Finelli et al., 2006). Multiple cross-sectional studies across the age spectrum (Hasler et al., 2004) in both genders (Vioque et al., 2000, Chaput et al., 2006) and from multiple countries (Patel and Hu, 2008, Park et al., 2009, Vioque et al., 2000) have identified associations between chronic short sleeping and increased body mass index (BMI: weight/height^2). Furthermore, two studies have reported an association of obesity in adolescents with sleeping 6 hours or less each week night (Noland et al., 2009, Seicean, 2007).

Despite the increasing attention to the connection of sleep duration and obesity, there are still limited data exploring these associations in the adolescent population (Gupta et al., 2002). Extensive research has focused on sleep regulatory mechanisms and developmental changes in adolescents (Carskadon et al., 1998, Gibson et al., 2006, Carskadon et al., 1993) but few studies have evaluated the association of short sleep duration and obesity in this population. Additionally, a recent meta analysis (Cappuccio et al., 2008) of subjects across the lifespan, from childhood through adulthood, incorporated studies predominantly from early childhood, not adolescence. Results were based on bivariate associations between sleep and obesity, without adjusting for other potential confounders.

In the current study, we evaluated the longitudinal relationship between sleep duration, and obesity in a large sample of adolescents 12 to 18 years of age. Based on previous studies, (Hasler et al., 2004, von Kries et al., 2002, Vioque et al., 2000) we hypothesied hypothesied that an average sleep duration of less than 6 hours in adolescents was associated with obesity.

PATIENTS and METHODS

This study was approved by the Institutional Review Board of the University of Pennsylvania. This was a secondary analysis of the National Longitudinal Study of Adolescent Health (ADD Health). ADD Health is a survey of youths, grades 7 to 12, that provided national representation of the U.S. middle and high school population in 1994 to 1995. The primary purpose of ADD Health was to explore the causes of health-related behaviours of adolescents and their outcomes in young adulthood (Harris et al., 2003).

Survey procedures, described elsewhere (Resnick et al., 1997) were approved by the University of North Carolina Institutional Review Board. In Wave I (1994 to 1995), >90,000 students completed in-school surveys, and a subset of 20,745 adolescents (and parents) then completed in-home surveys. Wave II (1996) included 14,738 Wave I adolescents who had still not graduated from high school, including dropouts. The two sections of the ADD Health data include the restricted-use data set, and the public-use data set. Key differences between the two sets of data are that the restricted-use data is the entire student sample, with more confidential information on the participants, whereas the public-use data was half of the total sample of the ADD Health (Resnick et al., 1997, Udry et al., 2003). For this study, the restricted data set from the first two waves were used.

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Outcome Measures

Obesity—Height and weight were converted to BMI, the main outcome variable. Variables were self reported in Wave I and self reported and objectively measured during home interviews in Waves II. For consistency, this study utilized self reported height and weight. In ADD Health, Goodman and colleagues (Goodman et al., 2000) reported a strong correlation between objectively measured and self reported height (r = 0.94, $P < .0005$) and weight (r = 0.95, $P < .0005$).

Classification of Sleep Duration—Sleep duration was the main predictor variable of interest in the present analysis. For the ADD Health study, one question addressed length of sleep. In both Wave I and II, adolescents were asked during the in-home interview "How many hours of sleep do you usually get?" Based on previous studies (Vioque et al., 2000, Hasler et al., 2004) we defined short sleep duration as less than 6 hours. Additionally, two other studies have demonstrated some association with sleep less than six hours and obesity in adolescents (Noland et al., 2009, Seicean, 2007). Mean sleep categories were then divided into < 6 hours, 6 to 8 hours, > 8 to 11 hours, and > 11 hours sleep. Adolescents with extreme sleep hours (<2.00 or >14) were coded as missing for this analysis. In Wave I, a total of 29 subjects were excluded due to extreme sleep hours; 8 with <1.5 hours and 21 with >14 hours per night. In Wave II, a total of 15 subjects were excluded due to extreme sleep hours; 2 with <1.5 hours and 13 with >14 hours per night.

