Criteria of metabolic syndrome teenagers at Islamic boarding schools East Java

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Abstract. Indonesia has a high prevalence of metabolic syndrome (MS) (13.3%) of the total population and has become a significant concern in this region. Importantly, the same daily lifestyle was found in the Islamic boarding school with a huge population of teenagers. This study aimed to identify the basic profile of metabolic syndrome in teenagers at the Islamic Boarding School in East Java Province, Indonesia. The baseline data from 200 senior high school students were addressed to measure the individual's blood pressure, total cholesterol level, BMI, fasting blood glucose level, HDL level, LDL level, and triglyceride level in the circulation. The results of this study showed that BMI, systolic, and diastolic blood pressure were significantly different in subjects with overweight-obesity symptoms ($p<0.01$). Moreover, the circulating levels of HDL, triglycerides, total cholesterol, and fasting blood levels were not significantly different between groups. To sum up, this preliminary non-clinical data found that the potential of metabolic syndrome at Islamic Boarding Schools may become a major concern in preventing the gradual increase of metabolic diseases in younger ages. Hence, this Islamic institution's nutritional policy and student physical activity program may become the primary target against metabolic syndrome.

1 Introduction

The global prevalence of metabolic syndrome (MS) reaches 22−25% and is increasing by 2% per year [1]. The prevalence in Indonesia, especially among teenagers, is starting to show worrying numbers along with the increase in the incidence of obesity in the group of teenagers aged 16−18 years, namely from 1.4% years in 2007 to 15.35% years in 2023 [2]. Metabolic syndrome is a collection of symptoms of metabolic disorders in the body, which include dyslipidemia [3] (increased triglyceride levels and decreased high-density lipoprotein/HDL), hyperglycemia, hypertension, and obesity [4]. Metabolic syndrome is not a disease but rather describes a collection of metabolic risk factors that are directly related to non-communicable diseases [5], especially atherosclerotic cardiovascular disease [6].

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Adolescents with metabolic syndrome are at risk of developing type 2 diabetes mellitus (T2DM) and cardiovascular disease[7].

Islamic boarding schools have a lifestyle that is mostly the same in terms of food consumption, sleeping hours, and sports activities [8]. Interestingly, Islamic boarding schools also have daily food consumption patterns high in carbohydrates and fats, lack of exercise activity, and short sleep hours. It is known that consuming food with >60% carbohydrates will trigger metabolic disorders, namely obesity [9]. Obesity is one of the risk factors for metabolic syndrome[4]. Inadequate sleep patterns and poor sleep quality can result in physiological and psychological balance disorders in a person [10]. Additionally, short sleep duration can lead to hypertension due to increased 24-hour blood pressure and heart rate, increased sympathetic nervous system activity, and increased salt retention [11]. Someone with low physical activity can experience a risk of metabolic syndrome 2 times greater than those who have good physical activity[12].

Currently, three definitions of metabolic syndrome have been formulated and are often used in research, namely the World Health Organization (WHO) definition; National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults Treatment Panel III (NCEP ATP-III); and the International Diabetes Federation (IDF) [13]. These three definitions have the same main components, namely abdominal circumference, fasting blood glucose, triglycerides, HDL, and blood pressure with different criteria for determining[14]. In this decade there have been no reports regarding risk factors in the Islamic boarding school population, so there is a low prevalence of metabolic syndrome in some populations, especially the Islamic boarding school population. The problem of metabolic syndrome in adolescents shows the importance of early detection and management to prevent comorbidities in the future. Therefore, the goal of this research is to know the risk factors of metabolic syndrome in adolescents in East Java Islamic boarding schools

2 Experimental Details

The research design is descriptive qualitative and this research starts from January to June 2023, taking place at the Zainul Hasan Genggong Islamic Boarding School. The sample was 200 children with an age range of 16-18 years. The subjects' blood samples were taken by medical personnel from STIKes Hafshawaty Zainul Hasan Genggong. This research has received permission from the health research ethics committee of the Hashawaty Islamic Boarding School Zainul Hasan Health Sciences with number: KEPK/256/STIKes-HPZH/X/2022. Weight, height, and blood pressure measurements were carried out in the Madrasah Aliyah Model Zainul Hasan Ganggong schoolyard. Measurements of HDL levels, LDL levels, triglyceride levels, total cholesterol levels, and fasting sugar levels were carried out at the Molecular Biology Laboratory, State University of Malang. The tools used in this research were 2 ml tubes, gloves, masks, centrifuges, syringes, box coolers, microtubes, micropipettes, microchips, tube racks, labels, and markers. The materials used in the research were a Glucose Test Kit, Cholesterol Test Kit, plaster, alcohol swab, 70% alcohol, tissue, and parafilm.

