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HbA1c Level in Type 2 Diabetes Mellitus Patients With and Without Obesity in An Indonesian Regional Hospital

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Abstract

Diabetes Mellitus (DM) is a disease characterized by hyperglycemia due to insulin deficiency or impaired insulin function. The International Diabetes Federation (IDF) estimated that approximately 463 million people aged 20 to 79 years old were affected by DM worldwide in 2019. Indonesia is the third highest with a prevalence of 11.3%. More than 90% of diabetic patients are obese which reduced insulin sensitivity. This study aimed to determine the difference in HbA1c levels between obese and non-obese patients with Type 2 Diabetes Mellitus (T2DM) at Tarakan Regional Hospital, Indonesia. Data from medical records of T2DM patients from January to December 2023 were collected based on inclusion and exclusion criteria using consecutive sampling method, resulting in 128 samples. The results of the study, as determined using the Mann Whitney test, indicated a significant difference in the HbA1c levels between T2DM patients with and without obesity (p=0.031), with non-obese T2DM patients tend to have better HbA1c control compared to their obese counterparts. Thus, it can be inferred that obesity affects the blood glucose control in diabetic patients. However, this result needs to be further researched as there are a few limitations inherent to this study, particularly the partial availability of certain medical record information, such as duration of diagnosis and medication adherenc.

Keywords: HbA1c, Obesity, Type 2 diabetes mellitus

Introduction

Diabetes mellitus (DM) is a disease characterized by hyperglycemia due to absolute or relative insulin deficiency, impaired insulin function, or both. According to the World Health Organization (WHO), DM is classified into two main types: type 1 diabetes mellitus (T1DM) and type 2 diabetes mellitus (T2DM).[1] The difference between these two types is based on age of onset, level of insulin function impairment, level of insulin resistance, and the need for insulin therapy for survival.[2] The International Diabetes Federation (IDF) estimated that in 2019, approximately 463 million adults aged 20–79 worldwide were living with diabetes globally, with a prevalence of 9.3% in that age group. Indonesia ranked seventh worldwide, with an estimated 10.7 million diabetic patients.[3]

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Obesity is defined as an excessive accumulation of body fat, typically occurring when caloric intake exceeds the energy expended through physical activity.[4] In patients with diabetes and obesity, the body has difficulty utilizing insulin produced, a condition known as insulin resistance.[5] Based on Basic Health Research (RISKESDAS) data, it is known that the prevalence of obesity is accompanied by an increase in the prevalence of DM from 2013 to 2018. More than 90% of diabetic patients are overweight or obese. In obesity, there is a decrease in insulin sensitivity, leading to hyperglycemia, which will eventually cause HbA1c levels to increase.[3] Although there is evidence of an association between obesity and increased HbA1c levels in diabetic patients, it is still necessary to measure the specific impact of obesity on HbA1c levels in T2DM patients.

This study addresses whether there is a significant difference in HbA1c values between T2DM patients with and without obesity at Tarakan Regional Hospital and shows the role of HbA1c as an important indicator in controlling long-term glycemic in diabetic patients.[3,6]

Several studies have examined factors that influence HbA1c levels, including the effects of obesity on insulin resistance and subsequent hyperglycemia.[7] However, specific comparative analysis of HbA1c levels between obese and non-obese T2DM patients in clinical conditions is still limited.

This study evaluates the distribution of gender and age among T2DM patients, their body mass index (BMI) profiles, fasting blood glucose (FBG) and HbA1c levels, and specifically the differences in HbA1c levels between obese and non-obese T2DM patients. These objectives aim to improve the understanding of how obesity impacts glycemic control, with the potential to inform clinical practice and increase patient awareness in diabetes management.

