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Relationship Between Waist Circumference and Body Mass Index With HbA1c Levels in Patients with Type 2 Diabetes Mellitus

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Abstract: Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia and complex pathophysiological mechanisms. Obesity, assessed through Body Mass Index (BMI) and waist circumference (WC), is commonly associated with poor glycemic control, yet previous studies have reported inconsistent findings. **Objective:** This study aimed to analyze the relationship between waist circumference and BMI with HbA1c levels in patients with T2DM at Haji General Hospital Medan. **Methods:** A quantitative analytical study with a cross-sectional design was conducted involving 48 patients with T2DM who met the inclusion criteria. Anthropometric data, including BMI and WC, were measured directly, while HbA1c values were obtained from medical records. Bivariate analysis was performed using the Spearman correlation test, and multivariate analysis was conducted using ordinal logistic regression. **Results:** The analysis showed no significant association between waist circumference and HbA1c levels ($r = -0.141$; $p = 0.339$) or between BMI and HbA1c levels ($r = 0.075$; $p = 0.611$). Multivariate analysis also indicated that BMI and WC simultaneously did not significantly affect HbA1c categories ($p > 0.05$). **Implications:** These findings suggest that glycemic control in T2DM patients is influenced by multifactorial mechanisms beyond anthropometric parameters, highlighting the importance of considering behavioral, clinical, and therapeutic factors in diabetes management. **Originality:** This study provides context-specific evidence by simultaneously evaluating BMI and WC in a clinical outpatient population, contributing to the ongoing debate regarding the relevance of simple anthropometric indicators in predicting glycemic control.

Keywords: type 2 diabetes mellitus; body mass index; waist circumference; HbA1c; glycemic control.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) remains a major global public health challenge due to its increasing prevalence, chronic complications, and substantial burden on health systems. Diabetes is a metabolic disorder characterized by impaired glucose regulation resulting from defects in insulin secretion, insulin action, or both (American Diabetes Association Professional Practice, 2024a). According to the International Diabetes Federation, approximately 588.7 million adults aged 20–79 years were living with diabetes in 2024, and this number is projected to rise to 852.5 million by 2050. The Southeast Asia region contributes considerably to this burden, with an estimated 106.9 million cases in 2024, while Indonesia ranks among the countries with the highest number of diabetes cases, reaching 20.4 million patients (Duncan et al., 2025). At the national subpopulation level, the prevalence of diabetes mellitus in North Sumatra Province is reported to be 1.4% (Kementerian Kesehatan Republik, 2023). Beyond its epidemiological magnitude, T2DM is clinically important because inadequate glycemic control accelerates the development of microvascular and macrovascular complications. In this context, glycated hemoglobin (HbA1c) serves as a key indicator of long-term glycemic control over the previous two to three months and is widely used to assess disease management outcomes (Sartika & Hestiani, 2019).

Among the modifiable risk factors associated with T2DM, obesity has consistently been recognized as a central determinant of insulin resistance and metabolic dysregulation. Excess adiposity, particularly visceral fat accumulation, contributes to chronic inflammation, lipotoxicity, and impaired insulin signaling, thereby worsening glycemic control (Klein et al., 2022). In clinical and epidemiological settings, Body Mass Index (BMI) and waist circumference are two of the most practical anthropometric indicators used to estimate obesity-related metabolic risk (Feng et al., 2023). However, the existing literature has produced inconsistent findings regarding their relationship with HbA1c. One group of studies reported no significant association between BMI and HbA1c among patients with T2DM (Irawan et al., 2022; Suandy et al., 2022). A second group of studies suggested that central obesity, as reflected by waist circumference, may be more closely associated with elevated HbA1c levels than general obesity (Sucitawati et al., 2019). A third line of evidence reported a significant positive association between BMI and glycemic control indicators, implying that higher BMI may predict poorer metabolic status (Deng et al., 2025). These discrepancies indicate that the relationship between anthropometric indices and HbA1c is not yet fully established and may vary across populations, settings, and clinical characteristics.

