IJMS
Vol 35, No 1, March 2010

Brief Report

Late Sleeping Affects Sleep Duration and Body Mass Index in Adolescents

Rajesh G.Kathrotia[1], Pinkesh V. Rao[2], Swapnil J. Paralikar[3], Chinmay J. Shah[2], Elvy R. Oommen[3]

Abstract

During adolescence, there is a tendency to sleep late and sleep less because of altered psychosocial and life-style changes. Recent studies have demonstrated the link between sleeping less and gaining weight in children, adolescents, and adults. We studied the effect of late sleeping and sleeping less on body mass index (BMI) in medical college freshmen. All participants were adolescents (104 male and 38 female adolescents, mean age 17.77±0.79 years). After obtaining informed consent, they filled out a questionnaire about their sleeping habits. Height and weight were measured after a brief history taking and clinical examination. BMI increased significantly with decrease in total sleep duration and with delayed bedtime. Late sleeping individuals (after midnight) had significantly less sleep duration (6.78 hours *v* 7.74 hours, P<0.001), more day time sleepiness (85.2% *v* 69.3%, P=0.033) and more gap between dinner time and going to sleep (234.16 min *v* 155.45 min, P<0.001). Increased BMI in late sleepers may be explained by low physical activity during the day caused by excess sleepiness and increased calorie intake with a gap of 5-6 hours between dinner and sleep. Sleep habits of late sleeping and sleeping less contribute to increase BMI in adolescents.

Iran J Med Sci 2010; 35(1): 57-60.

Keywords ● Late Sleeping ● duration of sleep ● BMI ● adolescents

[1]Department of Physiology, P.D.U. Medical College, Rajkot.
[3]Department of Physiology, Medical College, Baroda.
[2]Department of Physiology, Medical College, Bhavnagar. Gujarat, India.

Correspondence:
Rajesh G Kathrotia MD,
Department of Physiology, P.D.U. Medical College, Rajkot,
Gujarat, India.
Tel: +91 992 5768060
Fax: +91 278 2422011
Email: cjshah79@yahoo.co.in
rajeshkathrotia@yahoo.com
rajeshkathrotia@gmail.com
Received: 10 April 2009
Revised: 10 June 2009
Accepted: 23 July 2009

Introduction

Prevalence of obesity continues to rise in all age groups. Obesity is becoming one of the major health problems. It is during the adolescence years that most people develop lifestyle habits that are likely to form the foundation of their adulthood behaviors.

Adolescence development is accompanied by profound changes in the timing and amount of sleep and wakefulness.[1] In adolescence with more time is being spent on watching TV, playing video games, or surfing the internet, less time remains for sleep.[2] This sleep curtailment is a hallmark of modern societies, which is often considered harmless and efficient. Studies have shown a negative relationship between duration of sleep and body mass index (BMI) in children, adolescents and adults.[3,4] However, the aspect of late sleeping is taken for granted and there is not much evidence of association between bedtime and BMI. We investigated the relationship between sleeping habits including bedtime, sleep duration, daytime sleepiness, BMI, and eating habits in adolescents.

Subjects and Methods

One hundred and forty two adolescents entering medical school were included in the study upon obtaining an informed consent. The study was approved by the institutional Ethical Committee. All illnesses or surgical procedures were excluded by a short medical history taking and clinical examination. Height and weight were measured and BMI was calculated. A closed end questionnaire involving the present sleep habits was filled by the students. On the basis of the bedtime, the study group was divided into early (sleeping before midnight) and late (sleeping after midnight) sleepers. BMI and other sleeping habits were compared separately between the two groups, and between male and female adolescents in each group.

Statistical analyses was conducted using Epi Info statistical software version 3.3.2. Unpaired Student *t* test was applied to test the significance. Chi square test (Fisher test in case of smaller values) was applied to test the association. Pearson's correlation co-efficient (r) was calculated to study linear correlation. Probability value of <0.05 was considered as statistically significant.

Results

There was an inverse correlation between BMI and total duration of sleep (r=-0.17, P=0.046). Table 1 shows that those sleeping less than 6 hours had significantly higher BMI, compared with those sleeping more than 8 hours (unpaired t test, P=0.028).

Table 1: BMI and sleep duration (n=142)

Sleep duration	Number of participants (n)	BMI (kg/m^2) Mean±SD
Less than 6 hours	14	20.9±2.6
6-7 hours	46	20.2±3.3
7-8 hours	51	19.6±2.6
8-9 hours	27	19.6±2.4
More than 9 hours	4	18.2±3.2

Late sleeping was directly correlated with BMI. There was a progressive increase in BMI with delayed bedtime (r=0.18, P=0.029). BMI of the students who were going to bed before midnight was significantly less than those with bedtime after midnight (P=0.012, table 2).

As shown in figure 1, total duration of sleep (night as well as day sleep hours) was much greater in those gone to bed early. A significantly higher percentage of students who had gone to bed before 10 pm had total sleep hours of more than 8 hours, as compared with those gone to bed after midnight.

