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Research Article
Nutritional Status, Lipid Profile and Blood Pressure among Primary Schoolchildren in Urban West Java, Indonesia

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Abstract

Background and Objective: Nutritional status could affect schoolchildren's health and cognitive function, which may then influence their learning achievement. Overweight and obesity are common nutritional problems in schoolchildren and can negatively affect their health. The purpose of this study was to analyze the nutritional status, lipid profile and blood pressure of primary schoolchildren in urban areas of West Java, Indonesia. **Materials and Methods:** This study used a cross-sectional design. The total sample in this study included 95 fifth grade students at public elementary schools in Bandung, West Java, Indonesia. One-way analysis of variance (ANOVA) with *post hoc* least significant difference (LSD) tests was conducted to analyze the differences between groups using IBM SPSS Ver 22.0 software. **Results:** Overall, 28.4% (27 people), 32.6% (31 people) and 38.9% (37 people) of the schoolchildren were in the normal, overweight and obese nutritional status groups, respectively. The average levels of blood parameters were 171.4±33.7 mg dL^{-1} for total cholesterol, 126.1±66.1 mg dL^{-1} for triglycerides, 111.1±33.8 mg dL^{-1} for low-density lipoprotein cholesterol (LDL-C) and 49.2±9.8 mg dL^{-1} for high-density lipoprotein cholesterol (HDL-C). The average systolic blood pressure was 107.3±12.3 mmHg, while the average diastolic blood pressure was 69.8±11.0 mmHg. HDL-C and systolic blood pressure differed significantly in normal nutritional status, overweight and obese children ($p<0.05$). **Conclusion:** Triglycerides, HDL-C and blood pressure differed among schoolchildren with normal nutritional status, overweight and obesity.

Key words: Blood pressure, lipid profile, nutritional status, obesity, overweight, schoolchildren, urban

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Nutritional status is an important component of children's health and can affect their academic achievements. According to the Indonesia Basic Health Research study in 2013, the prevalence of underweight (based on a body mass index (BMI) in category A) in children aged 5-12 years was 11.2%, comprising 4.0% very thin and 7.2% thin children. However, the prevalence of overweight (10.8%) and obese (808%) children aged 5-12 years was also high[1]. Based on these data, Indonesia is currently experiencing a double burden of malnutrition. According to the percentages, overweight and obesity pose a greater problem than under nutrition.

Overweight and obesity are the result of an imbalance between the energy consumed through food and drink and the energy expended through metabolic processes and physical activity, with the excess energy stored in the body as fat. Overweight and obesity in schoolchildren present a nutritional problem that warrants special attention, as the prevalence of overweight and obese schoolchildren has been increasing in not only developed countries but also in developing ones. Globally, the percentage of overweight and obese population in Africa is greater than that in Asia, however, the prevalence is higher in Asia when considering the pediatric population[2]. This increasing trend has also been observed in Indonesia. Since 2010, the prevalence of overweight and obese schoolchildren has increased from 9.2% in 2010 to 18.8% in 2013, including 10.8% overweight and 8.8% obese children[1,3].

Some of the disorders that emerge in obese schoolchildren include diabetes, dyslipidemia, cardiovascular disease and hypertension[4-7]. Dyslipidemia is a fat metabolism disorder characterized by an increase or decrease in the lipid fraction in plasma, high levels of low-density lipoprotein (LDL) cholesterol and decreased levels of high-density lipoprotein (HDL) cholesterol. Dyslipidemia is a component of metabolic syndrome, which is characterized by high triglyceride and low HDL-C levels. Dyslipidemia is also a risk factor for coronary heart disease and stroke[8]. The prevalence of stroke in Indonesia has also increased each year. Based on the interviews conducted in the Indonesia Basic Health Research study, the prevalence of stroke increased from 8.3 per million in 2007 to 12.1 per million in 2013[3]. Musculoskeletal conditions are another problem that often occurs in overweight children. Children who are overweight experience pain in their feet, knees and hips more often than children with normal nutritional status[9]. Furthermore, dyslipidemia may interfere with their immune system[10].