Nutrition—Two nutritional variables documented in the literature (Thompson et al., 2003, Keski-Rahkonen et al., 2003) as increasing the risk of obesity were assessed. One variable was the frequency of eating in a fast food restaurant. The other variable selected was whether children skipped breakfast. This criterion was selected based on several cross-sectional studies (Keski-Rahkonen et al., 2003, Siega-Riz et al., 1998, Melnik et al., 1998) which reported BMI or weights of children and adolescents who skipped breakfast were higher than those who had breakfast. For both these variables, responses were categorised as less than twice a week or ≥ twice a week.

Physical inactivity—Initially, inactivity score was based on three questions, which used standard 7-day recall of the number of hours spent (1) watching television, (2) watching videos, and (3) playing video or computer games. Analysis of activity using all three questions had revealed a peak of 60 hours/week of inactivity; approximately 8.5 hours per day. It was thought that these results may have been erroneous as subjects may have been multi-tasking or reporting video watching as also television watching. Therefore, total inactivity score was based on only one question, the 7-day recall of television viewing. Based on previous studies reporting that ≥ 2 hours per day of television viewing led to increased risk of weight gain, the total inactivity score was categorised as ≥ 2 hours per day or < 2 hours per day, with a sedentary lifestyle defined as ≥ 2 hours per day (Eisenmann et al., 2008, Gortmaker et al., 1999).

Depression—Depression was assessed using the Center for Epidemiologic Study-Depression Scale (CES-D). The CES-D has been widely used in studies of adolescents' emotional health Roberts et al. (1991) used the receiver operating characteristic (ROC) curve to analyze data obtained from a large, diverse community sample of students in grades 9 through 12. They determined that scores ≥ 24 maximized the sensitivity and specificity of the CES-D for predicting major depressive disorder as defined by the Diagnostic and Statistical Manual of Mental Disorders, Third Edition (DSM-III), criteria (Roberts, 1991). As used by Roberts et al, (Roberts, 1991) depression was defined as a cut off ≥ 24 points. This cutoff was used as a dichotomous variable to indicate depression.

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Additional covariates—Additional covariates included in the analysis were age, race, gender, and parental income. In the ADD Health database, race was self identified among the following categories as white (non Hispanic), black or African American (non Hispanic), Hispanic, Asian American, and other. Socioeconomic status was based on parental report of household income.

Statistical Analysis

The primary outcome for this study was obesity, defined as BMI > 95th percentile for age. All analyses were performed using Statistical Analysis System (SAS) 9.1 (SAS Institute Inc, Cary, NC) and were conducted using methods for survey data, with grand sampling weights from Wave II used to provide nationally representative estimates. Additionally, the cluster design of the ADD Health study was adjusted for in all analyses. Simple and multiple logistic regression was used to evaluate the effects of the potential predictive variables on the risk of obesity. Multiple regressions were adjusted for age, race, gender, parental income and pre-existing obesity (obesity at Wave I). A significance level of 0.05 was used for all analyses.

RESULTS

Adolescents, who completed both Wave I and II, were included in the sample. Thus, the final sample size was 13,568 adolescents Demographic variables are shown in Table 1. The majority of participants were non Hispanic white, with substantial representation of non Hispanic black, Hispanics and Asian Americans.

On average, adolescents slept 7.91 ± 0.04 hours in Wave I, with little change in sleep hours by Wave II (Table 2). In Wave I, weighted analysis of typical sleep duration showed that the majority of adolescents slept an average of 8 to 11 hours each night. Adolescents who slept less than 6 hours represented 3.77% of the sample. By Wave II, the percentage of adolescents who slept less than 6 hours rose slightly to 5.06%, with a slight decrease in the 8 to 11 hour sleepers (OR=1.91, 95% CI=1.27–2.90, p=0.004) .

