

## Quality of sleep and hypertension in adolescents

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### Abstract

**Background** Adolescents with hypertension are at risk of morbidity and mortality due to cardiovascular problems in later life. Hypertension may be influenced by poor quality of sleep, so early detection of hypertension and ensuring good quality of sleep in adolescence is needed.

**Objective** To assess for a possible association between poor sleep quality and hypertension in adolescents.

**Methods** We conducted a cross-sectional study from January to March 2013 in Mustafawiyah Boarding School, Mandailing Natal, North Sumatera. Subjects' quality of sleep was assessed by the *Pittsburgh Sleep Quality Index* (PSQI) questionnaire and their systolic and diastolic blood pressures were measured. Quality of sleep was categorized as either good or poor. Blood pressure was categorized as either normotensive or hypertensive. An association between poor sleep quality and hypertension was analyzed by Chi-square test.

**Results** Two hundred forty adolescents participated in this study, of whom 210 (87.5%) subjects were normotensive and 30 (12.5%) subjects were hypertensive. We found higher systolic blood pressure [114.9 (SD 11.7) vs. 109.5 (SD 10.5)] mmHg as well as diastolic blood pressure [74 (SD 9.1) vs. 69.9 (SD 7.5)] mmHg in adolescents with poor sleep quality compared to those with good sleep quality ( $P=0.001$ ).

**Conclusion** Poor sleep quality is associated with hypertension in adolescents. [Paediatr Indones. 2016;56:272-6. doi: 10.14238/pi56.5.2016.272-6].

**Keywords:** adolescent; blood pressure; sleep quality

Hypertension has long been known as one of society's common health problems. Health care workers should be on the alert for hypertension in children and adolescents because the condition can continue to adulthood. Hypertension increases the risk of morbidity and mortality due to cardiovascular problems.<sup>1,2</sup>

A study in the Dallas Independent School District in 1976-1977 found that the prevalence of systolic blood pressure and diastolic blood pressure affected by school-aged children was probably between 0.37% and 1.2%, respectively, while the rate of the incidence of hypertension in children and adolescents was probably between 1% to 3%.<sup>3</sup> In Indonesia, the incidence of hypertension in children and adolescents varied from 3.55 to 4.6%.<sup>1</sup>

Past studies have noted that more than 80% of adolescent hypertension cases are due to essential hypertension, followed by kidney disease.<sup>1,3</sup> Risk factors for elevated blood pressure in adolescents

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include heredity, age, sex, salt intake, lifestyle, stress, and obesity.<sup>4-6</sup> Nevertheless, a lesser known risk factor for hypertension is sleep quality.<sup>7-10</sup> The aim of our study was to assess for a possible association between sleep quality and hypertension in adolescents.

## Methods

The cross-sectional study was done from January to March 2013 to evaluate for a correlation between sleep quality and blood pressure in adolescents from the Mustafawiyah (*Pesantren*) Boarding School in Penyabungan Subdistrict, Mandailing Natal District, North Sumatera. The inclusion criteria consisted of children aged 11 to 16 years who were physically and mentally healthy and provided informed consent for participation. The exclusion criteria consisted of chronic diseases which could affect blood pressure, such as nephrotic syndrome or cardiovascular abnormalities, a history of parental hypertension, obesity, smoking, or caffeine consumption.

The *Pittsburgh Sleep Quality Index* (PSQI) is a standard questionnaire used for assessing sleep quality within the previous month. The reliability of PSQI for the whole scores had Cronbach alpha of 0.83. Validation was done by using a cut-off score of 5 on the PSQI, which yielded a sensitivity of 89.6% and specificity of 86.5%.<sup>12</sup> The PSQI consists of 10 score points of general sleep quality and followed by seven score components such as sleep quality, latent sleep, sleep duration, efficient sleep habits, insomnia, use of sleeping pills, and problems functioning during the day in the previous month. Each assessment component was scored from 0 (no problem) to 3 (problem). Hence, all components add up to a score of 0 to 21. Using a PSQI cut-off score of 5, scores of <5 were categorized to be good sleep quality, and scores > 5, were categorized to be poor sleep quality.<sup>12</sup> A PSQI cut-off score of 5 had sensitivity of 89.6% and specificity of 86.5%.<sup>12</sup>

A total of 467 adolescents filled the PSQI questionnaires. Their heights, weights, and blood pressures were measured. Of these, 240 adolescents met the inclusion criteria, 133 with good sleep quality and 107 adolescents with poor sleep quality.

Hypertension was defined to be the mean systolic

blood pressure and/or diastolic blood pressure (based on 3 or more measurements) above the 95<sup>th</sup> percentile for age, sex, and height at the 4<sup>th</sup> task force.<sup>10, 11</sup>

The data were processed and analyzed with SPSS for Windows version 15.0 software. Chi-square test was used to assess for a correlation between poor sleep quality and elevated blood pressure, and T-test was used to assess for disparity of the mean systolic and diastolic blood pressures between adolescents with good and poor sleep quality, as well as risk ratio (RR). Results were considered to be statistically significant for P values <0.05 with 95% confidence interval (CI). The study was approved by the Ethics Committee of the University of Sumatera Utara Medical School, Medan, North Sumatera.