Methods

This research used an analytical observational cross-sectional design to compare HbA1c levels based on obesity status in T2DM patients. The research was conducted at Tarakan Regional Hospital in Jakarta throughout 2023. Participants were selected using a consecutive sampling method. A minimum sample size of 64 participants per group (obese and non-obese) was determined using a comparative analytical formula for categorical variables.. Inclusion criteria included a T2DM diagnosis for at least one-year, regular outpatient care, age ≥19 years, and more than one HbA1c test. Exclusion criteria included incomplete medical records, patients under 19, and conditions that could affect HbA1c test results. Data were obtained from patients' medical records, including HbA1c test results (performed according to the hospital's standard laboratory procedures) and anthropometric measurements (height and weight) used to calculate Body Mass Index (BMI). Obesity status was determined using the Asia-Pacific BMI criteria, in which non-obese was defined as BMI <25 kg/m^2 (including pre-obesity with a BMI of 23–24.9 kg/m^2) and obese was defined as BMI ≥25 kg/m^2.[15] This categorization was used to divide participants into obese and non-obese groups. Age was categorized into younger adults (<60 years) and elderly (≥60 years) if required. HbA1c was further classified as well-controlled (<6,5%), moderate (6,5–8%), or poorly controlled (>8%), in line with standard clinical practice.[14] The median HbA1c levels between obese and non-obese patients were compared using the Mann–Whitney U test. A p-value <0.05 was considered statistically significant. All data analyses were performed using statistical software. The study was approved by the Ethics Committee of the Faculty of Medicine and Health Sciences, Krida Wacana Christian University (Approval No. 1669/SLKE/IM/UKKW/FKIK/KEPK/X/2023).

Results

This study was conducted at Tarakan Regional Hospital in Jakarta using secondary data obtained from medical records of T2DM patients from January to December 2023. The research findings are presented as follows. Table 1 shows the distribution of patient characteristics based on gender. The majority of DM patients were female, totaling 68 individuals (53.1%). By age group, there was an equal number of younger

Table 1 Distribution of Study Subjects by Gender, Age Group, and Body Mass Index (BMI)

Characteristics	Total	%	FPG (mg/dL) Median (Min–Max)	HbA1c (%) Median (Min–Max)
Gender				
Male	60	46.9	123.50 (55–279)	6.90 (4.60–15.20)
Female	68	53.1	153.50 (68–336)	8.15 (5.40–12.10)
Age				
Younger Adult	64	50.0	145.50 (78–336)	7.90 (5.00–15.20)
Elderly	64	50.0	123.50 (55–321)	7.25 (4.60–12.70)
BMI				
Without Obesity	64	50.0	123.50 (55–321)	7.10 (4.60–15.20)
Obesity	64	50.0	147.00 (83–336)	8.20 (5.00–12.00)

Table 2 HbA1c Profile in Patients With Type 2 Diabetes Mellitus by Obesity Status

BMI Category		HbA1c (%)		
		Well-controlled	Moderately controlled	Poorly controlled
Obesity	Frequency	9	22	33
	Median (min-max)	6.10 (5.0–6.4)	7.10 (6.5–8.0)	9.00 (8.1–12.0)
Without Obesity	Frequency	20	22	22
	Median (min-max)	6.00 (4.6–6.4)	7.00 (6.5–8.0)	9.05 (8.1–15.2)

adult and elderly patients. The median value (min–max) of FPG based on gender categories was highest among female patients, at 153.50 (68–336) mg/dL. Based on age categories, the highest FPG value was found among in younger adult patients, at 145.50 (78–336) mg/dL. Based on patient BMI, the highest value was recorded in obese patients, at 147.00 (83–336) mg/dL.

The median value (min - max) of HbA1c based on the highest gender category is found in female patients at 8.15 (5.40–12.10) % in line with FPG value of 153.50 (68-336) mg/dL. Based on age categories, the highest HbA1c value is found in younger adult patients, at 7.90 (5.00–15.20)%, consistent with FPG value of 145.50 (78–336) mg/dL. Based on patient BMI, the highest value was recorded in obese patients, at 8.20 (5.00–12.00)%, in line with FPG value of 147.00 (83–336) mg/dL.

Table 2 presents the HbA1c profiles of T2DM patients by BMI category. Among patients with obesity, most had poorly controlled HbA1c levels (n=33), with a median of 9.00%. Only 9 patients in this group had well-controlled HbA1c levels. Conversely, in the non-obese group, most patients had well-controlled or moderately controlled HbA1c values (n=42).

Table 3 shows the statistical analysis using the Mann–Whitney U test. The median HbA1c value in patients with obesity was 8.20% (range: 5.00–12.00%), which was higher than the median in non-obese patients at 7.10% (range: 4.60–15.20%). This difference was statistically significant (p=0.031).