Table 2: BMI and bedtime (n=142)

Bedtime	Number of participants (n)	BMI (kg/m^2) Mean±SD
≤10 PM	17	19.47±3.05
10-11 PM	55	19.57±3.11
11-12 PM	41	20.26±2.88
12 AM -1AM	24	20.30±2.21
after 1 AM	5	21.08±1.54

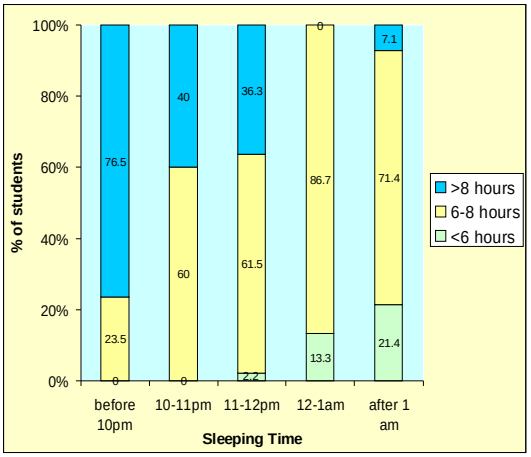

Figure 1: Total sleep duration in students sleeping at different times (n=142).

Comparison of male and female adolescents in table 3, shows no significant difference in BMI, sleep hours, and day time sleepiness. However female adolescents tend to sleep early and wake up early compared male adolescents. And the duration between dinner and sleep time was significantly less in female adolescents.

Comparison of BMI and sleep habits of late sleepers and early sleepers showed that a significantly higher BMI (P=0.012) in late sleepers. Late sleepers woke up later, had less night sleep duration and less total sleep duration compared with early sleepers (P=0.001). There was significantly more time gap between dinner and sleep in late sleepers (P=0.033) and a higher proportion of day time sleepiness was seen among late sleepers compared with early sleepers (table 4). Also compared with early sleepers, more proportion of late sleepers woke up tired (Chi square test, P=0.92).

BMI was significantly higher in male late sleepers. Total as well as night sleep duration were significantly less in the late sleepers (P=0.001). Late sleepers also had significantly more time gap between dinner and sleep times (P=0.004). More proportion of male late sleepers felt sleepy during the day and woke up tired, however, the difference in early sleepers was not statistically significant (Chi square test, P=0.14).

Table 3: Characteristics and differences between male and female participants

	Total (n=142)	Males (n=104)	Females (n=38)
Age (years)	17.8±0.8	17.8±0.8	17.5±0.6
BMI (kg/m^2)	19.9±2.9	20.2±2.8	19.3±2.8
Sleeping time (PM)	11:29±1:19	11:36±1:42	11:09±0:50*
Waking time (AM)	6:42±0:50	6:49±0:46	6:26±0:51*
Sleep latency (min)	14.9±8.2	13.5±8.7	16.1±13.5
Night sleep duration (hours)	7.2±0.9	7.2±1.0	7.2±0.9
Total sleep duration (hours)	7.4±1.0	7.3±1.0	7.5±1.0
Day time sleepiness (%)	75.4	78.84	65.79
Fixed bed time (%)	78.3	77.5	80.6
Wake up tired (%)	21.8	24	15.8
Time between dinner and sleep (min)	185.3±59.3	193.9±60.3	161.8±50.1*

Values are Mean±SD, *P<0.05 on applying unpaired Students *t* test for difference between male and female adolescents.

Table 4: BMI and sleeping habits in early and late sleepers

	Late sleepers (after midnight)			Early sleepers (before midnight)		
	Total (n=54)	Males (n=45)	Females (n=9)	Total (n=88)	Males (n=59)	Females (n=29)
BMI (kg/m2)	20.7±2.7	20.6±2.7	21.1±2.7	19.4±2.8*	19.8±2.9*	18.7±2.5*
Sleeping time (AM/ PM)	12:31±0:44	12:34±0:47	12:17±0:26	10:50±0:34*	10:52±0:34*	10:49±0:34*
Waking time (AM)	7:06±0:38	7:06±0:37	7:06±0:47	6:28±0:52*	6:35±0:49*	6:13±0:55*
Night sleep duration (hours)	6.6±0.8	6.5±0.8	6.8±0.9	7.60±0.8*	7.7±0.8*	7.4±0.8
Total sleep duration (hours)	6.8±1.0	6.7±0.9	7.2±1.3	7.7±0.9*	7.8±0.9*	7.6468±0.9
Time between dinner and sleep time (min)	234.2±49.6	239.6±51.8	206.6±23.4	155.4±42.5*	159.2±39.5*	147.9±48.1*
Day time sleepiness	85.2%	86.7%	77.8%	69.3%*	72.9%	62.1%
Fixed bed time	73.6%	70.5%	88.9%	81.2%	82.8%	77.8%
Wake up tired	22.2%	24.4%	11.1%	21.6%	23.7%	17.2%

*P <0.05 on applying unpaired Students *t* test for difference of mean and Chi square test for difference of proportions between early and late sleepers.