In addition to the physical health effects, overweight and obesity can also affect children's mental health. Overweight and obese children tend to have lower self-confidence and to be prone to depression[11-13]. The purpose of this study was to determine the nutritional status, lipid profile and blood pressure of primary schoolchildren in urban West Java, Indonesia.

MATERIALS AND METHODS

Participants and study design: This study was the part of a survey that examined overweight and obesity among schoolchildren and efforts to address these conditions through nutritional education and traditional game interventions in urban areas in West Java. The sample in this study included 95 schoolchildren, who were recruited from six public elementary schools in the city of Bandung, West Java, Indonesia. The inclusion criteria for this study were as follows: Boys or girls in 5th grade in the selected public schools who were willing to participate in this study and provided informed consent after receiving an explanation of this study. The following exclusion criteria were used: Children who had a history of disease and those who had a chronic disease such as diabetes, heart disease or hypertension. This study used a cross-sectional design. The data were collected from October-December, 2016. The present research was approved by the Ethical Committee of the Faculty of Public Health, Diponegoro University, Semarang, number 271/EC/FKM/2016.

Anthropometry: Body weight was measured to 0.1 kg using a *Camry EB9003* digital scale manufactured by Zhongshan (Baishawan Industry Park, Qiwan Road E, Zhongshan, Guangdong, China). Height was measured using a microtoise stature meter (precision 0.1 cm). The BMI for age was calculated as the body mass in kilograms divided by the square of height in meters using WHO AnthroPlus software 2007 and was classified according to age and gender.

Blood pressure: Blood pressure (BP) was measured on the participant's right arm after they had been seated for 5 min. The BP was measured 3 times at intervals of 5 min and the mean of the three BP measurements was calculated.

Blood samples: Blood samples were collected in the morning after the participant had fasted for 10-12 h. Health workers from the internationally certified laboratory Prodia obtained approximately 5 mL venous blood samples using disposable syringes. The blood samples were inserted into a tube and

then stored in an ice box for analysis in the laboratory. Total cholesterol, HDL-C, LDL-C and triglyceride levels were analyzed using an enzymatic colorimetric test.

Statistical analysis: To determine the differences in lipid profile, BP and nutrition intake, one-way analysis of variance (ANOVA) was performed and the data were then further assessed using *post hoc* least significance difference (LSD) tests. The relationships between two variables were analyzed using Pearson correlation with SPSS software (SPSS, Inc., IBM, Chicago, Illinois, USA).

RESULTS

The sample size in this study was 95 schoolchildren, consisting of 48.4% boys and 51.6% girls with an average age of 10.9±0.5 years. The average±standard deviation of weight and height was 45.1±10.7 kg and 141.7±7.5 cm, respectively. The schoolchildren's nutritional status was divided into three categories: Normal (28.4%), overweight (32.6%) and obese (38.9%).

The participant's BP was mostly in the normal range, the percentage of participants with a normal BP in the normal, overweight and obese nutritional status groups was 31.9, 29.0 and 69%, respectively. Based on Table 1, the highest percentage of total cholesterol was found in "borderline" category in obese children (43.8%), the highest percentage of triglyceride was found in "high" category in obese children (45.7%). The most prevalent LDL-C group was obese schoolchildren in the "borderline" range, at 56.3% and the highest percentage of participants in terms of HDL-C was obese schoolchildren in the "high" category, at 70.6%.

Lipid profile based on children's nutritional status: The average total cholesterol in children with normal nutritional status was 171.9±30.1 mg dL^{-1}, in overweight children was, 172.1±34.9 mg dL^{-1} and in obese children was, 170.4±35.9 mg dL^{-1}. The average triglyceride level was 105.7±41.4 mg dL^{-1} in normal nutritional status children, 117.6±54.4 mg dL^{-1} in overweight children and 148±82.7 mg dL^{-1} in obese children. The mean HDL-C in normal nutritional status children was 54.2±10.7 mg dL^{-1}, in overweight children, 50.5±9.2 mg dL^{-1} and in obese children, 44.5±7.2 mg dL^{-1}. Finally, the average LDL-C was 106.4±30.7, 113.7±41.1 and 112.2±29.7 mg dL^{-1} in normal nutritional status, overweight and obese children, respectively. Based on one-way ANOVA (Table 2), there were no differences in total cholesterol or LDL-C between normal nutritional status, overweight and obese children. However, there was a significant difference in triglyceride and HDL-C levels between the three nutritional status groups. The average triglyceride level was lower in normal nutritional status than obese children. Based on one-way ANOVA (Table 2), the average HDL-C was higher in the normal nutritional status children than in the obese and overweight children. Correlation analysis showed that there was a negative correlation