Despite growing interest in the relationship between obesity indices and glycemic control, several important gaps remain. First, prior findings are still fragmented, with some studies focusing only on BMI and others emphasizing waist circumference, making it difficult to compare the relative contribution of general and central obesity within the same population. Second, many studies have been conducted in heterogeneous demographic groups or non-clinical populations, limiting their direct applicability to patients with established T2DM in outpatient hospital settings. Third, evidence from Indonesian clinical settings, particularly at the regional hospital level, remains limited, even though contextual factors such as lifestyle, treatment adherence, and metabolic profiles may differ substantially across populations. Therefore, examining BMI and waist circumference simultaneously in patients with T2DM at Haji General Hospital Medan offers a more context-specific assessment and provides added value by clarifying whether these commonly used anthropometric indicators are meaningfully related to HbA1c in this population. This constitutes the practical and empirical novelty of the present study.

Based on these considerations, this study aimed to analyze the relationship between waist circumference and Body Mass Index with HbA1c levels in patients with type 2 diabetes mellitus at Haji General Hospital Medan. This study was designed to address the inconsistency in previous findings by evaluating both anthropometric parameters within the same clinical population. The working hypothesis of this study is that higher waist circumference and higher BMI are associated with higher HbA1c levels, reflecting poorer glycemic control in patients with T2DM. By testing this hypothesis, the study is expected to contribute to the ongoing discussion on whether simple anthropometric measures remain useful as clinical markers of glycemic status in routine diabetes care.

RESEARCH METHOD

Research Design

This study employed an analytical observational design with a cross-sectional approach to analyze the relationship between waist circumference and Body Mass Index (BMI) and HbA1c levels in patients with type 2 diabetes mellitus. Ethical approval for this study was obtained from the Health Research Ethics Committee (KEPK), Faculty of Medicine, Universitas Muhammadiyah Sumatera Utara, with approval number 1660/KEPK/FKUMSU/2025.

Study Location and Time

This study was conducted at the Endocrine Outpatient Clinic of Haji General Hospital Medan, located at Jalan Rumah Sakit Haji No. 1, Medan Estate, from November to December 2025.

Population and Sample

The study population consisted of patients with type 2 diabetes mellitus who received outpatient care at the Endocrine Clinic of Haji General Hospital Medan. The study sample included patients with type 2 diabetes mellitus who met the following inclusion criteria: (1) Patients diagnosed with type 2 diabetes mellitus by a physician and attending the endocrine clinic at Haji General Hospital. (2) Patients who underwent HbA1c examination. (3) Patients who were willing to undergo BMI and waist circumference measurements and had signed the informed consent form.

The exclusion criteria included patients with diabetes who had other conditions that could affect BMI and waist circumference, such as renal failure, liver cirrhosis, Cushing syndrome, and cancer, as well as conditions that could influence HbA1c levels, including anemia, thalassemia, and thyroid disorders.

The sampling technique used was consecutive sampling. The required sample size was calculated using the correlation formula with $Z\alpha = 1.96$, $Z\beta = 1.28$, and $r = 0.45$ (Deng et al., 2025), resulting in a minimum sample size of 48 participants.

Operational Definition

Table 1. Operational Definition of Research Variables

Variable	Operational Definition	Measurement Tool	Scale	Measurement Result
Waist Circumference	Measurement of the waist circumference between the crista iliaca and the 12th rib (costa XII)	Measuring tape	Ratio	In centimeters (cm)
Body Mass Index (BMI)	Body weight (kg) divided by height (m^2)	Weighing scale & stadiometer	Ordinal	Underweight: <18.5; Normal: 18.5–22.9; Overweight: 23.0–24.9; Obesity I: 25.0–29.9; Obesity II: ≥30.0
HbA1c Level	Percentage of hemoglobin A1c obtained from medical records	Laboratory results	Ordinal	<5.7% = Normal; 5.7–6.4% = Prediabetes; ≥6.5% = Diabetes

Waist circumference is defined as the measurement of the waist taken between the crista iliaca and the 12th rib (costa XII), expressed in centimeters (cm), using a ratio scale. Central obesity is defined as present when the waist circumference exceeds 90 cm in men and 80 cm in women (Frisca et al., 2019).