Table 3 Comparison of HbA1c Values Between Obese and Non-Obese Patients With Type 2 Diabetes Mellitus

BMI Category	HbA1c (%) Median (Min–Max)	p-value
Obesity	8.20 (5.00–12.00)	0.031
Without Obesity	7.10 (4.60–15.20)	

Discussion

Based on Table 1, female patients predominated in this study and also had the highest median FPG and HbA1c values.. This finding aligns with a study by Omega et al., which showed a higher prevalence of female DM patients at Mount Maria Hospital in Tomohon.[9] This is supported by the research conducted by Wuni et al., observed a higher frequency of T2DM among female patients in both obese and non-obese groups at Raden Mattaher Hospital in Jambi.[10] This may be related to the higher risk factors for T2DM in females, as women have a greater potential for increased BMI compared to men. Hormonal changes during menstruation, pregnancy, and menopause can also affect glucose metabolism and insulin sensitivity.[9]

Furthermore, the highest median FPG and HbA1c values were observed in the younger adult group. This is consistent with research by Salsabila and Donna, who highlighted that glucose intolerance typically begins around age 45 due to increasing fat content in muscle tissue, which contributes to insulin resistance. When insulin resistance is accompanied by dysfunction of pancreatic beta cells (cells that release insulin), it leads to failure to control blood glucose levels, resulting in an increase in HbA1c levels.[12]

As shown in Table 2, a larger proportion of obese T2DM patients had poorly controlled HbA1c levels compared to non-obese patients. This observation is supported by findings from Wuni et al., which showed that obese patients with uncontrolled HbA1c accounted for 43 (86.0%) individuals, while obese patients with controlled HbA1c accounted for only 7 (14.0%) individuals.[10] This is also supported by a study

by Bernadette and Mohammad, which showed a relationship between BMI and HbA1c values, where high BMI corresponds to high HbA1c values. Obese individuals have a 7-fold higher risk of developing diabetes compared to non-obese individuals. This is because fat cells in obese individuals release pro-inflammatory chemicals that make the body less sensitive to insulin by disrupting the function of insulin-responsive cells and their ability to respond to insulin. Obesity can also trigger metabolic changes in the body, causing adipose tissue to release a number of free fatty acids, proinflammatory cytokines, and other factors involved in the development of insulin resistance. Insulin resistance is accompanied by dysfunction of pancreatic beta cells, it leads to failure to control blood glucose levels, resulting in an increase in HbA1c levels.[11] Obesity alters body metabolism where release of fat molecules from adipose tissue enters the bloodstream, reducing insulin sensitivity of insulin-responsive cells. Fasting blood glucose and HbA1c levels can increase due to lipid accumulation caused insulin resistance.[13] The pancreas continues to produce insulin in sufficient quantities to maintain normal blood glucose levels, but the insulin cannot work optimally to transport glucose into cells due to high cholesterol and triglyceride levels in obese individuals, thus T2DM is closely related to obesity.[10]

Table 3 shows a statistically significant difference in HbA1c levels between obese and non-obese T2DM patients (p=0.031), indicating that obesity is associated with poorer glycemic control.This result is supported by Eka et al.[8] who reported a significant difference (p=0.000) in mean HbA1c levels between obese and non-obese adolescents, with higher values in the obese group. Similar findings were reported by Bernadette and Mohammad, which showed a test analysis result between BMI and HbA1c values with a result of p=0.00.[11] Obese individuals have a strong association with insulin resistance and experience increased cytokines, proinflammatory markers, and other substances involved in the pathophysiology of insulin resistance.[8,11] Obesity alters the body's metabolism, where fatty molecules are released from adipose tissue into the bloodstream, thereby reducing the insulin sensitivity of insulin-responsive cells.[13] The pancreas continues to produce sufficient insulin to maintain normal blood glucose levels, but this insulin cannot function optimally in transporting glucose into cells due to high cholesterol and triglyceride levels in individuals with obesity, which is why Type 2 Diabetes Mellitus (T2DM) is closely linked to obesity.[10] Obesity also impacts pancreatic β cell dysfunction leads to impaired glucose control. Dysfunction of pancreatic β cell leads to inadequate insulin secretion, resulting in higher glucose concentrations in circulation. Continuously increasing glucose concentrations above physiological ranges result in manifestations of hyperglycemia and an increase in HbA1c values.[8,11]

In conclusion, this study demonstrates a significant difference in HbA1c levels between obese and non-obese T2DM patients. It can be inferred that obesity affects the blood glucose control in diabetic patients. However, this result needs to improve further. There are a few limitations, particularly the partial availability of certain medical records such as duration of diagnosis and medication adherence.

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