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Correlation between body mass index (BMI) and blood glucose level among people in RMCI Jakarta: A cross-sectional study

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ABSTRACT

Obesity is a condition where an individual's body weight is abnormal (BMI >30), leading to excessive fat accumulation. This condition can induce type 2 diabetes mellitus, which results in abnormal insulin production, causing blood sugar levels to spike. This study aims to determine the strength of the correlation between BMI and blood glucose level using a cross-sectional method. We used bivariate data collection, and Pearson's method to determine the strength of the correlation between these two variables. In this study, data from 102 individuals were collected from people in Reformed Millenium Center Indonesia (RMCI) Jakarta. The correlation between BMI and blood glucose levels with r value 0.82 and significance 2-tailed p-value 0.411. The analysis showed a weak positive relationship, but the correlation is not statistically significant. A suggestion for future research is to use body fat percentage as a reference instead of BMI.

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INTRODUCTION

Obesity has a major role causing various diseases like cardiovascular and type-2 diabetes mellitus. This condition showed in excessive weight and body fat due to some variety factors, such as dietary habits with high carbohydrates, physical inactivity, and some psychological factors. Imbalance of the excess energy stored and utilized by the body is one of the main causes of obesity (Chandrasekaran & Weiskirchen, 2024). Furthermore, obesity can induce insulin resistance, inflammation, and other metabolic interference, which increases the risk of Diabetes (Chadt et al., 2000).

The prevalence of obesity increased over decades. Obesity in adults had more than doubled since 1990, and children also adolescents aged 5-19 years had obesity from 2% to 8%

globally in 1990-2022 (World Health Organization, 2024). Based on Indonesia Health Survey 2023, adults living with obesity increased from 21,8% to 23,4% in 2018-2023 (BKPK, 2024). Body Mass Index (BMI) classified the level of obesity based on body weight in kilograms (kg) divided by height in meters (m) squared. The person with BMI 30 to 34,9, 35 to 39,9, and 40 or more would be classified as obese (class 1), obese (class 2), and obese (class 3), respectively (Weir & Jan, 2024).

In 2021, approximately 537 million adults (20-79 years) were living with diabetes. This number increased from 1980 where the global diabetic population was estimated at 108 million. Diabetes was the third leading causes of death, preceded by stroke and ischemic heart diseases. In Indonesia, Diabetes has emerged as a major public health challenge with 19,5 million people were diagnosed at 2021. Specifically, Diabetes Mellitus contributed for 43 deaths in 100,000 women and 39 deaths in 100,000 men (International Diabetes Federation, 2021; World Health Organization, 2023).

Diabetes mellitus characterized by high blood glucose level. Type 1 DM was autoimmune condition that destruct of pancreatic beta-cells causing cells did not secrete insulin, and Type 2 DM causing the body did not utilize insulin in the bloodstream, resulting in elevated blood glucose levels (Chandrasekaran & Weiskirchen, 2024). Insulin is a hormone to facilitate the uptake of glucose through insulin-sensitive receptors. Glucose is the main source for the cell's energy of the body. The insulin maintains the blood glucose level to balance the stored and the utilize glucose to meet its need. High blood glucose level called hyperglycemia can lead to some life-threatening complications such kidney failure, blindness, nerves, and heart damage (Ruze et al., 2023).

Recent studies have shown the positive correlation between the BMI and blood glucose level (Ge et al., 2022; Patel et al., 2023; Radhina et al., 2023; Sepp et al., 2014). Although there was correlation, some studies have shown no significant correlation in statistical assay between random blood glucose level and BMI (Bakari A.G. et al., 2006; Thummakomma & Rajeswari, 2020; Yuliati et al., 2022). Mean ages of the subjects was different of these studies that shown correlation but not statistically significant. Despite enormous studies in BMI and glucose level, correlation in both parameter's studies were needed. Therefore, this research aimed to determine the correlation between BMI and blood glucose level among people in the Reformed Millenium Center of Indonesia (RMCI), in Kemayoran Jakarta. The people in the RMCI area had wide range of ages. These variety may show the variations in the results of BMI and blood glucose level to obtain the picture of the correlation between these parameters. This study expected to have a role in adding the monitoring diabetes data in Jakarta, especially in the areas around RMCI. Monitoring diabetes cases was very important since the update calculation diabetes cases data throughout Indonesia from the Indonesia Health Survey 2023. With the update results in monitoring the diabetes cases, may have an intervention to people with diabetes. As examples in increasing counseling and giving therapeutic especially in areas with many cases of diabetes. Early detection will reduce the burden on the government in providing therapy and may reduce morbidity and mortality due to diabetes, especially diabetes mellitus type 2.

