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Body Mass Index and Abdominal Circumference Towards Hypertension in Adolescent in A Senior High School of South Tangerang, Indonesia

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ABSTRACT
Hypertension is associated with the risk of cardiovascular disease, metabolic syndrome and central obesity. Hypertension that occurs in adolescence will continue into adulthood. This study aims to identify the incidence of hypertension in adolescents and its relationship with body mass index and abdominal circumference. A total of 133 female students and 87 male students at a State Senior High School in South Tangerang, Indonesia were selected using proportional stratified random sampling to be subjects in this cross sectional study conducted in January to August 2018. Blood pressure variables were grouped into normal and prehypertension/hypertension. Body mass index was classified into overweight and not overweight, abdominal circumference was grouped into central obesity and not obesity. The relationship between body mass index and abdominal circumference with prehypertension / hypertension were determined by Chi Square test at a significance level of 0.05. The incidence of prehypertension/hypertension in adolescent girls in the study population was 8.3% and 13.8% in adolescent boys. Prehypertension / hypertension associated with obesity based on BMI ($p < 0.05$; CI 20.650; 2.392-178.306) and abdominal circumference ($p < 0.05$; CI 14.00; 1.77 - 110.57) in adolescent boys, whereas in adolescent girls, prehypertension/hypertension is associated with obesity based on BMI ($p < 0.05$).

Keywords: *Prehypertension, hypertension, BMI, Central Obesity, adolescence*

1. INTRODUCTION

Hypertension is a major contributor to the global disease burden. Systolic blood pressure is a risk factor for stroke and coronary heart disease [1]. High blood pressure in children and adolescents is a growing health problem, along with the epidemic of obesity and physical inactivity around the world. The combined prevalence of high blood pressure and hypertension in children is about 6%, or 3%, respectively. The combined prevalence increases almost fivefold, to about 30%. In Indonesia, the prevalence of hypertension among adolescents aged 15-17 years is 5.3 percent. For boys, it was 6.0% and 4.7% for girls. The prevalence of adolescent hypertension in rural and urban areas is around 5% (rural 5.6%, urban 5.1% in 2013 [2]

High blood pressure in childhood correlates with higher blood pressure and risk of cardiovascular disease (CVD) in adulthood, and this association is strengthened with age. Primary hypertension in children is associated with other risk factors for CVD, including hyperlipidemia and insulin resistance. The child also has target organ damage from hypertension, including left ventricular hypertrophy and pathological vascular changes (i.e., carotid intima-media thickness) [3].

Previous research has documented the main factors for hypertension including age, gender, smoking, exercise, family history, eating habits, and body mass index (BMI). The prevalence of obesity has been increasing worldwide. It is a defining risk factor in many chronic diseases such as hypertension, dyslipidemia, and type 2 diabetes mellitus. High body weight and obesity, through measurement of BMI, are the main causes of this disorder [4]. Assessing the relationship between body mass index (BMI) and hypertension has important public health implications in South Asian countries, where the burden of hypertension is high and obesity is increasing at the population level [5].

Adolescent overweight and obesity are a problem of epidemic proportions worldwide. An estimated 32% of adolescents are overweight or obese. An increase in body mass index (BMI) in adolescence, defined as a period from 10 to 19 years, is strongly associated with morbidity and mortality in adulthood. However, a growing body of research is showing that some of these complications are present during adolescence. Adolescent overweight has been associated with comorbidities such as dyslipidemia, nonalcoholic steatohepatitis, type 2 diabetes mellitus, obstructive sleep apnea, and hypertension [6]. In

Indonesia, prevalence of overweight adolescent aged 16 to 18 years was 1.4% in 2007 and increase to 7.3% in 2013 [2].

Abdominal circumference (AC) can be used to measure obesity and it is also a risk factor of hypertension [7], [8]. However, in adolescent, the use of AC to meaure obesity is limited due to changes in body composition caused by growth and development [8] . Therefore the aim of this study was to describe the incidence of hypertension, association between BMI and the incidence of hypertension, and association between abdominal circumference and the incidence of hypertension in adolescents.

2. METHODS

2.1. Study Design and Sample

The design of this study was cross-sectional, carried out at State Senior High School 6 in South Tangerang, Indonesia from January to August 2018. Total sample 217 students (130 girls and 87 boys) were selected using stratified proportional random sampling.

2.2. Blood Pressure Measurement

Students' blood pressure (BP) was measured 3 times at 5 minute intervals using a digital blood pressure measuring device. The systolic and diastolic blood pressures are the average of 3 measurements. Blood pressure (BP) was classified as normal (BP less than the 90th percentile) prehypertension (BP between the 90th and 95th percentile. In adolescents, BP equal to or exceeding 120/80 mmHg is prehypertension, even if this figure is less than the 90th percentile), or hypertension (BP greater than the 95th percentile) according to the recommendations of the 2004 Fourth Report o the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescent Screening [9] In bivariate analysis, blood pressure is divided into two, namely normal and prehypertension / hypertension (PreHTN/HTN).

