Association between obesity and sleep disorders in primary school children: a cross-sectional study

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ABSTRACT

BACKGROUND The prevalence of obesity in primary school children in Jakarta has reached 14% in 2013. Among many disorders, obesity can cause sleep disorders. However, sleep disorders in children are often overlooked by parents, even though they can cause physical, social, and psychological impacts. Therefore, it is necessary to find the association between obesity and sleep disorders in primary school children.

METHODS This cross-sectional study was performed between July–September 2015 on 107 children attending Menteng 01 Primary School, Jakarta. Children's weight and height were measured and then their parents filled out the brief infant sleep questionnaire (BISQ). The collected data were analyzed using chi-square.

RESULTS In this study, 20.6% of the children were obese, which was higher than the prevalence of obesity in Jakarta. Meanwhile, sleep disorders occurred in 62.6% of children. Data about children's sleep habits and parents' opinion about their children's sleep were obtained. It showed that snoring and parents' opinion about sleep disorders were factors associated with children's sleep disorder. Statistical analysis also showed a significant association between obesity and sleep disorders in children ($p = 0.037$).

CONCLUSIONS The incidence of obesity in primary school children is high and is associated with sleep disorders.

KEYWORDS children, obesity, primary school, sleep disorders

In 2013, as many as 42 million children under age 5 are overweight or obese worldwide. In Indonesia, 10.8% of primary school children (5–12 years) are overweight and 8% are obese. About 84% of these obese children will remain obese through adulthood. Childhood obesity will affect various aspects of life, such as physical, social, psychological, and so forth. Physical impacts of obesity in children have increased risks of developing chronic diseases, such as hypertension, respiratory problems, diabetes, sleep apnea, hyperlipidemia, and cancer. Social and psychological impacts found in obese children include stigma, emergence of negative feelings, such as anxiety, shame, and a poor self-image.[1–3] Obese children can experience sleep disorders. Epidemiological studies performed in China in 2013 showed that as many as 69.3% of children aged 6–14 years old experience sleep disorders. According to the National Sleep Foundation, being overweight can increase a child's risk of experiencing sleep apnea which is a serious disorder. An increase in one standard deviation of body mass index (BMI) (5.7 kg/

m^2) results in increased risk of sleep apnea as high as 4.2 times.

During sleep, about 75% of growth hormone (GH) is released, >3 times when awake. GH is responsible for stimulating growth, regulating body metabolism, and regenerating all body cells. Sleep disorders in children can affect their growth and development. Unfortunately, it is often overlooked by parents. Therefore, sleep disorders in obese children should be recognized to anticipate early symptoms and prevent its impact. This study was aimed to determine the incidence and association of obesity and sleep disorders in primary school children.[3–5]

METHODS

Study populations

A cross-sectional study was performed from July–December 2015 in 107 elementary school children aged 6–12 years old who attended school in Menteng 01 Primary School, Jakarta during the academic year 2015/2016. The study protocol was approved by the Medical Ethics Committee of Universitas Indonesia (No. 581/UN2.F1.D1/KBK/PDP.01/2015). An ethical clearance amendment for a revision of the title was also approved by the same institution (No. 832/UN2.F1.D1/KBK/PDP.01/2015). Subjects were recruited by consecutive sampling. Subjects were included if they have no special diet program or chronic diseases previously diagnosed by doctor. Subjects' parents were asked to sign the informed consent and fill the questionnaire.