## Results

The 240 subjects were grouped according to sleep quality (good vs. poor) and according to blood pressure status (normotensive vs. hypertensive), for the purposes of statistical analysis.

**Table 1.** Characteristics of subjects

Characteristics	All (N=240)	Normotensive group (n=210)	Hypertensive group (n=30)
Gender, n(%)			
Male	150 (62.5)	141 (67.1)	9 (30)
Female	90 (37.5)	69 (32.9)	21 (70)
Mean age (SD), years	14.7 (0.9)	14.8 (0.9)	21 (70)
Mean body height (SD), cm	151.5 (7.5)	151.7 (7.7)	150.1 (5.7)
Mean body weight (SD), kg	48.7 (8.3)	48.6 (8.4)	49.4 (7.9)

**Table 1** shows that the of the 240 subjects, 150 (62.5%) were male and 90 (37.5%) were female. Thirty (12.5%) subjects were hypertensive and 210 adolescents (87.5%) were normotensive. Of the 30 hypertensive subjects, 9 were male (30%) and 21 were female (70%). The mean age of all subjects was 14.7 (SD 0.9) years, the mean height was 151.5 (SD 7.5) cm, and the mean weight was 48.7 (SD 8.3) kg.

Of 240 adolescents, 133 (55.5%) had good sleep quality, comprised of 91 (68.4%) males and 42 (31.6%) females. The 107 (44.5%) adolescents with poor sleep

**Table 2.** Distribution of male and female subjects according to sleep quality as assessed by PSQI

Characteristics	Good sleep quality group (n=133)	Poor sleep quality group (n=107)
Gender, n(%)		
Male	91 (68.4)	48 (44.9)
Female	42 (31.6)	59 (55.1)

quality comprised of 48 males (44.9%) and 59 females (55.1%) (Table 2).

The PSQI components for assessing sleep quality are shown in Table 3. We noted that 26/30 (86.7%) adolescents with hypertension had < 5 hours of sleep per day.

Table 4 shows that the mean systolic blood

**Table 3.** Components of sleep quality from the PSQI

Sleep quality index	Hypertensive group (n=30)	Normotensive group (n=210)
When do you usually go to bed? n(%)		
< 9pm	2	28 (13.3)
9pm-12am	21	143 (68.1)
>12am	7	39 (18.6)
How long does it take you to fall asleep each night? n(%)		
<15min	9	98 (46.7)
16-30min	8	79 (37.6)
31-60min	10	23 (11)
>60min	3	10 (4.8)
When do you usually get up in the morning? n(%)		
<4am	12	40 (19)
4-6am	18	153 (72.9)
>6am	0	17 (8.1)
How many hours of actual sleep do you get at night? n(%)		
<5hours	26	37 (17.7)
>5hours	4	173 (82.3)
Cannot get to sleep within 30min, n(%)		
Not during the past month	30	210 (100)
Wake up in the middle of the night or early morning, n(%)		
Not during the past month	23	183 (87.1)
<1x/week	3	18 (8.6)
1-2x/week	2	7 (3.3)
≥3x/week	2	2 (1)
Use the bathroom at night, n(%)		
Not during the past month	25	186 (88.6)
<1x/week	1	16 (7.6)
1-2x/week	3	6 (2.9)
≥3x/week	1	2 (1)
Cannot breath comfortably, n(%)		
Not during the past month	30	210 (100)

**Table 4.** Mean systolic and diastolic blood pressures

Blood pressure	Sleep quality		P value
	Poor	Good	
Mean systolic (SD), mmHg	114.9 (11.70)	109.5 (10.50)	0.001
Mean diastolic (SD), mmHg	74 (9.10)	69.9 (7.50)	0.001

pressure in the poor sleep quality group was significantly higher than that of the good sleep quality group [114.9 (SD 11.7) vs. 109.5 (SD 10.5) mmHg, respectively; (P=0.001)]. In addition, the mean diastolic blood pressure in the poor sleep quality group was significantly higher than that of the good sleep quality group [74 (SD 9.1) mmHg vs. 69.9 (SD 7.5)

Sleep quality index	Hypertensive group (n=30)	Normotensive group (n=210)
Cough or snore loudly, n(%)		
Not during the past month	30	189 (90)
<1x/week	0	17 (8.1)
1-2x/week	0	4 (1.9)
Feel to cold, n(%)		
Not during the past month	30	204 (97.1)
<1x/week	0	6 (2.9)
Feel to hot, n(%)		
Not during the past month	27	207 (98.6)
<1x/week	2	0
1-2x/week	1	3 (1.4)
Have bad dreams, n(%)		
Not during the past month	29	200 (95.2)
<1x/week	0	0
1-2x/week	1	3 (1.4)
Have pain, n(%)		
Not during the past month	28	205 (97.6)
<1x/week	2	5 (2.4)
Other reason for trouble sleeping? n(%)		
Not during the past month	30	208 (99)
<1x/week	0	2 (1)
Drug consumption, n(%)	30	210 (100)
How often have you had trouble staying awake? n(%)		
Not during the past month	29	205 (97.6)
<1x/week	1	5 (2.4)
Problem solving, n(%)		
Not during the past month	28	204 (97.1)
Minor problems	2	6 (2.9)
Average sleep quality, n(%)		
Very good	0	2 (2)
Good	25	200 (95.2)
Bad	5	8 (3.8)

**Table 5.** Association between sleep quality and blood pressure status

	Blood pressure		P value	RR (95% CI)
	Hypertensive (n=30)	Normotensive (n=210)		
Poor sleep quality	23	84	0.001	4.1 (1.8 to 9.2)
Good sleep quality	7	126		

mmHg, respectively; (P=0.001)].

