Distribution of Body Mass Index and Random Plasma Glucose as Early Detection Diabetes Mellitus in Indonesian Student

by Nur Rochmah

Distribution of Body Mass Index and Random Plasma Glucose as Early Detection of Diabetes Mellitus in Indonesian Students

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ABSTRACT

Background: Diabetes mellitus (DM) is a chronic metabolic disorder characterized by abnormal elevated blood glucose levels resulting from defects in insulin secretion, insulin action, or both. The prevalence of DM in children and adolescents is increasing worldwide. Until recently, early detection of DM was still not widely done in Indonesia. Therefore, this study aimed to measure BMI and random plasma glucose in Indonesian students. **Methods:** This descriptive study involving 8th and 9th grade students at Alif Laam Miim Islamic Boarding School Surabaya aged 13 - 18 years old. Height and weight were measured using standard anthropometry. Capillary blood samples were taken on the index or middle finger of the student using a single-use lancet. Statistical analysis was conducted with SPSS using the T-test, Mann-Whitney, and Chi square test. **Results:** This study included 95 subjects with the mean age of 14.65 ± 1.83 years old. There is no significant difference of BMI (p = 0.63) and random plasma glucose (p = 0.09) between males and females. The distribution of BMI for underweight, healthy weight, overweight, and obesity were 6.32%; 64.21%; 14.74%; 14.74% respectively. None of them had a high range of random plasma glucose. **Conclusion:** Indonesian students in Surabaya had a healthy weight and a normal range of plasma glucose.

Keywords: diabetes mellitus; body mass index; random plasma glucose; children; adolescence

INTRODUCTION

Diabetes mellitus (DM) is a long-term metabolic condition marked by abnormally high blood sugar levels brought on by deficiencies in insulin secretion, insulin action, or both [1]. Based on their etiopathogenetic, there are two groups of DM types, including type 1 and type 2 DM. Type 1 Diabetes Mellitus (T1DM) is defined by an inability to produce insulin due to the destruction of pancreatic-cells, which is typically the outcome of T-cell-mediated autoimmunity. In contrast, Type 2 Diabetes Mellitus (T2DM) is characterized by insulin resistance and insufficient insulin secretory compensation [2].

T1DM was the most prevalent form of diabetes in children, whereas T2DM was more prevalent in adults and obese individuals [3]. Recent research indicates that the prevalence of T2DM in children and adolescents has increased over the past several decades [2, 4, 5]. The prevalence of T2DM in children and adolescents has increased due to the lifestyle factors, which also contribute to the global rise in obesity [4]. In the United States, the prevalence among adolescents with T2DM is increasing from 9 to 12.5 cases per 100.000 youth [5]. The incidence of T2DM in children increases with age and the peak age onset of T2DM occurs at puberty [6]. Childhood onset of T2DM is associated with greater risk of microvascular and macrovascular complication [5]. The Indonesian Pediatric Society (IPS) had only recorded 1,249 Indonesian children with T1DM from 2017–2019.

The prevalence of T1DM in Indonesia raises over 10 years, from 3.88 per 100 million in 2000 to 28.19 per 100 million in 2010. The diagnosis and treatment of T1DM in children is often delayed. In Indonesia, the number of T1DM with Diabetic Ketoacidosis (DKA) at diagnosis remained high (71%) [7]. Consequently, screening for DM in children is essential in order to provide an early diagnosis and intervention to prevent future problems. The screening for diabetes mellitus consisted of measuring glycemia and doing a risk assessment for DM [8].

In 2010, the proportion of adolescents in Indonesia was around 43.5 million people. Badan Pusat Statistik (BPS) Indonesia said that there are 426,786 adolescents aged 10-19 in Surabaya [9]. Approximately, 87% of adolescents have a sedentary lifestyle and a poor diet. It can result in obesity and raise the risk of metabolic disorders, including diabetes in old age [10]. The World Health Organization (WHO) has suggested Body Mass Index (BMI) assessment as the simplest method for classifying obesity [11]. BMI measurement is a simple and inexpensive method for screening for obesity and other weight disorders [12]. Until recently, early detection of diabetes mellitus was still not widely done in Indonesia, especially in the student population. Therefore, we aimed to measure BMI and random plasma glucose in Indonesian students.

