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Obesity and Hypertension among Adolescents in Jakarta, Indonesia

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Abstract: Hypertension has been demonstrated in several populations to have a positive correlation with obesity. Persistent hypertension in adolescents is often predictive of future hypertension in adults, cardiovascular disease and early death. This study aimed to determine the prevalence of obesity and the associated risk of hypertension among adolescents in Jakarta, Indonesia. The cross sectional study was conducted to 213 adolescents. Weight, height and blood pressure were measured using standard methods. Body mass index (BMI) was calculated and categorized by age and sex. The prevalences of normal and obese among the adolescents were 69.0 and 6.1%, respectively. The prevalences of hypertensive range systolic blood pressure among the adolescents categorized as normal and obese were 42.2 and 76.9%, respectively and those of hypertensive range diastolic blood pressure among the normal and obese ones were 21.1 and 38.5%, respectively. Pearson's correlation analyses between BMI for age and systolic blood pressure ($r = 0.310$; $p = 0.000$) and between BMI for age and diastolic blood pressure ($r = 0.168$; $p = 0.014$) demonstrated positive correlations. The sufficiency levels of energy, protein and carbohydrate had a significant association with the systolic blood pressure. The sufficiency levels of energy and carbohydrate were significantly associated with the diastolic blood pressure. The determinant factors of the systolic blood pressure were the sufficiency levels of calcium, protein, iron and carbohydrate and those of the diastolic blood pressure were the sufficiency levels of energy and carbohydrate. A long-term follow up of hypertension in adolescents into adulthood is recommended.

Key words: Adolescents, hypertension, nutrient intake, obesity

INTRODUCTION

Many recent studies have indicated that the prevalence of obesity in adolescents has been increasing worldwide (Hanley *et al*., 2000; Oduwole *et al*., 2012). According to WHO in (2003), the prevalences of overweight and obesity were the highest in the WHO regions of America (62% for overweight in both sexes and 26% for obesity) and the lowest in the WHO regions of South East Asia (14% overweight in both sexes and 3% for obesity). Obesity was associated with an increased risk for all causes of mortality and especially with an increased prevalence of hypertension (Trudeau *et al*., 2003). Hypertension in adolescents is defined as blood pressure values which are consistently above 120 mmHg for systolic blood pressure and above 90 mmHg for diastolic blood pressure. Persistent hypertension in adolescents is often predictive of hypertension in their adulthood, a cardiovascular disease and early death.

Hypertension among adolescents is lack of attention. The current health programs just focus on children under five and pregnant women. Whereas, adolescents are in fact also the window of opportunity to solve health and nutritional problems in the world. The aim of this study was to determine the prevalence of obesity and the associated risk of hypertension among adolescents in Jakarta, Indonesia. The findings of this study can provide some useful guidance to health professionals in order to develop effective intervention programs for early prevention of hypertension.

MATERIALS AND METHODS

Subjects: This cross sectional study was carried out at junior and senior high schools in Jakarta, Indonesia. The population of the Jakarta consists of low to high income socioeconomic classes, thus any selected schools are representative of the general urban population. The schools were selected by a purposive method. The adolescents at the schools were randomly selected using a table of random numbers from the name list. All of the adolescents from the selected schools who were in a state of apparently good health were eligible as the subjects for this study. Inform consents were obtained from the participating adolescents. An ethical approval was obtained from the ethics and research committee of the Medicine Faculty, Diponegoro University, Indonesia.

Measurement: All of the measurements were taken by the investigators who had received an adequate training in these procedures. Anthropometric measurement included body height and weight. The body height and weight were obtained by using standardized techniques and a calibrated equipment. The height was taken to the

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nearest 0.1 cm using a microtoise. The subjects were asked to remove their shoes before the measurement was taken. The weight was taken using a digital weighing scale. The weight was measured to the nearest 0.1 kg without shoes, hand phone and wallet. The body mass index (BMI) was calculated as the body weight (kg) divided by the squared body height (m^2). The BMIs were classified by z-score as severely thin (z-score < - 3 SD), thin (-3SD = z - score = -2SD), normal (-2SD < z-score = +1SD), overweight (+1SD < z - score = +2SD) and obese (z-score >+2SD). The blood pressure was measured by using an automatic blood pressure monitor. The measurement was taken from the subjects' left arm and the subjects were seated. Two blood pressure readings were obtained, with a 5-minute interval between readings and the mean of the readings was taken as the subjects' blood pressure. Hypertension in adolescents is defined as blood pressure values which are consistently above 120 mmHg for the systolic blood pressure and above 90 mmHg for the diastolic blood pressure. Normotension in adolescents is defined as blood pressure values which are consistently under 120 mmHg for the systolic blood pressure and under 90 mmHg for the diastolic blood pressure.