Anthropometry

Anthropometric measurements included weight and height. Weight measurement was done using SECA® 704 scales standardized to the nearest 0.01 kg. Height measurement was done using a measuring height SECA® 206 to the nearest 0.1 cm. Each subject's height and weight were measured three times, and the mean value from those measurements was used to calculate BMI. BMI was calculated by dividing weight (kg) by square of height (m^2) and then plotted to the US National Center for Health Statistics-Centers for Disease Control and Prevention BMI-for-age percentiles charts for boys/girls to determine their nutritional status. The subjects were classified as obese when their BMI were plotted at the 95th percentiles and above.[6]

Brief infant sleep questionnaire (BISQ)

BISQ is a questionnaire of sleep evaluation for children, including sleep duration, night waking, way to fall asleep, and opinion on the children's sleep.[7] The questionnaire consists of 13 questions that assess a child's sleep in the last 2 weeks and is filled by people who know the children's sleep patterns, such as parents or caregivers. Sleep disorders were defined when there were one or more conditions, such as sleep duration of fewer than nine hours a night (the National Sleep Foundation recommends that primary school-age children should sleep 9–11 hours a day),[8] waking up at night >3 times, and staying awake >1 hour.

Data analysis

The data were analyzed using univariate and multivariate analysis. Univariate analysis was performed to see the frequency distribution of the data. Bivariate analysis was performed to determine an association between dependent and independent variables in this study. Data were analyzed using chi-square test of hypothesis to determine association between two categorical variables. Statistical tests were performed using the Statistical Package for the Social Sciences (SPSS) 23.0 software for Windows.

RESULTS

There were 107 subjects aged 6–12 years old collected in this study, including 51 boys (47.7%) and 56 girls (52.3%). Twenty two children (20.6%) were obese based on nutritional status measurements. Sleep disorders were experienced by 67 children (62.6%) according to the duration of sleep, frequency, and duration of waking up at night. The characteristics of the study participants can be seen in Table 1.

In this study, 66 children (61.7%) sleep <9 hours at night. The average sleep duration each night of all subjects was 8.19 hours, ranging from 6–12 hours. Most of them started sleeping at 21:00 pm, with the earliest and latest time was at 18:00 pm and 23:00 pm respectively. Fifty four children (50.5%) were reported waking up at night, mostly were 1–2 times every night for 5–10 min each time and only one child woke up for 2 hours at night. A total of 21 children (38.9%) were awakened due to hot/cold weather, while others were caused by urge to urinate, noise, hunger, falling off the bed, nightmares, accidentally hit by his/her co-sleeping partner, thirst, and wetting the bed (Table 1).

Table 1. Children's characteristics

Variables	Frequency n (%)
Gender	
Male	51 (47.7)
Female	56 (52.3)
Nutritional status	
Obese	22 (20.6)
Not obese	85 (79.4)
Sleep disorders	
Yes	67 (62.6)
No	40 (37.4)
Sleep duration	
>9 hours	41 (38.3)
<9 hours	66 (61.7)
Wake up at night	
Yes	54 (50.5)
No	53 (49.5)
Cause of waking up	
Hot/cold weather	21 (38.9)
Urge to urinate	18 (16.8)
Noise	4 (7.4)
Hungry	3 (5.6)
Falling off the bed	3 (5.6)
Nightmare	2 (3.7)
Others*	3 (5.6)
Snoring	
Always	5 (4.7)
Sometimes	41 (38.3)
Never	61 (57)
Sleep location	
Child own room	29 (27.1)
Co-sleeping with parents	47 (44)
Co-sleeping with siblings	31 (29)
Sleep position	
Supine	14 (13.1)
Prone	2 (1.9)
Lateral	32 (29.9)
Mixed position	59 (55.1)
Activities before sleep	
Straight to bed	68 (63.6)
Lying next to their parents	21 (19.6)
Listening to music	2 (1.9)
Watching television	16 (14.9)
Nap	
Yes	69 (64.5)
No	38 (35.5)
Parents' opinion about child sleep pattern	
Very good	14 (13.1)
Good	63 (58.9)
Fair	23 (21.5)
Poor	7 (6.5)
Parents' opinion about sleep disorders	
Not a problem at all	56 (52.3)
Minor problem	17 (15.9)
Serious problem	34 (31.8)

*Others refers to awakened by the hot/cold weather, and the others were awakened by the noise, hunger, urge to urinate, fall off the bed, nightmare, accidentally hit by his co-sleeping partner, thirsty, and wet his/her bed

During their sleep, 5 children (4.7%) always snore, 41 children (38.3%) snore sometimes, and the remaining children never snore (Table 1). Snoring is often found in obese children. Snoring was experienced by 9 obese children (8.4%) and 37 non-obese children (34.6%). Meanwhile, 13 obese children (12.1%) never snore. Statistical analysis showed that snoring was associated with sleep disorders ($p < 0.001$).