METHODS

This descriptive study involving 8th and 9th grade students at Alif Laam Miim Islamic Boarding School Surabaya aged 13 - 18 years old. This study was approved by the Faculty of Medicine Health Research and Ethics Committee with ethical clearance number 139/EC/KEPK/FKUA/2022. Informed consent was already obtained from the subject's guardians. Height and weight were measured using standard anthropometry done by healthcare professionals. Height was measured to the nearest 0.1 cm using a wall-mounted tape measure (Onemed) while body weight was measured to the nearest 0.1 kg (Onemed). Capillary blood samples were taken on the index or middle finger of the student using a single-use lancet to measure random plasma glucose (*ACCU CHECK*). Students who refused to have their height, weight, and random plasma glucose measured were excluded from this study.

Body Mass Index (BMI) was calculated by dividing weight in kilograms with the square of height in meters. BMI was categorized for underweight (<5th percentile), healthy weight (5th percentile - <85th percentile), overweight (>85th percentile - <95th percentile), and obesity (≥95th percentile) based on the BMI-for-age percentile growth charts [12].

Random plasma Glucose was categorized by normal (<200 mg/dL) and high (≥200 mg/dL) [13]. Data was entered in and statistical analysis was performed using SPSS version 17 with p-value < 0.05 was considered as statistically significant. The variables were expressed as mean ± standard deviation and frequency (percentage). Difference variable in numeric data between male and female was analyzed using T-test or Mann-Whitney U test based on the Kolmogorov-Smirnov normality test. Meanwhile, categoric data was analyzed with Chi-square or Fisher-exact to compare frequencies.

RESULT

This study enrolled 95 students in Surabaya. The demographic characteristics of subjects are shown in Table 1. The mean age of the subject is 14.65 ± 1.83 years old. There is no significant difference of BMI (p = 0.63) and random plasma glucose (p = 0.09) between males and females. BMI was further classified into four categories based on the CDC criteria [12]. The distribution of the BMI based on the categories can be seen in Figure 1. From 95 students, none of them had a high range of random plasma glucose that can be seen in Table 3.

TABLE 1: Demographic Characteristics of Samples

Characteristic	All (n = 95)	Males (n = 42)	Females (n = 53)	p-value
Age (years)	14.65 ± 1.83	14.80 ± 1.06	14.79 ± 1.04	0.96
Anthropometry				
Height (m)	1.57 ± 0.08	1.64 ± 0.05	1.52 ± 0.07	0.00*
Weight (kg)	56.03 ± 13.06	60.80 ± 14.78	52.33 ± 10.03	0.00*
Body mass index (kg/m²)	22.60 ± 4.57	22.48 ± 4.78	22.68 ± 4.47	0.63
Random plasma glucose (mg/dL)	95.10 ± 9.25	93.07 ± 10.86	96.32 ± 7.68	0.09
Parental Ethnicity				0.58
Javanese	79 (83.2)	37 (88.1)	42 (79.2)	
Madura	13 (13.7)	4 (9.5)	9 (17.0)	
Other	3 (3.2)	1 (2.4)	2 (3.8)	
History of family with DM*				0.55
Yes	16 (16.8)	6 (14.3)	10 (18.9)	
No	79 (83.2)	36 (85.7)	43 (81.1)	

DM, Diabetes Melitus; *, statistically significant

BMI, Body Mass Index
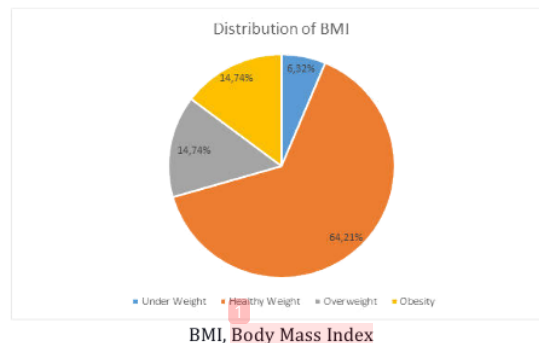**FIGURE 1:** Distribution of Body Mass Index (BMI)