Statistical analysis: The data were processed through descriptive and inferential analyses and presented in tables. The descriptive analysis was used to describe the variables examined. Pearson correlation statistics were used to determine correlation coefficients between BMI and various variables. A Stepwise regression was used to determine the determinant factor of the systolic blood pressure and the diastolic blood pressure. A $p<0.05$ was considered significant.

RESULTS

Two hundred and nineteen subjects met the eligibility criteria and were recruited into this study and 213 subjects with the complete data were subsequently analyzed. There were 103 males and 110 females. The ages ranged from 11-17 years (mean, 15.04±1.04). The means of the ages, BMIs and diastolic blood pressures for both sexes were similar ($p = 0.671$, 0.647, 0.306), while those of the systolic blood pressure were significantly different ($p = 0.025$).

The BMIs categorized by sex are displayed in Table 1. The prevalences of normal, overweight and obese were 69.0, 16.9 and 6.1%, respectively.

BMI and blood pressure: The systolic blood pressure stratified by BMI for age is displayed in Table 2 and the systolic blood pressure stratified by BMI for age is displayed in Table 3. The prevalences of hypertensive range systolic blood pressure among the normal and obese adolescents were 42.2 and 76.9%, respectively. The prevalences of hypertensive range diastolic blood pressure among the normal and obese adolescents were 21.1 and 38.5%, respectively. A steady increase was observed in the prevalence of both hypertensive range systolic blood pressure and diastolic blood pressure. Pearson's correlation analyses between BMI

Table 1: BMI for age by sex

	Sex					
	Male		Female		Total	
BMI for age	N	(%)	n	(%)	N	(%)
Severely Thin	3	2.9	0	0	3	1.4
Thin	10	9.7	4	3.6	14	6.6
Normal	67	65.0	80	72.7	147	69.0
Overweight	14	13.6	22	20.0	36	16.9
Obese	9	8.7	4	3.6	13	6.1
Total	103	100	110	100	213	100
Mean±SD Z-score	-0.05±2.26[a]		0.06±1.19[a]		0.01±1.78	

Different letters in the same row show $p<0.05$

Table 2: Systolic blood pressure stratified by BMI for age

	Systolic blood pressure					
	Normotension		Hypertension		Total	
BMI for age	n	(%)	n	(%)	n	(%)
Severely Thin	2	66.7	1	33.3	3	100
Thin	7	50.0	7	50.0	14	100
Normal	85	57.8	62	42.2	147	100
Overweight	13	36.1	23	63.9	36	100
Obese	3	23.1	10	76.9	13	100
Total	110	51.6	103	48.4	213	100
Mean±SD	118.10±11.86		130.66±8.21		121.05±12.31	

Table 3: Diastolic blood pressure stratified by BMI for age

	Diastolic blood pressure					
	Normotension		Hypertension		Total	
BMI for age	n	(%)	n	(%)	n	(%)
Severely Thin	3	100	0	0	3	100
Thin	9	64.3	5	35.7	14	100
Normal	116	78.9	31	21.1	147	100
Overweight	27	75.0	9	25.0	36	100
Obese	8	61.5	5	38.5	13	100
Total	163	76.5	50	23.5	213	100
Mean±SD	70.85±5.94		86.34±3.73		74.48±8.57	

Table 4: Association of Sufficiency Levels of Energy and Nutrients and Blood Pressure

	Systolic blood pressure	Diastolic blood pressure
Variable	r; p-value	r; p-value
Sufficiency level of energy	-0.204; 0.003**	-0.149; 0.030*
Sufficiency level of protein	-0.189; 0.006**	-0.115; 0.095
Sufficiency level of iron	0.024; 0.731	-0.109; 0.112
Sufficiency level of calcium	0.071; 0.302	0.046; 0.507
Sufficiency level of vitamin A	-0.041; 0.556	-0.042; 0.543
Sufficiency level of vitamin C	-0.051; 0.462	-0.030; 0.659
Energy from fat	0.109; 0.114	0.128; 0.063
Energy from carbohydrate	-0.135; 0.048*	-0.142; 0.038*