Location is one of the contributors to sleeping disorders. It can be categorized into sleeping in their own bedroom, or co-sleeping with parents and siblings using different or same bed (bed-sharing).[9,10] In this study, 29 children (27.1%) sleep in their own bedroom, 47 children (44%) co-sleep with their parents, and 31 children (29%) co-sleep with their siblings. Bed-sharing was found in 59 children of the co-sleeping category.

Activities before sleep, position and nap are another recorded contributors of sleep disorders. A total of 68 children (63.6%) went straight to bed, while others lie next to their parents before falling asleep, fall asleep while watching television or listening to music. Less than half of the children slept in one position, with lateral position as the most common position (29.9%). Nap was found in 69 children (64.5%) with an average duration of 1.8 hours, ranging from 0.5–5 hours.

Parents' opinion about sleep disorders was also measured. More than half of parents (58.9%) stated that their children's sleep pattern was good and only 6.5% stated it as poor. Moreover, 52.3% of parents perceived sleep disorders as not a problem and thus required no special attention (Table 1). Statistical analysis found that parents' opinion about their

Table 2. Relationship between obesity and sleep disorders

Variable	Sleep disorders		*p*	OR (95% CI)
	Yes, n (%)	No, n (%)		
Nutritional status				
Obese	18 (16.9)	4 (3.8)	0.037	3.306 (1.031–10.607)
Not obese	49 (45.6)	36 (33.7)		
Snoring				
Yes	46 (43.0)	0 (0.0)	**<0.001**	-*
No	21 (19.6)	40 (37.4)		
Parents' opinion about children sleep pattern				
Very good/good	50 (46.7)	27 (25.2)	0.427	1.416 (0.599–3.348)
Fair/poor	17 (15.9)	13 (12.1)		
Parents' opinion about sleep disorders				
A problem	41 (38.3)	10 (9.3)	**<0.001**	4.731 (1.986–11.271)
Not a problem at all	26 (24.3)	30 (28.0)		

OR=odds ratio; CI=confidence interval
*OR cannot be obtained

children's sleep pattern had no association (p = 0.427; OR 1.416; 95% CI 0.599–3.348), while parents' opinion about sleep disorders had a significant association with sleep disorders (p < 0.001; OR 4.731; 95% CI 1.986–11.271) (Table 2).

In this study, 18 obese children (16.9%) and 49 non-obese children (45.6%) had sleep disorders. There was a significant association found between obesity and sleep disorders in this study (p = 0.037; OR 3.306; 95%CI 1.031–10.607) (Table 2).

DISCUSSION

The prevalence of obese children in this study was 20.6% (Table 1), which is higher than the prevalence in Jakarta in 2013 (14%). The high prevalence can be related to parents' upper middle-income status. High socio-economic status affects lifestyle, including access to food and physical activity pattern, that modify the calorie balance.[2,11,12]

Sleep disorders were experienced by 62.6% of children (Table 1), which is higher compared to prevalence of the study performed by Sekartini and Adi[9] (44.2%). This study used the same questionnaire (BISQ) but with different subjects' age (under 3 years old). However, it is still lower than the prevalence of sleep disorders found by Wang et al[5] in China (69.3%) which was conducted in children with the same age range using different questionnaires (Child's sleep habits questionnaire/CSHQ). This can be caused by several factors, including lack of parents' concern regarding children's sleep pattern. Children's sleep pattern is formed in the family and parental factor play an important role in the formation of good sleep pattern for children. Other important contributing factors include environment of home or bedroom and internal factors from the child.[5,9]