2.3. Body Mass Index Measurement

Body Mass Index (BMI) is determined by measuring weight and height and expressed by BMI for age z score (BAZ). Body weight is measured to an accuracy of 0.5 kilograms (kg) using digital scales. Height was measured to an accuracy of 0.1 centimeter (cm) using a microtoise. The BAZ value is calculated using the WHO Anthro Plus software [10] then divided into three categories, namely normal if the BAZ is between -1 and 1 standard deviation (SD), overweight if BAZ is +1 SD and below +2 SD, obesity if BAZ is above +2 SD [11]. For further analysis, BAZ was categorized into normal and overweight / obese.

2.4. Abdominal Circumference Measurement

Abdominal circumference was measured using a metline with an accuracy of 0.1 cm then categorized into 2. Normal if the abdominal circumference is equal to or below 70 cm and obesity if the abdominal circumference is more than 70 cm.

2.5. Statistical Analysis

Blood pressure, body mass index and abdominal circumference were described as mean and standard deviation, whereas hypertension and obesity were described as proportions. The relationship between hypertension and obesity was analyzed using chi-square test at a significance level of 0.05 (p value <005).

2.6. Ethical Clearence

This research has an ethical clearance number 074 / PE / KE / FKK-UMJ / IV / 2018, which was obtained from the ethical committee of the Faculty of Medicine and Health, Universitas Muhammadiyah Jakarta

3. RESULT

Characteristic of sample in this study is described in Table I. Mean of age of sample were 16 years. Mean of Systolic blood pressure, diastolic blood pressure and abdominal circumference in adolescent boys were relatively higher than in adolescent girls. Incident of preHTN in adolescent boys 16.1% was relatively higher than in adolescent girls (8.3%) as well as HTN (14.9% in boys and 10% in girls). Obesity based on BMI and abdominal circumference were higher in adolescent girls than boys.

Based on BMI (Table II), proportion of PreHTN/HTN in overweight/obese adolescent boys was higher (87.5%) compare to adolescent boys with normal BMI but PreHTN/HTN (25.3%). Chi-square test shows that there is a significant relation between BMI and prehypertension/hypertension (p value=0.000). In adolescent girls, proportion of PreHTN/HTN in overweight/obese adolescent was also higher (100%) compare to proportion of PreHTN/HTN in normal BMI and this relationship was significant (p=0.000).

Table III shows the correlation between obesity based on abdominal circumference with PreHTN/HTN. Proportion of adolescent boys with PreHTN/HTN and overweight/obesity was higher (40%) than in adolescent boys with PreHTN/HTN but normal BMI (4.5%). Statistical test result that there was significant association (p=0.002) between BMI and PreHTN/HTN in adolescent boys. Proportion of adolescent girls with prehypertension/hypertension and obesity was also higher (23.2%) than adolescent girls with PreHTN/HTN but not obese.(10.46%) . There was no significant correlation (p=0.070) between abdominal circumference with PreHTN/HTN in adolescent girls.

Table 1. Characteristic of sample

Variable	Value[a]		
	Boys n=87	***Girls n=130***	***Total N=217***
Age (yr.)	16.07 ± 0.74	16.10 ± 0.83	16.09 ± 0.80
Systolic Blood Pressure (mmHg)	117 ± 13.89	109.06 ± 12.27	112.22 ± 13.48
Diastolic Blood Pressure (mmHg)	71.24 ± 7.85	68.63 ± 10.19	69.63 ± 9.39
Abdominal Circumference (cm)	78.71 ± 12.18	72.84 ± 7.51	75.61 ± 11.90
Blood Pressure Classification			
Normal	60 (69.0 (	106 (81.5)	166 (76.5)
Prehypertension (PreHTN)	14 (16.1)	11 (8.5)	25 (11.5)
Hypertension (HTN)	13 (14.9)	13 (10.0)	26 (12.0)
BMI Classification			
Normal	79 (90.8)	126 (96.3)	205 (94.5)
Overweight	6 (6.9)	3 (2.3)	9 (4.1)
Obese	2 (2.3)	1 (8.0)	3 (1.4)
Abdominal Circumference Classification			
Normal	22 (25.3)	48 (36.9)	70 (32.3)
Obese	65 (74.7)	82 (63.1)	147 (67.7)

[a] Values are mean ± SD or No. (%)

Table 2. Association between IMT and Prehypertension/Hypertension in Adolescent

Variable	PreHTN/HTN				Total		p-value	OR
	PreHTN/HTN		Normal		n	%		
	n	%	n	%				
Body Mass Index (Boys)								
Overweight/Obes	7	87.5	1	12.5	8	100	0.000	20.65 (2.39 – 178.31
Normal	20	25.3	59	74.7	79	100		
Body Mass Index (Girs)								
Overweight/Obes	4	100	0	0	4	100	0.000	0.16 (0.11 – 0.24)
Normal	20	15.9	106	84.1	126	100		

Table 3. Association between abdominal circumference and Prehypertension/hypertension in adolescent

