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Original Article

Association between sleep quality and obesity in adolescents

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Abstract

Background Sleep quality can be measured by the Pittsburgh Sleep Quality Index (PSQI). One component of the PSQI is duration of sleep, which is often highly inadequate in adolescents. Inadequate sleep may lead to obesity in adolescents.

Objective To assess for an association between sleep quality and incidence of obesity in adolescents.

Methods This case–control study was conducted at Santo Thomas I Senior High School, Medan, North Sumatera, from July to August 2015. A total of 227 adolescents were divided into two groups: the case group consisting of 101 obese adolescents and the control group consisting of 126 non-obese adolescents. Study data was collected by questionnaires and PSQI. We interviewed subjects on their food consumption for the three days prior and calculated their average caloric intake. The data were analyzed by non-paired T-test, Chi-square, Mann-Whitney, and multivariate analyses.

Results There was a significant association between sleep quality and obesity [OR 3.87 (95%CI 1.920 to 7.829)]. Median PSQI (range) score in the obese group was significantly higher than in the non-obese group [6.00 (2-16) vs. 5.00 (2-12), respectively (P=0.0001)]. In addition, sleep latency (P=0.002) and sleep duration (P=0.0001) were significantly different between groups. Multivariate analysis revealed a significant association between poor sleep quality and high caloric intake.

Conclusion Sleep duration in obese adolescents is significantly shorter than that in non-obese adolescents. In addition, sleep latency in obese adolescents was significantly longer than that in non-obese adolescents. **[Paediatr Indones. 2017;57:41-6. doi: 10.14238/pi 57.1.2017.41-6]**.

Keywords: *sleep quality; obesity; adolescents*

Sleep is a universal behavior in every animal species, and has been studied from insects to mammals. It is one of the most significant human behaviors, accounting for roughly one third of human life.[1] Sleep is generally considered to be a restorative process, having beneficial effects on immune function, and essential for physical growth, emotional stability, maintenance of cognitive function, and intellectual growth in adolescence.[2-4] The quality of sleep can be measured by the *Pittsburgh Sleep Quality Index* (PSQI).[5,6]

The most prominent changes in sleep patterns during adolescence are bedtime and waking time. Adolescents go to bed later and get up earlier because of school, and feel increasingly sleepy during the day.[7,8] Sleep deprivation has neurohormonal effects that can lead to increased caloric intake and subsequent obesity.[9,10]

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Childhood obesity has reached epidemic levels globally. The *World Health Organization* (WHO) reported that an estimated 22 million children under 5 years of age and 10% of school-aged children between 5 and 17 years were overweight or obese.[9,11,12] Nutrition and physical activity have been the major focus of research on obesity prevention, while other risk factors such as sleep quality have received much less attention.[13]

We aimed to assess for an association between sleep quality and obesity in adolescents.

Methods

This case-control study was performed in Santo Thomas I High School, Medan, from July 2015 until August 2015. Subjects were students aged 15 to 18 years who provided informed consent. The exclusion criteria were adolescents with at least one obese parent, consumed corticosteroids, or had a family history of diabetes mellitus.

Subjects' weights and heights were measured and their body mass index (BMI) calculated and plotted on the *CDC 2000* BMI curve[14] Subjects were divided into two groups: the case group of obese adolescents and the control group of non-obese adolescents that included underweight, normal weight and overweight subjects. Subjects filled study data questionnaires and PSQI. Subjects' food consumption was verified by interview and we calculated the average caloric intake for the three days prior. A food model was used to help subjects describe the amount of food they had consumed.[15] *The Nutrisurvey Program* was used to calculate caloric intake. High caloric intake was defined to be a higher than average caloric intake, according to the Indonesian Ministry of Health Regulation [*Peraturan Menteri Kesehatan Indonesia* (*Permenkes*)] No. 13/1975. Non-high caloric intake was defined to be average or lower than average caloric intake, according to the Ministry of Health Regulation.[16]

The PSQI is an effective instrument for measuring quality of sleep. The PSQI can be used to differentiate "poor" and "good" sleep quality by measuring seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medications, and daytime dysfunction over a one-month period. A global score of ≤5 indicates a "good" quality of sleep, while global score of >5 indicates a "poor" quality of sleep, with higher scores reflecting poorer sleep quality.[6]

This study was approved by the Research Ethics Committee of the University of Sumatera Utara Medical School. Data were analyzed by non-paired T-test, Chi-square test, Mann-Whitney test, and multivariate analysis. Level of significance was defined by $P<0.05$ with 95% confidence intervals.

Results

A total of 227 adolescents who fulfilled the inclusion criteria were divided into two groups: the case group of 101 obese adolescents and the control group of 126 non-obese adolescents. Subjects' characteristics are described in **Table 1**. More males in obese group.