**Correlation is significant at the 0.01 level; *Correlation is significant at the 0.05 level

Table 5: Determinant factors of the systolic blood pressure

	Systolic blood pressure	
Variables	B	Sig.
Constant	141.065	0.000
Sufficiency level of calcium	0.078	0.000
Sufficiency level of protein	-0.192	0.000
Sufficiency level of iron	0.129	0.000
Sufficiency level of carbohydrate	-0.250	0.002
R^2; F (Sig)	0.186; 11.860 (0.000)	

Table 6: Determinant factors of the diastolic blood pressure

	Diastolic blood pressure	
Variables	B	Sig.
Constant	84.652	0.000
Sufficiency level of energy	-0.044	0.018
Sufficiency level of carbohydrate	-0.119	0.023
R^2; F (Sig)	0.046; 5.047 (0.007)	

for age and systolic blood pressure (r = 0.310; p= 0.000), BMI for age and diastolic blood pressure (r = 0.168; p=0.014) demonstrated positive correlations.

Association of sufficiency levels of energy and nutrition and blood pressure: The association of the sufficiency levels of energy and nutrient and blood pressure is displayed in Table 4. The findings showed that the sufficiency levels of energy, protein and carbohydrate were significantly associated with the systolic blood pressure. The sufficiency levels of energy and carbohydrate were significantly associated with the diastolic blood pressure. The determinant factors of systolic and diastolic blood pressure are displayed in Table 5 and 6. Based on the result derived from Stepwise Regression analysis, the determinant factors of systolic blood pressure were sufficiency levels of calcium, protein, iron and carbohydrate. The determinant factors of diastolic blood pressure were sufficiency levels of energy and carbohydrate.

DISCUSSION

Adolescents represents an important life stage for the development of healthy nutrition behaviors. The nutritional demands associated with rapid physical and cognitive development and maturation are substantial (Regol *et al*., 2002; Spear, 2002). In developing countries, adolescents increasingly demonstrated early signs of adverse nutrition related condition including subclinical obesity and hypertension (WHO, 2003).

The high prevalence of overweight (16.9%) and obese (6.1%) observed in this study is alarming especially when compared with the prevalence overweight (13.8%) and obese (9.4%) among adolescents in Lagos, Nigeria. The increasing prevalence of overweight and obese in our society was associated with a gradual adoption of the western lifestyle (Oduwole *et al*., 2004; Agyemang *et al*., 2005; Ejike *et al*., 2008) and reduction in physical activities.

This study showed that the blood pressure was positively correlated with the BMI for age. The association between the blood pressure and BMI for age is attributed to various interacting complex systems that have been observed in obese children. They include over activity of the renin-angiotensin and sympathetic nervous systems, insulin resistance and abnormalities in vascular structure and function (Sorof and Daniels, 2002).

According to the findings of this study, the sufficiency levels of energy, protein and carbohydrate are significantly associated with the systolic blood pressure. The sufficiency levels of energy and carbohydrate are significantly associated with the diastolic blood pressure. The higher intakes of energy, protein and simple carbohydrate are associated with the higher BMI. The higher BMI (obese) subjects had significantly higher total cholesterol, LDL-Cholesterol, triglycerides and blood pressure and significantly lower HDL-Cholesterol than normal weight subjects (Yosepin *et al*., 2013). Adequate dietary fiber (complex carbohydrate) intakes have been associated with a lower blood pressure in adolescents, because the soluble fiber can contribute to the total cholesterol, LDL-Cholesterol, triglycerides reduction. Fruits, vegetables, cereal, oats, whole grains and legume are good sources of soluble fiber (Adams, 2005).

The determinant factors of the systolic blood pressure were sufficiency levels of calcium, protein, iron and carbohydrate. The determinant factors of the diastolic blood pressure were sufficiency levels of energy and carbohydrate. Calcium was required for myocard contraction. Adequate dietary calcium intakes have been associated with a lower blood pressure in adolescents (Bartosh and Aronson, 1999). Calcium plays a role in regulating calcitropic hormones to maintain blood pressure (Bukoski and Kremer, 1991; Jorde and Bonna, 2000). Iron has a role in the erythropoiesis and blood volume maintenance. When iron status is adequate, iron stores, erythropoiesis and blood volume remain normal (Alton, 2005).

Conclusion: In conclusion, the prevalence of overweight and obese in this study in Jakarta, Indonesia was high. Obesity significantly increased the risk of both the hypertensive range systolic and diastolic blood pressure. The threat is enormous and calls for action by stakeholders to combat this epidemic. The role of health education and mass public enlightenment on the dangers of some westernization of the lifestyle cannot be over-emphasized. Association between BMI for age, blood pressure and lipid profile among adolescents can be the future study.

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