Variable	PreHTN/HTN				Total		p-value	OR
	PreHTN/HTN		Normal		n	%		
	n	%	n	%				
Abdominal Circumference (Boys)								
Overweight/Obes	26	40	39	60	65	100	0.002	14.00 (1.77-110.57)
Normal	1	4.5	21	95.5	22	100		
Abdominal Circumference (Girls)								
Overweight/Obes	19	23.2	63	76.8	82	100	0.070	2.59 (0.90 – 7.38)
Normal	5	10.46	43	89.6	48	100		

4. DISCUSSION

Table I shows the characteristics of the samples in this study. The most striking finding was seen in the abdominal circumference classification, where both boys and girls had a prevalence classification of obesity compared to the normal classification. The number of obese categories in the abdominal circumference classification was found to be higher in the boys (74.7%) than girls (63.1%) [8]. This was also found in the study of Pazin et al. (2020) where the average abdominal circumference in boys is higher than in girls (68.5: 66.9). This is thought to be influenced by changes in modern lifestyles, where there are changes in eating habits, physical activity, and sedentary behavior which lead to an increase in BMI and obesity in the present [12]. Study conducted by Y, Wang in China was also found that overweight/obesity adolescent boys 1.5 times more likely to consume calories and sugar sweetened beverages exceeded DRI recommendation by China Standard than girls [13]

In the hypertension category, it was found that most adolescents were in the normal category in both boys and girls (69%: 81.5%, respectively). Meanwhile, the incident of pre-hypertension was found to be more in boys (16.1%) than in girls (8.5%), likewise the incident of hypertension was also found to be more in boys (14.9%) than in girls (10.0%). The study conducted by McNiece et al. (2007) also found a similar case, where boys have a higher incidence of pre-hypertension rates (15.94%) than girls (8.62%). Likewise, the incidence of hypertension where this incidence was more common in boys (2.20%) than girls (0.79%) [14].

In the BMI classification, this study found that most of the sample groups had a normal BMI classification. However, it was also found that the incidence of adolescent with the overweight category was found more in boys (6.9%) than in girls (2.3%). Marques et al. (2018) in their study also found the same results, namely the

prevalence of the overweight category was more found in boys than in girls (17.6%: 16.4%) [15].

Various factors that influence the trends in the incidence of hypertension and obesity in adolescents. One of the factors is lack of execise. Study that conducted by Mahfouz, et.al. in Saudy Arabia found that adolescent with lack of physical class exercise practice in the previous week 1.4 times more to be obesity (aOR = 1.452, 95% CI = 1.149-2.117) [16]. Other factors associate with incidence of hypertension were overweight/obese (AOR-5.7 95%CI- 2.4-13.6), low fruit consumption (AOR-2.02 95% CI-1.499-2.7) and high soft drink consumption (AOR-2.21 95%CI- 1.446-3.39) [17].

Based on BMI, this study found a significant relationship between being overweight/obese and PreHTN/HTN. Adolescent Boys who are overweight are 20.65 times more likely to experience PreHTN/HTN, while adolescents girls whose BMI is normal are prevented from PreHTN/HTN. These results confirm the research conducted by Freedman and Berenson, Sorof and Daniels and Wang, et al. Freedman and Berenson found that children who participated in the Bogalusa Heart Study who were overweight were 4.5 times more likely to have an increase in systolic blood pressure (SBP) and a 2.4 times increase in diastolic blood pressure (DBP) [18]. A school-based hypertension and obesity screening study conducted by Sorof and Daniels noted that the prevalence of hypertension in obese adolescent was 3 times higher than non-obese adolescents [19], while study by Wang et.al in Shandong, China, found that children and adolescents with high BMI (overweight body and obesity levels 1-3) have higher blood pressure levels and a relatively high prevalence of blood pressure than children and adolescents with normal and low BMI (lean levels 1-3)[20].

Apart from BMI, Waist Circumference (WC) can be used to predict arterial hypertension in young children [7], [21]–[23], and thus help identify those who need more attention [7]. This study measures abdominal circumference as an indicator of central obesity and its association with the incidence of PreHTN/HTN in adolescents. The results showed that male adolescents who are overweight/central obesity are 14 times more likely to suffer from PreHTN/HTN than male adolescents who are not have centrally obese. However, in adolescent girls there was no significant relationship between overweight / central obesity and PreHTN/HTN. The results of this study are in line with research conducted by Pazin et.al. in Brazilian adolescents it was observed that those aged 15 to 17 years had a BP prevalence that was 2.5 times higher. boys and girls [8].

5. CONCLUSION

In conclusion prehypertension and hypertension were occurred in this study population. Body mass Index and abdominal circumference have descriptively association with incidence of prehypertension/hypertension. The incidence of prehypertension/hypertension in adolescent girls in the study population was 8.3% and 13.8% in adolescent boys. Prehypertension / hypertension associated with obesity based on BMI ($p < 0.05$; CI 20.650; 2.392-178.306) and abdominal circumference ($p < 0.05$; CI 14.00; 1.77 - 110.57) in adolescent boys, whereas in adolescent girls, prehypertension/hypertension is associated with obesity based on BMI ($p < 0.05$).

AUTHORS' CONTRIBUTIONS

First author developed ceoncept, wrote paper draft and responsible of the paper content. second author contributed to analyst and interpreted data

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