Table 1: Sample Distribution by Lipid Profile, Blood Pressure and Nutritional Status

	Nutritional status			
Variables	Normal (n = 27)	Overweight (n = 31)	Obese (n = 37)	Total (n = 95)
Blood pressure (mmHg)				
Normal (<90th percentile)	22 (31.9)	20 (29.0)	27 (39.1)	69 (100)
Prehypertension (90-95th percentile)	3 (20.0)	6 (40.0)	6 (40.0)	15 (100)
Hypertension (>95th percentile)	2 (18.2)	5 (45.5)	4 (36.4)	11 (100)
Total cholesterol (mg dL^{-1})				
Acceptable (<170)	15 (26.3)	19 (33.3)	23 (40.4)	57 (100)
Borderline (170-199)	3 (18.8)	6 (37.5)	7 (43.8)	16 (100)
High (> = 200)	9 (40.9)	6 (27.3)	7 (31.8)	22 (100)
Triglyceride (mg dL^{-1})				
Acceptable (<90)	9 (30.0)	12 (40.0)	9 (30.0)	30 (100)
Borderline (90-129)	9 (30.0)	9 (30.0)	12 (40.0)	30 (100)
High (> = 130)	9 (25.7)	10 (28.6)	16 (45.7)	35 (100)
HDL-C (mg dL^{-1})				
Acceptable (<40)	22 (37.9)	19 (32.8)	17 (29.3)	58 (100)
Borderline (40-45)	2 (10.0)	10 (50.0)	8 (40.0)	20 (100)
High (>45)	3 (17.6)	2 (11.8)	12 (70.6)	17 (100)
LDL-C (mg dL^{-1})				
Acceptable (<110)	15 (26.3)	20 (35.1)	22 (38.6)	57 (100)
Borderline (110-129)	3 (18.8)	4 (25.0)	9 (56.3)	16 (100)
High (> = 130)	9 (40.9)	7 (31.8)	6 (27.3)	22 (100)

HDL-C: High-density lipoprotein cholesterol, LDL-C: Low-density lipoprotein cholesterol

Table 2: Difference in Blood Pressure and Lipid Profile Based on Children's Nutritional Status

	Nutritional status			
Variables	Normal (n = 27)	Overweight (n = 31)	Obese (n = 37)	p-value
Systolic blood pressure (mmHg)	97.8±11.4[a]	109±10.7[b,x]	112.9±10.2[c,x]	0.000*
Diastolic blood pressure (mmHg)	66.3±9.9[a]	68.8±10.1[a,x]	73.3±11.8[b,x]	0.034*
Total cholesterol (mg dL^{-1})	171.9±30.1	172.1±34.9	170.4±35.9	0.976
Triglyceride (mg dL^{-1})	105.7±41.4[a]	117.6±54.4[a,x]	148±82.7[b,x]	0.026*
HDL-C (mg dL^{-1})	54.2±10.7[a]	50.5±9.2[a,x]	44.5±7.2[b,y]	0.000*
LDL-C (mg dL^{-1})	106.4±30.7	113.7±41.1	112.2±29.7	0.691

HDL-C: High-density lipoprotein cholesterol, LDL-C: Low-density lipoprotein cholesterol, *Statistically significant difference. Means with the same letter in a row are not significantly different

between nutritional status and HDL-C level (r = -0.447, p<0.01), suggesting that as the BMI/age z-score increased, HDL-C levels decreased.