At Wave I, the mean BMI was 22.21 ± 0.11 kg/m^2 with 10.6% of the sample being obese (BMI>95th percentile) (Table 2). The mean BMI in Wave II was 22.87 ± 0.10 kg/m^2. By Wave II, obesity prevalence had increased to 11.2% (Table 2). Of those adolescents who were obese at Wave I, 75.14% (n=1037) were still obese at Wave II, while only 347 adolescents developed obesity between Waves I and II. Thus, obesity at Wave I was related to obesity at Wave II (p<0.001).

Longitudinal Relationship with Obesity

As shown in Tables 2 and 3, there was a significant association between short sleep at Wave I and obesity in unadjusted analyses. Adolescents who had less than 6 hours of sleep in Wave I were almost twice as likely to be obese in Wave II compared to adolescents with normal sleep (OR=1.91, 95% CI=1.27–2.90). However, once adjustments were made for existing obesity at Wave I, as well as age, gender, race, and parental income, there was no significant association between sleep duration at Wave I and obesity at Wave II (p=0.214). This lack of association between sleep at Wave I and obesity at Wave II was evident even when considering adolescents who were (p=0.374) and were not (p=0.648) obese at Wave I separately.

There was an association between sleep duration and depression. Depressed adolescents tended to sleep less than non-depressed adolescents at both Waves I and II (p<0.001).

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Longitudinally, both depression and excessive television watching at Wave I were associated with a higher risk of obesity at Wave II in adjusted analyses (Table 4, Model 1). Depressed adolescents were almost twice as likely to be obese (OR=1.84, 95% CI=1.25–2.72), while adolescents who watched television excessively were 37% more likely to be obese (OR=1.37, 95% CI=1.09–1.72).

Cross-Sectional Relationship with Obesity

Cross-sectionally, sleep duration at Wave II was not associated with obesity at Wave II even in unadjusted analyses (p=0.157). At Wave II, only excessive television watching was associated with a higher risk of obesity in adjusted analyses (Table 4, Model 2). Consistent with Wave I models, adolescents watching more than 2 hours of TV a day were approximately 36% more likely to be obese (OR=1.36, 95% CI=1.04–1.79).

DISCUSSION

This study is the largest to date evaluating the effect of shortened sleep duration on obesity, in a sample of 13,568 adolescents. The results do not support the hypothesis that less than 6 hours sleep has an association with obesity, based on cross sectional results in Wave II, and longitudinal results from Wave I to Wave II. When adjusted for age, race, gender, socioeconomic status, depression, and BMI at Wave I, sleep duration was not a significant risk factor for the onset of obesity in Wave II. Instead, television watching for ≥ two hours a day in Wave I was predictive of obesity in Wave II. Considering a recent meta-analysis that demonstrated a consistent increase in obesity among short sleepers in children and adults (Cappuccio et al., 2008), the results of this study raise more questions about the causal pathways that may lead to increased adiposity in adolescents.

Although results were unexpected, these data are consistent with previous studies of potential environmental risk factors such as television watching (inactivity or sedentary behaviour) which may lead to obesity in adolescents (Gordon-Larsen et al., 2003, Gordon-Larsen et al., 2002, Eisenmann et al., 2008). Television viewing clearly impacted obesity in Wave II. The majority of adolescents that were obese in Wave I continued to be obese in Wave II. These results are similar to previous studies, indicating that prolonged television viewing, was associated with obesity in children and adolescents (Dietz and Gortmaker, 1984).