Most children experiencing sleep disorders were caused by a shorter duration of night sleep according to age. Children aged 6–12 years require 9–11 hours of sleep a night,[8] but 61.7% of them slept <9 hours,[7] showing a lack of sleep quantity. This is usually caused by difficulty in falling asleep (delayed sleep onset) and/or maintaining sleep (prolonged waking). Aside of quantity issue, sleep disorders can also be caused by lack of sleep quality. This was characterized by waking up several times (>3 times) or for a long duration (>60 min) that cause sleep fragmentation. In this study, only one child was found to have a lack of sleep quality.[9]

Child's bed can also affect sleep patterns. In this study, 44% of children co-sleep in their parents' bedroom, with 31.8% also share bed with their parents. A study by Sekartini and Adi[9] showed that no child should sleep with their parents. Parents usually sleep later and wake up earlier than their child, leading the child to follow the parents' sleep time. Besides, children who sleep with their parents have an increased risk of getting wedged and falling out of bed. Zhang et al[10] also reported similar findings. If children insist on

sleeping with their parents, they should use a separate bed. Similar effect is also found when children sleep with their siblings because it can affect each other's sleep pattern. Children who sleep in their own room can sleep longer at night, fall asleep faster, wake up less frequently at night, and wake up shorter at night than those sleeping with their parents. Therefore, children should sleep separately from their families. If it is not possible, then parents can help by scheduling children's sleep every day and not letting them involved in parents' activities.[9]

Activities before sleep can affect the time to fall asleep at night. Activities that stimulate children physiologically, cognitively, and emotionally should be avoided. In this study, there were children who listen to music and watch TV before going to bed. These activities can increase the time needed to fall asleep and reduce total sleep duration. Nuutinen et al[13] found that the presence of electronic media in bedroom contributes to poor sleep quality, irregular sleep habits, reduced sleep duration, late sleep/wake up, and irregular sleep-wake patterns. Therefore, children should not do any stimulating activities before sleep.

Sleeping position also affects the quality of sleep. The best sleeping position is lateral position because the body is in an entirely resting position. Moreover, this position is also the best one for people who snore. Kim et al[14] found that children who sleep in supine position tend to snore compared to those who sleep in other positions. In this study, 29.9% of children slept in lateral position whereas others slept in various positions. Thus, children should be accustomed to lying down in a lateral position.[14]

Snoring may indicate presence of sleep apnea that can affect sleep patterns, such as shortened sleep time, reduced sleep efficiency, disturbed sleep, reduced rapid eye movement sleep, and increased heart rate. In this study, 43% of children snored during their sleep (Table 1). Children who are obese tend to snore while sleeping. This is associated with fat deposition around the respiratory tract that causes airways clogging. Snoring was found in 40.9% of obese children from this study and statistical analysis showed an association with sleep disorders (Table 2). Snoring can also be caused by adenotonsillar tissue growth that narrows the upper airway lumen. The adenoidal-nasopharyngeal space becomes narrow at the age of 4–5 years, and then adenoid reaches its largest size at 7–10 years when the facial frame develops rapidly. This combination causes a narrowing of the upper airways resulting in snoring.[14,15]

Napping also can affect night sleep habits. The number and duration of naps vary according to age. In this study, 64.5% of children still nap with an average duration of 1.8 hours (Table 1). Naps should be done on a regular schedule. When nap time is skipped, the child should not nap and stay awake until the next sleep period. This aims to keep children's regular sleep pattern. Nap duration is also influential. Children with longer nap have later sleep time, resulting in reduced night sleep duration and waking up late in the morning.[4]