Differences in PSQI score and caloric intake between groups are shown in **Table 2**. Overall PSQI scores are a total of the individual component scores. Obese subjects had higher median sleep latency and duration scores than the non-obese subjects, indicating poorer quality in these two components of the PSQI. Median caloric intake was based on food consumption for three days and obese subjects also had significantly higher caloric intake than the non-obese group.

Table 1. Baseline characteristics of subjects

Characteristics	Obese group (n=101)	Non-obese group (n=126)
Gender, n (%)		
Male	62 (61.4)	50 (39.7)
Female	39 (38.6)	76 (60.3)
Median age (range), years	16.0 (15.0-17.9)	15.8 (15.0-17.9)
Mean body weight (SD), kg	87.5 (13.5)	60.5 (10.0)
Median body height (range), cm	165.0 (142-179)	162.0 (147-181)
Median BMI (range), kg/m^2	31.2 (24-47)	23.0 (17-29)

A comparison of sleep quality and obesity is shown in **Figure 1**. Poor sleep quality was found in 55.8% of obese subjects and 44.2% of non-obese subjects.

The associations between obesity and sleep quality as well as obesity and caloric intake are shown in **Table 3**. The risk of obesity in males with poor sleep quality was higher than that in females (OR 4.3 *vs.* 3.7, respectively). Caloric intake was categorized as

Table 2. The distribution of PSQI score and quantity of caloric intake between obese and non-obese group

Variables	Obese group (n=101)	Non-obese group (n=126)	P value
Median PSQI (range)	6.00 (2-16)	5.00 (2-12)	0.0001
Median PSQI components (range)			
Subjective sleep quality	1.00 (0-3)	1.00 (0-2)	0.348
Sleept latency	1.00 (0-3)	1.00 (0-3)	0.002
Sleep duration	2.00 (0-3)	1.00 (0-3)	0.0001
Habitual sleep eficiency	0.00 (0-3)	0.00 (0-2)	0.137
Sleep disturbance	1.00 (0-3)	1.00 (0-3)	0.291
Use of sleeping medication	0.00 (0-3)	0.00 (0-3)	0.088
Daytime dysfunction	1.00 (0-3)	1.00 (0-3)	0.464
Median caloric intake (range), kcal	2,682.40 (1,961-3,233)	2,212.20 (1,534-2,799)	0.0001

*Mann-Whitney test
0-3 value based on scoring PSQI questionnaire for every components
Subjective sleep quality : 0= very good 1= good, 2=poor, 3=very poor
Sleep latency : total score of
- Time falling asleep 0=<15 minutes 1=16-30 minutes 2=31-60 minutes 3= >60 minutes
- Cannot sleep in 30 minutes 0=not during the past month 1=less than once a week 2=once or twice a week 3=three or more times a week

Sleep duration 0=> 7 hours 1=>6-7 hours 2=5-6 hours 3=<5 hours
Sleep efficiency : 0: ≥85% 1=75-84% 2=65-74% 3=<65%
Sleep disturbance, Use of sleeping medication, Daytime dysfunction :
0=not during the past month 1=less than once a week 2=once or twice a week 3=three or more times a week

Table 3. The association of sleep quality and caloric intake with obesity

Variables	Obese group (n=101)	Non-obese group (n=126)	P value*	OR	95% CI
Sleep quality, n(%)					
Male					
Poor	45 (72.6)	19 (38.0)	0.001	4.3	1.94 to 9.60
Good	17 (27.4)	31 (62.0)			
Female					
Poor	32 (82.1)	42 (55.3)	0.005	3.7	1.45 to 9.42
Good	7 (17.9)	34 (44.7)			
Caloric intake, n(%)					
High	91 (90.1)	61 (48.4)	0.0001	9.7	4.62 to 20.33
Not high	10 (9.9)	65 (51.6)			

*Chi-square

Table 4. The association between sleep quality and caloric intake

Sleep quality	High caloric intake (n=152)	Not high caloric intake (n=75)	P value*	OR	95% CI
Poor	103 (67.8)	35 (46.7)	0.002	2.40	1.36 to 4.23
Good	49 (32.2)	40 (53.3)			

*Chi-square

high or not-high. A significantly higher percentage of obese subjects (both males and females) had poor sleep quality than did non-obese subjects [males: 72.6% *vs.* 38.0%, respectively (P=0.001); females: 82.1% *vs.* 55.3%, respectively (P=0.005)].

The association between sleep quality and caloric intake is shown in **Table 4.** There was a significant association between poor sleep quality and high caloric intake (OR 2.40; P=0.002).

Multivariate analysis of variables that contributed to obesity with P<0.25 is shown in **Table 5**. Overall, high caloric intake was the strongest factor that contributed to obesity.