Television viewing may lead to increased risk of obesity because watching television has been associated with increased dietary intake, leading to an imbalance in energy expenditure (Robinson, 1999, Gortmaker et al., 1996, Epstein et al., 2008, Reilly et al., 2005). Adolescence is characterized by a steep drop in physical activity (Kimm et al., 2002, USDHHS., 2001) an increasing amount of media exposure, (Roberts et al., 2005) inactivity, (Kaur et al., 2003) and poor food choices (Palumbo and Dietz, 1985). As stated earlier, these patterns of behaviours appear to be the driving forces behind weight gain in this age group. In this study, similar to other analyses of the full ADD Health sample (Gordon-Larsen et al., 1999), television viewing for more than 2 hours each day and acquired food preferences choices are potentially entrenched by adolescence. These factors had greater association than sleep duration with obesity.

What is still not clear, though, is how the relationship of timing and amount of television watching and shortened sleep are associated with obesity. Although we did not find a relationship between television viewing and sleep in adjusted analyses, there was a slight correlation between television viewing and shortened sleep (For wave I: the correlation was r=0.07, p<0.001; for wave II: the correlation was r=0.02; p=0.065).

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An additional problem is disentangling cause and effect. Television viewing may result in later sleep onset.(Calamaro et al., 2009) Thus, late night television watching may be a pathway by which adolescents have shortened sleep duration. Conversely, because of changing circadian rhythm with delayed sleep phase, (Carskadon et al., 1993) adolescents are up later, and utilize television or similar sedentary behaviours to fill the void (Eggermont and Bulck, 2006). Future longitudinal studies in adolescents are needed to determine at what time of the night adolescents are viewing television, and whether the timing directly influences sleep patterns, and ultimately, obesity.

Additionally, longitudinal studies evaluating obesity, sleep duration and environmental factors such as inactivity and food intake, need to start in early childhood. The differing results between studies of adolescents and sleep and obesity may be because of study design differences. Study results from younger children under 11 years of age appear uniform, despite differences in the definition of short sleep (Patel and Hu, 2008). Patel et al. in a recent systematic review of sleep duration and obesity reported eleven cross sectional studies all of which identified a positive association between sleep duration and weight gain in predominantly school age children under 11 years of age (Patel and Hu, 2008). Only four studies, with varying results, have examined the relationship of sleep in adolescents. Differences in definitions of short sleep duration varied across studies, as did the potential confounders addressed. Additionally, differences may be because of study methods, or may in part reflect a more complex relationship between sleep duration and weight in this age group because of onset of puberty (Patel and Hu, 2008).

Since depression is associated with sleep abnormalities, (Kessler et al., 2003) such as complaints of hypersomnia or insomnia (Kripke et al., 2002, ter Wolbeek et al., 2008) the influence and bidirectional relationship of depression on sleep and weight gain was considered. In the ADD Health adolescent population, over 9% of adolescents were reported to have moderate symptoms of depression (Rushton et al., 2002). It was important, therefore, to determine the confounding influence, if any, of depression on sleep and weight gain. When included and excluded as a variable in the analysis, it was clear that depression did not play a factor in shortened sleep duration leading to weight gain in this population. Given that sleep duration as well as obesity are affected by depressive symptomatology (DiPietro et al., 1992, Perlis et al., 1997) including depression as a potential cofounder adds strength to the results of this study.

Data for the original study were collected on these adolescents in 1995. Since that time period, there has been an explosion of media-related technology available for use at any time of the day or night. Adolescents engage others through computer games, mobile phones to text friends, and surfing the internet (NSF, 2006). These technologies were not available at the time this data were collected. Sleep is potentially impacted through late night use of these devices, and surveying adolescents regarding technology use in the twenty first century may provide different results (Calamaro et al., 2009).

Another limitation could be that a1-year follow-up may potentially not be a sufficient amount of time to explore a potential relationship between short sleep duration and BMI. In our study, this may particularly important given that there were only a small number of new cases of obesity between Wave 1 and Wave 2. An additional limitation of this study was that validated sleep questionnaires were not included in the ADD Health survey, and sleep duration was self reported. In addition, sleep duration was limited to a single question. A previous study has found that self-reported sleep duration estimates are similar to actigraphy (Wolfson et al., 2003), yet it is possible that at the time of completion of the questionnaire, mood, stress and environment could have influenced self-reported sleep duration and

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potentially confounded its association with BMI. Another limitation was that the study was observational and thus, only associations could be presented.