Research preparation Subjects were asked to fast for 10 hours at night. Subjects were not allowed to consume heavy food, they were only allowed to consume water. Before sampling subjects fill in the informed content. Height was measured using a microtome with an accuracy of 0.1 cm. Body weight measurements were carried out by subjects weighing themselves on a digital scale. Subjects stood without wearing footwear. Blood pressure data, including systolic blood pressure and diastolic blood pressure. Blood pressure measurements are carried out by experts using an Onemed digital blood pressure meter. Data on triglyceride total cholesterol and HDL levels were measured using the Lipid Pro tool. Measurement of

subjects' fasting sugar levels using the Glucose Test Kit. The data analysis used is descriptive of the mean blood pressure measurement results, total cholesterol levels, body height, weight, blood glucose levels, HDL levels, LDL levels, and triglyceride levels.

3 Results

The results of this research can be seen in Table 1. The total sample was 200 students divided into 4 groups according to BMI categories. The underweight group had 41 people, the normal group had 78 people, the overweight group had 29 people, and the obese group had 52 people. The mean age of subjects in the underweight group was 17.5 ± 0.91 years, consisting of 16 men and 25 women. The average age of the normal group was 16.92 ± 0.91 years with 24 men and 54 women. The mean age of the overweight group was 16.97 ± 0.87 years with 3 males and 26 females. The mean age of the obese group was 17.04 ± 0.82 years with 15 male subjects and 37 female subjects. The blood type of each group was highest in blood type O. The body mass index of each group was different, the underweight group had a BMI with a mean of 16.35 ± 1.37 kg/m^2, the normal group had a mean BMI of 21.08 ± 1.52 Kg/m^2. The mean BMI of the Overweight group and the obese group was 26.89 ± 1.41Kg/m^2 and 17.04 ± 0.82Kg/m^2.

Table 1. basic characteristics of the research sample

Parameters	Comparison according to BMI			
	Underweight	**Normal**	**Overweight**	**Obesity**
N	41	78	29	52
BMI (Kg/m2)	16.35 ± 1.37	21.08 ± 1.52	26.89 ± 1.41	34.47 ± 3.48
Age	17.5 ± 0.91	16.92 ± 0.91	16.97 ± 0.87	17.04 ± 0.82
Blood group				
A	4	4	2	4
B	6	17	3	10
AB	1	3	1	3
O	30	54	23	35
Gender				
Male	16	24	3	15
Female	25	54	26	37

Source: Primary Data 2023

The results of research on the metabolic syndrome criteria for subjects are shown in Table 2. The results of the metabolic syndrome blood pressure criteria show that the obese group has the highest number, namely 18 subjects or 34.61% of the total of 52 people compared to the normal group of 12 people with a percentage of 15.39%. The HDL level criteria for the underweight group had the highest sample size, namely 75.08%. The LDL criteria for the overweight group had the highest sample size, namely 3.45%. The triglyceride level criteria for the highest number of subjects were in the obesity group, namely 23.08%. Fasting blood sugar levels in the obesity category had the highest sample size, namely 32.69%. The criteria for total cholesterol levels in the normal group had the same sample size, namely 1.28% of the total of 78 people.

Table 2. Criteria for metabolic syndrome in teenagers at the Zainul Hasan islamic boarding school

Parameters	Comparison according to BMI							
	Underweight		Normal		Overweight		Obesity	
	<18.5 kg/m²		18.5-24.9 kg/m²		25-29.9 kg/m²		>30 kg/m²	
N	41		78		29		52	
Systolic (mmHg)								
>130	2	4.88%	3	3.85%	2	6.90%	11	21.15%
Diastolic (mmHg)								
>85	3	7.32%	9	11.54%	5	17.24%	7	13.46%
HDL levels (mg/dL)								
<40	32	78.05%	53	67.95%	22	75.86%	36	69.23%
LDL levels (mg/dL)								
130-159	0	0%	1	1.28%	1	3.45%	0	0%
Triglyceride levels (mg/dL)								
>150	3	7.32%	9	11.54%	4	13.79%	12	23.08%
Cholesterol levels (mg/dL)								
>200-239	0	0%	1	1.28%	0	0%	0	0%
Blood glucose levels (mg/dL)								
≥ 110	8	19.51%	20	25.64%	8	27.59%	17	32.69%