Blood pressure: The average systolic BP in normal nutritional status, overweight and obese children was 97.8±11.4, 109±10.7 and 112.9±10.2 mmHg, respectively. The average diastolic BP was 66.3±9.9 mmHg in normal nutritional status children, 68.8±10.1 mmHg in overweight children and 73.3±11.8 mmHg in obese children. Based on one-way ANOVA (Table 2), there was a significant difference in systolic BP among normal nutritional status, overweight and obese children. Children who were overweight and obese had an average systolic BP that was higher than that of normal nutritional status children (p<0.05). Based on one-way ANOVA (Table 2), there was a significant difference in diastolic BP among children in the normal nutritional status, overweight and obese groups. Children with normal weight had an average diastolic BP that was lower than that of obese children. Pearson correlation analysis showed that there was a positive relationship between nutritional status and systolic (r = 0.458, p<0.01) and diastolic BP (r = 0.252, p<0.05), meaning that as the BMI/Age z-score increased, children's systolic and diastolic BP also increased.

DISCUSSION

Dyslipidemia is a fat metabolism disorder that occurs as a result of the interaction between genetic and environmental factors[14]. Our study found higher total cholesterol, triglyceride and LDL-C levels but lower HDL-C levels than those reported in a study conducted in elementary schools in Iran[15]. One-way ANOVA showed that there were no differences in the total cholesterol or LDL-C levels between normal nutritional status, overweight or obese children. These results conflict with those of a study with children aged 3-18 years conducted in Poland, that study revealed that the total cholesterol, LDL-C and triglyceride levels of overweight and obese children differed significantly from those of children with normal nutritional status[16]. Total cholesterol levels in the blood are greatly affected by a person's food intake. Diets high in saturated fat can boost the levels of total cholesterol in the blood stream[17,18]. In addition to saturated fats, carbohydrates can also affect total cholesterol levels[11]. The schools used as research sites in this study were found to contain several street food vendors who sold mostly high-calorie snacks and foods processed by frying. The lack of significant difference between normal nutritional status and overweight or obese children in terms of total cholesterol and LDL-C levels might be due to the children's habit of eating snacks sold by a street food vendor.

The one-way ANOVA results showed that there were significant differences in triglycerides and HDL-C in children with normal, overweight and obese nutritional status. Children with normal nutritional status had higher HDL-C levels than overweight and obese children. The HDL-C level is influenced by several factors, including genetics, age, sex, diet, obesity and physical activity[19]. Compared with children with normal nutritional status, overweight and obese children engage in more sedentary behaviors, potentially because their heavier weight makes it difficult to perform physical activities such as running or jumping. The results of an Australian study on overweight and obese children indicated that high sedentary activity is associated with low HDL-C[20], which is a known risk factor for cardiovascular disease in this population. Multi-component interventions such as nutrition education, life style modification and physical activity could reduce the risk of dyslipidemia and metabolic syndrome in overweight and obese children[21-23].

Normal BP in children was defined as values <90th percentile[24]. The results showed that more than half of the samples had normal BP. A higher prevalence of hypertension was found in overweight and obese subjects. This finding was confirmed by the ANOVA, which showed a significant difference in systolic BP among children with normal nutritional status, overweight and obesity. Overweight and obese children had a higher average systolic BP than children with a normal nutritional status. The results of this study were similar to those of studies conducted in Shanghai, China, the

Caribbean and Turkey, which all indicated that overweight and obese children had higher BP[6,25,26]. Hypertension is a risk factor for metabolic syndrome in obese children[27].

CONCLUSION

There was a significant difference in triglycerides, HDL-C and systolic BP among children with normal nutritional status, overweight and obesity. Children with normal nutritional status had higher HDL-C and lower triglyceride levels than overweight and obese children, whereas overweight and obese children had higher systolic and diastolic BP. Nutritional status was positively associated with systolic and diastolic BP.

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SIGNIFICANCE STATEMENT

This study found that triglycerides, HDL-C and systolic and diastolic BP differed significantly among children with normal nutritional status, overweight and obesity. Overweight and obese children had higher triglyceride levels but lower HDL-C levels than children with normal nutritional status. This study also found a significant positive relationship between nutritional status (BMI/Age z-score) and BP, namely, BP (systolic and diastolic) increased as the z-score increased. The findings provide significant insight into the importance of preventing obesity among schoolchildren.

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