Use of BMI as a measure of adiposity rather than direct measurement of obesity, such as skinfold thickness, could be considered another limitation, To date, BMI has been strongly correlated to measures of adiposity in children and adolescents (Lindsay et al., 2001, Pietrobelli et al., 1998), insulin sensitivity in children (Freedman et al., 2001), and diastolic blood pressure measurements (Freedman et al., 2001). Because of this, BMI is a well validated marker of adiposity and increased risk of morbidity in children and adolescents.

CONCLUSION

The National Longitudinal Study of Adolescent Health provides the largest data set to date describing sleep duration and association with obesity. With the results of this study, the question may be raised as to how sleep can have an association with obesity in young children, not through adolescence, but again in adults. It is possible that, as obese children enter adolescence; key environmental factors such as inactivity play a much greater role than sleep duration. However, as these adolescents enter adulthood, sleep duration may play a bigger role as inactivity and poor nutrition continue, and co- morbidities such as obstructive sleep apnea, metabolic syndrome or hypertension develop, creating a vicious cycle (Fogelholm et al., 2007). Further research, particularly longitudinal studies with objective measurements of sleep, activity and nutrition, are needed to determine the biological mechanism underlying the association between short sleep duration and weight gain.

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Table 1

Child characteristics from Wave II of the National Longitudinal Study of the Adolescent Study Health Study Population (n= 13568)*

Variable Characteristic	N	Mean ± S.E. or %
Age (years)	13568	15.96 ± 0.11
Gender		
Female	6956	49.74
Male	6612	50.25
Race		
White, non-Hispanic	7289	67.06
Black, non-Hispanic	2839	15.38
Hispanic	2298	12.27
Other	1133	5.27
Parental Income ($1,000)	10414	43.32 ± 1.55

*Because of rounding, percentages may not all total 100. Weighted means and percentages are shown.

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Table 2

Summary of potential predictors (measured at Waves I and II) of obesity at Wave II.

	Wave I		Wave II	
Variable Characteristic	**N**	**Mean ± S.E. or %**	**N**	**Mean ± S.E. or %**
Eaten fast food	n/a[†]			
<2 days/week			5511	42.57
≥2 days/week			8045	57.42
Skipped breakfast	n/a[†]			
<2 days/week			5400	41.38
≥2 days/week			8159	58.61
TV watching (hrs/week)	13517	15.39 ±0.36	13478	14.39 ± 0.36
Sedentary Lifestyle (≥2 hrs/day of TV)				
No	7865	59.18	8452	63.59
Yes	5652	40.82	5026	36.44
Typical hours of Sleep / Night (hrs)	13518	7.91 ± 0.04	13531	7.68 ± 0.03
Typical Sleep Duration				
<6 hours	573	3.77	775	5.06
6 - <8 hours	4656	30.56	5346	36.86
8 - <11 hours	7929	62.68	7119	55.74
11 - <14 hours	351	2.98	286	2.34
Depressed (CES-D≥24)				
No	12297	90.99	12227	90.63
Yes	1271	9.01	1341	9.37
BMI	13188	22.24 ± 0.11	13226	22.87 ± 0.10
Obese				
No	11761	89.37	11771	88.79
Yes	1426	10.62	1455	11.20

[*]Because of rounding, percentages may not all total 100. Weighted means and percentages are shown.

[†]Not asked at Wave I.

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Table 3

Bivariate (unadjusted) comparison of obesity groups at Wave II by demographic and Wave I and II variables. . Weighted means or percentages are shown.