Source: Primary Data 2023

4 Discussion

The criteria for metabolic syndrome in children and adolescents are very difficult to determine because of the physiological changes that occur in growth and development during childhood and puberty[15]. This means that there are no guidelines that provide specific diagnostic criteria regarding metabolic syndrome in adolescents [16], therefore the metabolic syndrome criteria are modified for children and adolescents 18, besides that the limits used to determine obesity are different for Asians[17]. This study shows that the criteria for metabolic syndrome in adolescents that often appear are BMI, blood pressure, HDL levels, triglyceride levels, and fasting blood glucose levels. Interestingly, low HDL levels in each group accounted for more than half of the total number of subjects per group. Meanwhile, the highest percentage of low HDL levels was in the underweight group, namely 78.05%. Apart from that, the obese group had a higher percentage of low HDL levels compared to the normal group. Excess body weight has a close relationship with increasing triglyceride levels and decreasing HDL levels[18]. This is by the results of this study, namely that the obese group had the highest triglyceride levels, namely 23.08%. A person who is obese has excess adipose tissue which plays a role in the development of dyslipidemia by increasing the production of free fatty acids[19] and lipoprotein synthesis which will influence an increase in triglyceride levels and a decrease in HDL levels [20]. Obesity is a feature of metabolic syndrome, as are insulin resistance, fasting hyperglycemia, lipid abnormalities, and hypertension [21].

The second metabolic syndrome criterion is the subject's blood pressure, which is more than 130/85 mmHg. The blood pressure of subjects shown in the obese group had the highest number, namely 34.61%. Obesity is one of the risk factors that is often found in hypertension [22]. According to several studies, obesity and hypertension have a significant relationship. Some research explains that if a sufferer has a BMI in the obese category, they will have a 1.64 times risk of suffering from hypertension compared to a normal BMI [14]. Obesity can cause hypertension by various mechanisms, namely directly or indirectly. Obesity can directly result in increased cardiac output [23]. This is because the greater the body mass, the greater the amount of blood circulating and this causes cardiac output to increase [24]. Meanwhile, indirectly, obesity occurs through stimulation of the activity of the sympathetic nervous system and the Renin Angiotensin Aldosterone System (RAAS) by mediators. - mediators such as cytokines, hormones, and adipokines. The hormone aldosterone is closely related to water and sodium retention which can increase blood volume [25].

The third metabolic syndrome criterion is fasting sugar levels, namely >110 mg/dL. It is known from the research results that the obese group had the highest number of criteria for fasting sugar levels >110 mg/dL, namely 17 people out of a total of 52 people (32.69%). In obesity, there is a decrease in adiponectin and an increase in free fatty acids, which oppose the effects of insulin [26], causing a decrease in insulin sensitivity or insulin resistance [27]. Fatty acids and several other metabolites activate protein kinase and impair insulin signaling by increasing inhibitory serine phosphorylation of the Insulin Receptor substrate (IRS) [28], thereby causing insulin resistance [29]. In insulin resistance, there is an increase in glucose production and a decrease in glucose use [30], increasing blood sugar levels [31]. High and low blood sugar levels are influenced by various endogenous and exogenous factors. Endogenous factors, namely humoral factors such as the hormones insulin, glucagon, and cortisol as receptors in the muscles and liver [32]. Exogenous factors include the type and amount of food consumed and the activities carried out [33]. So, the criteria that often occur in this study are high blood pressure, decreased HDL levels, high triglyceride levels, and high fasting sugar levels in the subjects.

5 Summary

In this summary, the criteria for metabolic syndrome that often occur in teenagers in East Java Islamic boarding schools, especially the Zainul Hasan Islamic boarding school, are the criteria for high blood pressure, decreased HDL levels, high LDL levels, and high fasting blood sugar levels in obesity. where it is known that the higher a person's BMI, the higher the chance of metabolic syndrome occurring. As the metabolic syndrome criteria increase, this will trigger metabolic syndrome and lead to other metabolic diseases.

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