In addition, the existing diabetes cases had a correlation with BMI in previous studies, therefore the results of the analysis in this study are expected to strengthen the understanding of the relationship between BMI and blood glucose levels. This research finding can help to improve awareness in controlling the body weight and monitor the blood glucose level in normal range, so that it can reduce obesity related diseases.

RESEARCH METHOD

The research conducted using bivariate study, comparing two sets of data, Body Mass Index (BMI) and blood glucose level. We used a cross-sectional study, a quantitative approach designed to collect data from research subjects at a single point in time. This involves distributing and administering questionnaires or surveys to gather data from participants (Thomas, 2021). The sampling method utilized is voluntary response sampling, wherein participants volunteer to be

part of the study, and the researchers cannot specifically select the characteristics of the participants (Stratton, 2023). The study will be conducted through a seminar on type 2 diabetes mellitus and obesity. Participants will receive a questionnaire prior to the seminar. After the seminar, random blood sugar levels and body weight and height measurements will be taken from participants who consent to provide this data. The collecting blood glucose data method did not record respondent's last meal, because the data collected is random blood glucose. Measurement of body weight and height using the standard procedures, such as respondents must remove their shoes before these data collection and standing upright posture when measuring height. Random blood glucose was assayed using glucose strip test and blood pressure was measured in a seated position using automatic sphygmomanometer. BMI was calculated by body weight in kilograms (kg) divided by height in meters (m) squared (kg/m^2). Minimum target sample size is 30 participants, which is the minimum required for validity and reliability testing (Sugiyono, 2018). This study had limitations because the small samples size, so the results could not represent the large population. Therefore, the randomize sampling was carried out to reduce bias from the small sample size. In this study, the strength of correlation between BMI and blood glucose level was assayed using Pearson correlation. The Pearson correlation coefficient (r) would measure the strength and direction of linear relationship between these two variables. The descriptive analysis and correlation data was prepared with SPSS software version 29.0.2.0.

RESULTS AND DISCUSSIONS

Characteristics of Respondents

The sample size consisted of 102 respondents with male samples were 41 (40.2%) and female samples were 61 (59.8%) (Table 1). The highest percentage of the volunteers were female because of the location of the sampling majority by women. The respondents ages between 17 and 74 years, with the highest range were 17-25 years (71.57%), followed by the ages range 26-40 years (19.61%), and the last at range 41-74 years (8.82%) (Table 2). Teenagers and young adults were dominant as respondents. The analysis showed that 13 people on the underweight category (12.75%), 54 people on the normal category (52.94%), 27 people on the overweight category (26.47%), 4 people on the obesity class 1 (3.92%), and 3 people on the obesity class 2 (2.94%). It concluded that more than 50% of respondents had a normal body mass index (Table 3). Random blood glucose was in the range 70 to 194 mg/dL (Table 4). It showed that none of the samples in Diabetes category, because for random blood glucose data sampling, Diabetes categorized with test results >200mg/dL (American Diabetes Association, 2022).

Table 1. Gender distribution of the sample dataset

Variable		n	%
Gender	Male	41	40.2
	Female	61	59.8

Table 2. Age distribution of the sample dataset

Variable		n	%
Age	17 – 25	73	71.57
	26 – 40	20	19.61
	41 – 74	9	8.82

Table 3. BMI distribution of the sample dataset

Variable		n	%
BMI	Underweight	13	12,75
	Normal	54	52.94
	Overweight	27	26,47
	Obesity Class I	4	3.92
	Obesity Class II	3	2.94

Variable	n	%
Obesity Class III	1	0.98

Table 4. Descriptive statistic of age, blood glucose, and BMI

Variables	Minimum	Maximum	Mean	Std.Deviation
Age	17	74	25.74	11.94
Blood Glucose	70	194	107.68	24.79
BMI	15.78	45.79	23.74	4.84

The strength of correlation between blood glucose and Body Mass Index (BMI)

The correlation assay in this study using bivariate analysis, where it was statistical method to observe two variables that may had correlation. The variable used in this research was blood glucose and body mass index (BMI). The data was prepared with SPSS software to analyze with a bivariate method to determine the strong correlation between the variables. The result shown as Pearson correlation coefficient (r).