	Obese at Wave II			
	No (n=11,771)	Yes (n=1,455)	Unadjusted Odds Ratio	95% CI
Demographic Variables				
Age (years)	15.98	15.96	0.99	0.94 – 1.05
Gender				
Female	50.28	41.48	(ref)	
Male	49.72	58.52	1.41	1.20 – 1.66
Race				
White, non-Hispanic	68.35	61.78	(ref)	
Black, non-Hispanic	14.43	20.74	1.58	1.30 – 1.92
Hispanic	11.76	13.50	1.30	1.04 – 1.64
Other	5.45	3.98	0.81	0.44 – 1.49
Parental Income ($1,000)	44.44	36.02	0.99	0.99 – 0.99
Wave I Variables				
>2 hrs/day of TV				
No	60.52	48.88	(ref)	
Yes	39.47	51.11	1.61	1.39 – 1.87
Typical Sleep Duration				
<6 hours	3.37	6.17	1.91	1.27 – 2.90
6 - <8 hours	31.07	29.29	0.96	0.81 – 1.14
8 - <11 hours	62.64	61.57	(ref)	
11 - <14 hours	2.93	2.98	1.07	0.70 – 1.64
Depressed (CES-D≥24)				
No	91.30	89.12	(ref)	
Yes	8.70	10.89	1.27	1.03 – 1.57
Obese				
No	97.16	27.20	(ref)	
Yes	2.84	72.80	90.54	73.94 – 110.9
Wave II Variables				
Eaten fast food				
<2 days/week	41.94	46.15	(ref)	
≥2 days/week	58.06	53.85	0.88	0.75 – 1.03
Skipped breakfast				
<2 days/week	42.56	32.92	(ref)	
≥2 days/week	57.45	67.08	1.55	1.31 – 1.82
>2 hrs/day of TV				
No	64.79	54.13	(ref)	
Yes	35.21	45.57	1.58	1.35 – 1.85

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	Obese at Wave II			
	No (n=11,771)	Yes (n=1,455)	Unadjusted Odds Ratio	95% CI
Typical Sleep Duration				
<6 hours	4.94	6.09	1.43	1.01 – 2.06
6 - <8 hours	36.95	38.35	1.09	0.93 – 1.29
8 - <11 hours	55.85	52.82	(ref)	
11 - <14 hours	2.27	2.74	1.35	0.81 – 2.25
Depressed (CES-D≥24)				
No	91.01	88.83	(ref)	
Yes	8.99	11.17	1.31	0.98 – 1.74

(ref)= reference group for odds ratio)

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Table 4

Multiple logistic regressions for risk of Obesity at Wave II. Adjusted odds ratios and associated 95% confidence intervals are shown

	Model 1		Model 2		Model 3	
	OR	**95% CI**	**OR**	**95% CI**	**OR**	**95% CI**
Wave I Variables						
Sedentary Lifestyle	1.37	1.09 – 1.73	1.37	1.09 – 1.72		
Typical Sleep Duration						
<6 hours	1.57	0.94 – 2.62	1.41	0.84 – 2.37		
6 - <8 hours	0.89	0.67 – 1.19	0.86	0.65 – 1.14		
8 - <11 hours	(ref)		(ref)			
11 - <14 hours	1.14	0.55 – 2.34	1.15	0.56 – 2.33		
Depressed			1.84	1.25 – 2.72		
Wave II Variables						
Eaten fast food ≥2 days/wk					0.90	0.67 – 1.19
Skipped breakfast ≥2 days/wk					1.14	0.87 – 1.49
Sedentary Lifestyle					1.36	1.04 – 1.79
Typical Sleep Duration						
<6 hours					1.23	0.71 – 2.15
6 - <8 hours					0.95	0.73 – 1.25
8 - <11 hours					(ref)	
11 - <14 hours					0.84	0.38 – 1.89
Depressed					1.25	0.81 – 1.93

† All models adjusted for obesity at Wave I, age, gender, race, and parental income.