Table 4 also shows that female late sleepers had significantly higher BMI, late waking time, and more time gap between dinner and sleep times compared with female early sleepers (*t* test, P=0.002). Other parameters showed similar trend in male participants but were not statistically significant.

Discussion

Hypothalamic-pituitary functions including those that influence eating, energy balance, and metabolism are strongly related to circadian rhythms and highly integrated with sleep regulatory processes.[5]

Our study showed a significant increase in BMI with decreased total duration of sleep as well as with delayed bedtime, consistent with the findings of Bahammam and co-workers.[3] Studying the influence of sleep duration on circulating levels of leptin, Chaput and colleagues,[6] and Spiegel and others,[7] found short sleep duration, predicted an increased risk of being overweight/obese in adults and was related to a reduced circulating leptin level. Tehari and colleagues have shown a fall in leptin and a rise in ghrelin levels with decrease in duration of sleep contributing to increased BMI.[8]

On dividing the groups based on bedtime there was a significant difference between BMI of the early and late sleepers. Even in female and male participants separately, BMI, though normal, was more in late sleepers. The two groups were significantly different in terms of total sleep duration, day time sleepiness, and the gap between dinner and going to sleep, which might contribute to the increased BMI in late sleepers. Spiegel, Van Cauter, and their colleagues found that cortisol levels in the late afternoon and evening were higher after sleep restriction and also glucose levels during the first 90 min were higher during sleep restriction than sleep extension, despite insulin levels that were slightly higher.[7,9] Similar finding of lower glucose tolerance and higher insulin resistance in sleep deprivation has been reported by Yaggi and others.[10] Increases in cortisol levels in those who remain awake late and the hyperglycemic response produced thereafter is countered by plasma insulin increase. Furthermore, it has been found that late sleepers have on average a decrease in their total sleep duration, which contributes to BMI rise by appetite regulating hormones as discussed above.[6-8]

The mean time period between dinner and sleep in late sleepers in our study was 234 minutes (5-6 hours), compared with 155 minutes

(2-2.5 hours) in early sleepers. As late sleepers eat early and remain awake until late, they are likely to become hungry and eat, which may contribute to increased total energy intake and higher BMI. Furthermore, the day time sleepiness was significantly higher in late sleepers implying a less desire for physical activity and compounding to the causation of increased BMI as concluded by Sanjay and colleagues.[5]

Conclusion

The habit of late sleeping and, hence, sleeping less that occurs during adolescence contributes to cause overweight in the age group. Late sleeping, in turn, leads to outcomes such as waking up tired and feeling sleepy during the day. These changes in sleep and wake patterns contribute to increase BMI in adolescents. We strongly recommend fostering healthy sleep habits during adolescence, apart from guidance for diet and exercise for the prevention of obesity in adulthood.

Conflict of Interest: None declared

References

1 Wolfson AR, Carskadon MA. A Survey of Factors Influencing High School Start-Times. *NASSP Bulletin* 2005; 89: 47.

2 Vioque J, Torres A, Quiles J. Time spent watching television, sleep duration and obesity in adults living in Valencia, Spain. *Int J Obes Relat Metab Disord* 2000; 24: 1683-8.

3 BaHammam A, Bin Saeed A, Al-Faris E, Shaikh S. Sleep duration and its correlates in a sample of Saudi elementary school children. *Singapore Med J* 2006; 47: 875-81.

4 DE Greydanus, S Bhave. Editorial, Obesity and Adolescents: Time for Increased Physical Activity! *Indian Pediatrics* 2004; 41: 545-50.

5 Patel SR, Malhotra A, White DP, et al. Association between reduced sleep and weight gain in women. *Am J Epidemiol* 2006; 164: 947-54.

6 Chaput JP, Després JP, Bouchard C, Tremblay A. Short sleep duration is associated with reduced leptin levels and increased adiposity: Results from the Quebec family study. *Obesity (Silver Spring)* 2007; 15: 253-61.

7 Spiegel K, Leproult R, L'hermite-Balériaux M, et al. Leptin Levels Are Dependent on Sleep Duration: Relationships with Sympathovagal Balance, Carbohydrate Regulation, Cortisol, and Thyrotropin. J Clin Endocrinology Metab 2004; 89: 5762-71.

8 Taheri S, Lin L, Austin D, et al. Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. *PLoS Med* 2004; 1: e62.

9 Van Cauter E, Leproult R, Plat L. Age-Related Changes in Slow Wave Sleep and REM sleep and Relationship with Growth Hormone and Cortisol Levels in Healthy Men. *JAMA* 2000; 284: 861-8.

10 Yaggi HK, Araujo AB, McKinlay JB, Sleep duration as a risk factor for the development of type 2 diabetes. *Diabetes Care* 2006; 29: 657-61.