Parents sometimes do not notice the children's sleep pattern. In this study, 58.9% of parents believed their child's sleep pattern were good, even 13.1% stated very good. Though the prevalence of sleep disorders was very high, there was still a lack of parents' knowledge on the importance of sleep for children's growth. More than half parents (52.3%) considered sleep disorder in children as not a problem at all and only 31.8% consider it as a serious problem (Table 1). This data shows a poor parental knowledge on sleep, although there is a significant association between parents' opinion about sleep disorders and their children's sleep disorders from this study (Table 2). Therefore, more effort is required to ensure parents understanding on children's sleep requirements, good sleep hygiene, and signs of sleep problems. Parents were asked to make sleep diary/journal consisting of children's bedtime, sleep latency, wake time and daytime nap duration every day to increase awareness on their children's sleep pattern. Parents must be made aware of the negative effects that will occur if sleep disorders go untreated. McDowall et al[16] found that parents with increased sleep knowledge were more likely to report earlier bedtimes, wake times, and more consistent sleep routines for their children.[9,17,18]

Sleep disorders in children affect their growth and development. Children tend to have poor concentration and impaired cognitive function and memory that adversely impact their school performance. It also affects their behavior into more impulsive, irritable and impatient, and increases the risk of anxiety, stress, depression, and attention deficit hyperactivity disorder. There is also increased risk for occurrence of other diseases in the future because of its effect on the body's immune system. Children who experience sleep disorders will feel sleepy

during the day, hard to wake up in the morning, and sometimes headache when waking up. Wahlstrom et al[19] found that postponing school time would increase sleep duration for 1 hour and lead to good results, i.e., increased student attendance, increased concentration of learning during the day, better learning achievement, and reduced the incidence of depression.[20,21]

The association between obesity and sleep disorders was statistically significant ($p < 0.05$; Table 2). The results of this study were similar to a study by Canapari et al.[22] It was performed in children aged 5–18 years and had a statistically significant association between BMI and sleep disorders, especially sleep apnea. Obesity causes fat deposition in various places in the body. Fat deposited around the upper airway causes narrowing of the airway thus increasing the likelihood of collapse. Deposition of fat in the abdominal wall results in reduced lung volume. Therefore, people with obesity tend to have less functional residual capacity (FRC) when compared to people with normal weight.[22–24]

Adipocytes in human body produce adipocyte-derived proteins, such as lipoprotein lipase, hormone-sensitive lipase, and perilipin. These proteins affect fat metabolism, causing increased CO_2 production and breathing needs. Moreover, leptin resistance causes respiratory depression. Leptin plays an important role in lung development and influences the distribution of muscle fibers in the diaphragm. Disruption of leptin signals can affect the control of the respiratory muscles in the upper airways which causes nocturnal hypoventilation.

In obese children with obstructive sleep apnea, the oxygen entering the body is less coupled with reduced FRC, leading to increasingly severe desaturation in each breath. This hypoxic state can cause vascular inflammation in the brain, also increase the risk of cardiovascular disease and other related diseases.[24,25]

The number of children who experiencing sleep disorders is not followed by parents' awareness on children's sleep pattern, even though sleep disorders have a variety of negative impacts. Sleep disorders can be prevented by doing sleep hygiene to maintain a consistent sleep schedule for bedtimes, wake up times, and nap times.[26] The limitations of this study were the use of questionnaires filled by parents allowing for information bias. The description of sleep in this study relied on parents who may become less aware of their child's sleep after they grew older. A study by Owens et al[15] found that parents are less accurate reporters of sleep disruptions for school-aged children than for younger children. Besides, the tools used in this study only assess simple sleep pattern and behavior.Other tools are needed to find out the types of sleep disorder. This study was performed in a cross-sectional method so the causal relationship cannot be known. In the future, a similar study with larger samples, other methods, and other tools may be needed.

In conclusion, obesity is associated with sleep disorders in primary school children. High incidence of obesity leads to higher incidence of sleep disorders. Parents need to be aware of their children's nutritional status and sleep pattern. Parents' knowledge is still lacking and thus an education needs to be given about the importance of sleeping in children.

Conflict of Interest
The authors affirm no conflict of interest in this study.

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