**Table 5** shows that the incidence of hypertension in the poor sleep quality group was 21.5%, which was much higher than the incidence of hypertension in the good sleep quality (5.2%).

From the statistical analysis, it was found that there was significant disparity in the incidence of hypertension in the group with poor sleep quality compared to the group with good sleep quality (P=0.001). We also found that those with poor sleep quality had a 4.1 times greater risk of hypertension than those with good sleep quality (RR 4.1; 95%CI 1.8 to 9.2).

## Discussion

Past studies have suggested that sleep quality and blood pressure are associated in adolescents. As such, blood pressure should be an important component of routine check-ups.<sup>5,7,10</sup>

A study in the Dallas Independent School District found that the prevalence of elevated systolic was 0.37% and diastolic blood pressure in school-aged children was 12%, while the incidence of hypertension in children and adolescents was 1-3%.<sup>3</sup> From the study in England on 1996 on 14.686 children aged 10 to 15 years found that 4.2% of the children were affected by hypertension.<sup>4</sup> Less than 5% of the children, with the majority of them was adolescent, were affected by hypertension in one blood pressure measurement.<sup>1,3</sup> In Indonesia, the rate of the incidence of hypertension in children and adolescents was reported to be 3.55-4.6%.<sup>1</sup>

In our study of 240 adolescents, 30 (12.55%) had high blood pressure. Subjects' mean age was 14.7 (SD 0.9) years, which indicated that high blood pressure had probably not yet been detected. The prevalence

of hypertension in our study was higher than national figures (3.55-4.6%).<sup>1</sup> A review article in 1996 reported that more male than female adolescents had hypertension.<sup>4</sup> However, we found that more females (70%) than males (30%) were hypertensive.

The Tucson Children's Assessment of Sleep Apnea Study on 230 children aged 6 to 11 years showed a correlation between elevated systolic and diastolic blood pressure and sleep efficiency, respiratory system problems, and obesity.<sup>7</sup> We found a significant disparity in systolic and diastolic blood pressure between adolescents with good sleep quality and adolescents with poor sleep quality. Student's T-test revealed that the mean systolic blood pressure in adolescents with poor sleep quality was significantly higher than that in adolescents with good sleep quality [114.9 (SD 11.7) mmHg vs. 109.5 (SD 10.5) mmHg, respectively; (P=0.001)]. Similarly, the mean diastolic blood pressure in the poor sleep quality group was significantly higher than that of the good sleep quality group [74 (SD 9.1) mmHg vs. 69.9 (SD 7.5) mmHg, respectively; (P=0.001)].

A Columbia University study in between 1982 and 1992 found that <5 hours of sleep per day increased the risk of hypertension (OR 2.10; 95%CI 1.58 to 2.79; P<0.001).<sup>9</sup> We found that 86.7% of our hypertensive subjects (26 adolescents) slept < 5 hours per day. The cohort study in Cleveland, Ohio, 2002-2006 found that healthy adolescents with poor sleep quality were related to the incidence of pre-hypertension with OR 3.5; 95%CI 1.5 to 8.0.7 We also found that a significantly higher percentage of hypertensive subjects were in the poor sleep quality group than were in the good sleep quality group (RR 4.1; 95%CI 1.8 to 9.2; P=0.001).

The theory which supported this study was related to the system of a person's homeostasis which was disturbed because of his poor sleep quality. Disturbances in homeostatic mechanisms can cause brain activity to increase. The increased work load in the brain could stimulate hormone secretion, influencing peripheral, such as through the epinephrine and norepinephrine pathways. Epinephrine brings about the increase in peripheral so that there would be an increase in blood pressure.<sup>13</sup> Another theory is that poor sleep quality increases brain activity and stimulates adrenalin secretion, leading to disturbances in fat metabolism. Consequently, arteriosclerosis

occurs and disturbs the hemodynamic system leading to increased in peripheral and blood pressure.<sup>13,14</sup> A limitation of our study was that sleep quality was measured by a self-reporting questionnaire, which may have been subject to reporting bias. Also, the sample size should have been larger.

In conclusion, poor sleep quality and high blood pressure is significantly associated in adolescents. Using the PSQI questionnaire to assess sleep quality, we find that adolescents with poor sleep quality have a 4.1 times higher risk of hypertension than adolescents with good sleep quality.

### Conflict of Interest

None declared.

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