TABLE 2: Distribution of Random Plasma Glucose

Category	Total (n)	Percent (%)
Normal (<200 mg/dL)	95	100%
High (>200 mg/dL)	0	0

DISCUSSION

This study reveals that the majority of students had a healthy BMI (64.21%) and that the proportion of students with overweight and obesity is the same (14.74%). The prevalence of overweight is approximately 18% and obesity is approximately 30.7%, which is quite low compared to previous studies conducted among university students in Indonesia [14]. Higher prevalence of obesity and overweight compared to this study also found in other countries like Boston (34% of females and 32% of males), India (27%), Qatar (46% of males and 44% of females), and Morocco (42%) [15-18]. However, Norwegian has a lower number of children and adolescents with obesity (5.2% of males and 8.0% of females) [19]. A significantly lower prevalence of overweight and obesity in our study compared to other nations may be attributable to the fact that the study population resides in a boarding school that provides daily meals. The school also has a tight policy prohibiting kids from purchasing food from outside the school. It restricts kids' access to junk food and other unhealthy foods that may contribute to obesity. Another study with boarding school students as the population found a reduced prevalence of overweight and obesity among children and teenagers [20].

The screening program will be influenced by a number of variables, such as: 1) disease (severity, prevalence, potential pre-clinical detection, extended latency period, improved outcomes with early identification); 2) screening test (validity, reliability, ease of use, ability to detect disease pre-clinically); and 3) screening program [21]. The ADA suggests evaluating children and teenagers who are overweight and have two risk factors, such as acanthosis nigricans, hypertension, hyperlipidemia, or a first- or second-degree relative with a history of type 2 diabetes. The ADA and the American Academy of Pediatrics advise screening at-risk patients every two years beginning at age 10 or the start of puberty before age ten [22]. Elevated blood glucose levels lead to the development of problems during the lengthy pre-clinical phase of diabetes. So many healthcare guidelines now advise screening for the disease in order to detect diabetes early. The objective is to identify asymptomatic patients so that earlier treatment can have a positive effect on the disease's progression. The most probable culprits in the development of T1DM are genetic susceptibility, environmental factors, vitamin D processing, and viruses. There is no substantial evidence indicating the root cause as of yet [21].

None of the students in this study had a high range of RPG based on ADA criteria (>200 mg/dL). In our study, around 26 children had RPG 100 mg/dL and the maximum value of RPG was 123 mg/dL in one child. It contrasts with a study from India who found that 5.3% of the obese children population in their study had an elevated RPG (>130 mg/dL) [23]. Study from Qatar also found 6% of boys and 2% of girls with elevated blood sugar (RPG ≥140 mg/dL and/or Fasting Plasma Glucose ≥ 100 mg/dL) [17]. Nevertheless, in a study with samples of the US adult population without diagnosed diabetes, a single RBG ≥100 mg/dL was found strongly associated with undiagnosed diabetes and was the single strongest predictor of undiagnosed diabetes outperforming other risk factors [24].

International Diabetes Federation (IDF) also recommends that individuals with RPG value 100 - 199 mg/dL should undergo a formal diabetes testing [8]. Until now, the recommended screening and diagnostic tools for prediabetes and diabetes are Fasting Plasma Glucose (FPG), Oral Glucose Tolerance Test (OGTT) and HbA1c [13]. In actual practice, however, most practitioners employ RPG as a screening tool because it may be performed and prescribed on the same day as the patient's visit [25, 26]

To the best of our knowledge, this is the first study in Indonesia that shows a distribution of BMI and RPG as early detection of DM in children and adolescents. Nevertheless, this study had several limitations: first, a small amount of population size was used in this study; second, even though BMI was the easiest way to use for screening obesity, it can't measure total amount of body fat in the body directly; third, this study uses RPG as a screening test of dysglycemia instead of FPG, OGTT, or HbA1c.

CONCLUSION

Our study showed that most adolescents in a boarding school in Surabaya had a healthy weight and a normal range of plasma glucose. However, it's important to continuously do BMI and glucose screening as an early detection of DM, especially in overweight and obesity adolescents. Further studies with more complete and bigger data are needed to make a better analysis between BMI and RPG as an early detection of DM.

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