Table 5. The correlation between blood glucose and body mass index (BMI)

		Blood glucose	BMI
Blood glucose	Pearson Correlation	1	.82
	Sig. (2-tailed)		.411
	N	102	102
BMI	Pearson Correlation	.82	1
	Sig. (2-tailed)	.411	
	N	102	102

Based on table 5, the Pearson correlation (r) between BMI and blood glucose was 0.82 and significance 2-tailed p-value was 0.411. Based on Pearson analysis, the strength correlation ranges from 0 to 1, where 0 shows that two variables do not have correlation and 1 show that two variables have strong correlation. The r value that obtained from the research has positive relation even though has weak positive correlation. The significance 2-tailed p-value was obtained 0.411 which is higher than significance level (0.05). It was indicated that the observed correlation is not statistically significant. The details about correlation can be seen clearly on the scatter plot design below.

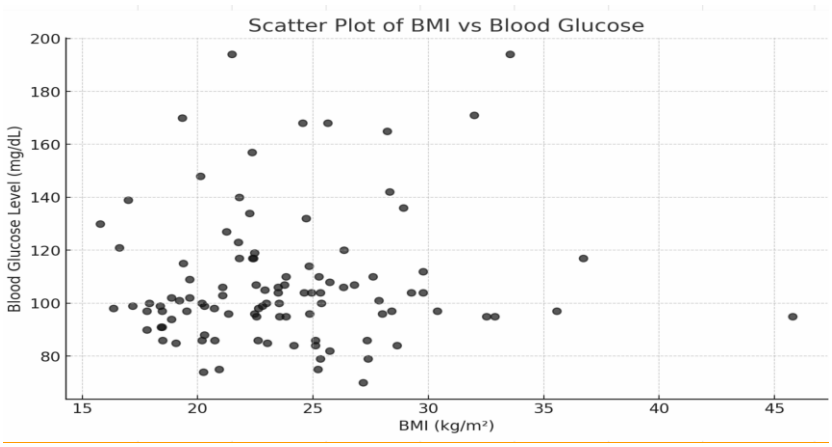

Figure 1. Scatter plot BMI and blood glucose level

Based on the scatter plot result, distribution of blood glucose and BMI seems quite random. There were patterns that show that the higher BMI and the higher blood glucose. Some studies demonstrate the same results, if the BMI elevated then it followed by increases blood

glucose level, or they have linear relations (Adnan et al., 2013; Chandrasekaran & Weiskirchen, 2024; Huang et al., 2023).

This research has low r value because of some factors. The BMI only calculates body weight generally without considering other components such as muscle mass, bone density, or water content so it may not be a reliable representation for the body conditions (Centers for Disease Control and prevention, 2024). Another variable that can be considered for accurate results of the research is metabolic syndrome such as hypertension and high triglyceride level which can bring on insulin resistance. The development of insulin resistance was related to decline metabolic clearance rate of insulin (MCR_I). These responses impaired to individual with type two diabetes mellitus (Gastaldelli et al., 2021). Moreover, type two diabetes mellitus is a complex disease and caused by many factors. Analysis for the correlation between this disease with obesity needs comprehensive examination of other variables like genetics condition, adipose tissue, adiponectin, fat mass and fat distribution, free fatty acids, and microbiome on digestive system (Chandrasekaran & Weiskirchen, 2024; Klimontov & Semenova, 2022; Wang et al., 2022).

CONCLUSION

The results of the study indicate that there was a weak positive correlation between Body Mass Index (BMI) and blood glucose level. The Pearson test results showed a positive correlation with Pearson correlation coefficient (r) of 0.82 and significance 2-tailed p-value 0.411. Our studies concluded that the observed correlation is not statistically significant. There were limitations in this study, including a small sample size, so these results could not represent a large population. Fasting blood glucose and large number of overweight conditions is preferable in the next research. Further research to obtain information related to insulin resistance index levels is needed, to see if there is a possibility of insulin resistance that influence the incident of diabetes. The data related to lifestyle, diet, and physical activity can also be added, so that other factors that affect blood glucose levels can be considered. A more comprehensive study could be conducted by measuring body fat levels as a variable in research to understand the correlation with type 2 diabetes mellitus.

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