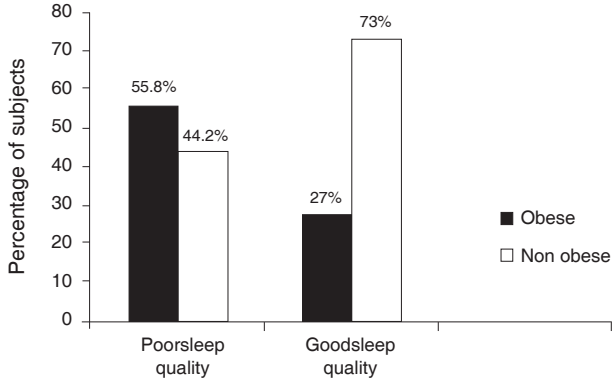

Figure 1. Comparison of obesity and sleep quality

Table 5. Multivariate analysis of factors that contribute to obesit

Variables	P value	OR	95% CI
Sleep quality	0.0001	3.87	1.92 to 7.83
Gender	0,0001	4.02	2.03 to 7.97
Caloric intake	0.0001	12.03	5.23 to 27.66

*Chi-square

Discussion

Obesity is the accumulation of excess body fat which may adversely affect health.[17] High rates of childhood obesity have been evident not only in developed countries, but in recent years developing countries have also joined the trend.[18] The prevalence of obesity in Indonesia has reached 10.3%, with nearly the same incidence reported in Medan (10.4%).[19,20] In this study, the mean body weight of both the obese and non-obese groups exceeded normal body weight, according to *Angka Kecukupan Gizi* (recommended daily allowance/ RDA) recommendations, that is, 46-56 kg for males and 46-50 kg for females.[16] The median body heights of both groups were appropriate, for age according to RDA recommendations, that is, 155-165 cm. The BMI in both groups exceeded the RDA recommendation, that is, 18.42-20.56 kg/ m2 for males and 19.14-20.02 kg/m2 for females.[16] This result may have been due to the inclusion of overweight subjects in the non-obese group.

We found that the risk of obesity in males was greater than that in females. Our finding is consistent with studies in Brazil and South Korea, which found that 53% of obese adolescents were male. The higher likelihood of being overweight or obese among male youths may be associated with testosterone, which is actively produced during puberty. Testosterone decreases serum leptin secretion by 62%.[21,22] Leptin is a hormone that controls satiety. Low leptin levels lead to an increase in appetite.[11,21] Several epidemiological studies have noted links between obesity and sleep.[12] The major sleep problem among adolescents is sleep deprivation. 23 Sleep duration also contributes to sleep quality.[6,12]

In our study, most adolescents had poor sleep quality, and the median PSQI score in the obese group was significantly higher than that in the non-obese group. A study in Lebanon found that 58.7% of adolescents had poor sleep quality with the mean PSQI score was 6.57 and a range of PSQI scores of 3 to 10. 24 In addition, a Texas study stated that in obese woman aged 16 - 40 years, the mean PSQI score was 6.2. 25 Our median PSQI scores were similar to that in the Lebanon (6.57) and Texas studies.

Shorter sleep duration is associated with increased ghrelin levels and decreased leptin levels. Ghrelin increases the appetite, whereas leptin reduces it; hence, these hormonal changes lead to an increase in appetite.[25-27] Furthermore, later bedtimes may provide more opportunities to eat. These conditions together tend to lead to an increased caloric intake. Short sleep duration also causes tiredness and daytime drowsiness, which in turn can lead to decreased physical activity and a preference for watching television.[27] Finally, some evidence has shown that when people sleep less, their core body temperature drops. All of these mechanisms (increased calori intake and decreased physical activity) have roles in altered energy expenditure.[9]

We found a significant difference in sleep duration between the two groups. The median score of sleep duration in obese group was 2 which means that the obese group had a sleep duration of 5 to 6 hours, whereas median score in the non-obese group was 2 which means the non obese had sleep duration ≥6 to 7 hours. Similarly, previous studies showed that increased BMI was associated with shorter sleep duration.[28,29]

Sleep latency was also significantly different between the two groups. A Sao Paulo study in obese adolescents aged 15 to 19 years reported that 63.3%

of subjects slept less than 8 hours per day, and 87.27% of the subjects reported that their sleep latency was more than 30 minutes.[30] We found that 55.8% of subjects with poor sleep were obese. Previous studies in Pekanbaru and Atlanta, reported that 39.4% and 43.7% of poor sleepers were obese.[31,32]

Several limitations in this study were the case-control method, the dependence on subjects' memory for data recollection, which may have been subject to recall bias, and the lack of data on daily physical activity and sedentary lifestyle.

In conclusion, there is a significant relationship between poor sleep quality and obesity in adolescents. Sleep duration in obese adolescents is significantly shorter than that in non-obese adolescents. In addition, sleep latency in obese adolescents was significantly longer than that in non-obese adolescents.

Conflict of Interest

None declared.

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