Body Mass Index (BMI) is defined as a parameter used to determine body weight classification, calculated using the formula: BMI = Body Weight (kg) / (Height (m))². The BMI classification follows the Asia–Pacific criteria, namely: underweight (<18.5 kg/m²), normal (18.5–22.9 kg/m²), overweight (23.0–24.9 kg/m²), obesity I (25.0–29.9 kg/m²), and obesity II (≥30.0 kg/m²) (Okawa et al., 2025)

HbA1c level is defined as the percentage of hemoglobin A1c obtained from laboratory examination results based on patients' medical records, categorized as follows: normal (<5.7%), prediabetes (5.7–6.4%), and diabetes (≥6.5%) (Perkeni, 2021). Glycemic control is categorized as controlled if HbA1c < 7.0% and uncontrolled if HbA1c ≥ 7.0% (American Diabetes Association Professional Practice, 2024b).

Data Collection Procedure

Primary data were collected through direct measurements of patients. To determine BMI, body weight was measured using a digital scale, with patients wearing light clothing and no footwear. Height was measured using a stadiometer while the patient stood upright with heels together and eyes facing forward. BMI was then calculated using the formula:

BMI = Body Weight (kg) / (Height (m))² Waist circumference was measured using a flexible measuring tape between the crista iliaca and the 12th rib (costa XII) while the patient stood upright and breathed normally, ensuring that no clothing or objects obstructed the tape from contacting the skin.

Secondary data in the form of HbA1c values were obtained from patients' medical records, specifically from the most recent laboratory examination results within the last three months.

Data Analysis

Univariate analysis was conducted to describe the characteristics of each variable, including waist circumference, BMI, and HbA1c levels, using descriptive statistics such as mean, standard deviation, frequency, and percentage.

Bivariate analysis was performed using the Spearman correlation test to assess the relationship between waist circumference and HbA1c, as well as BMI and HbA1c. This test evaluates the strength and direction of the association based on ranked data, with correlation coefficients ranging from −1 to +1 (Brannan, 2024).

Multivariate analysis was conducted using ordinal logistic regression to determine the simultaneous effect of waist circumference and BMI on HbA1c levels. The results were presented in the form of Odds Ratios (OR). All statistical analyses were performed using SPSS software with a significance level of $\alpha = 0.05$.

RESULT

Study Setting and Data Source This study was conducted at the Endocrine Outpatient Clinic of Haji General Hospital Medan, Medan City, North Sumatra Province, from November to December 2025, using a consecutive sampling technique. The study subjects consisted of 48 patients with type 2 diabetes mellitus who met the inclusion criteria. The research data comprised primary data, including measurements of body weight, height, and waist circumference, and secondary data in the form of HbA1c levels obtained from patients' medical records.

Univariate Analysis

Table 2. Distribution of Patients by Gender

Gender	Frequency (n)	Percentage (%)
Male	19	39.6
Female	29	60.4
Total	48	100

Based on the characteristics of patients with type 2 diabetes mellitus at Haji General Hospital Medan, the majority of patients were female, totaling 29 individuals (60.4%), while 19 patients (39.6%) were male. This finding is consistent with several studies indicating that women have a higher risk of developing type 2 diabetes mellitus, which is associated with hormonal factors, body fat distribution, and metabolic changes occurring after menopause.

Table 3. Distribution of Patients by Age

Age (years)	Frequency (n)	Percentage (%)
< 40	2	4.2
40–49	4	8.3
50–59	19	39.6
60–69	19	39.6
≥ 70	4	8.3
Total	48	100

The distribution of patients by age indicates that the majority were in the 50–59 years and 60–69 years age groups, each comprising 19 patients (39.6%). The smallest proportion of patients was found in the <40 years age group, with 2 patients (4.2%). The mean age of the patients was 58.6 years. This finding aligns with the theory that increasing age is associated with a decline in the functional capacity of various organs, including the pancreas and peripheral tissues, which leads to reduced insulin sensitivity and less effective glucose regulation.

Table 4. Distribution of Patients by Body Mass Index (BMI)

BMI Category	Frequency (n)	Percentage (%)
Normal	6	12.5
Overweight	5	10.4
Obesity I	24	50.0
Obesity II	13	27.1
Total	48	100

Most patients were classified as Obesity I, totaling 24 individuals (50.0%), followed by Obesity II with 13 individuals (27.1%), normal BMI with 6 individuals (12.5%), and overweight with 5 individuals (10.4%). No patients were categorized as underweight. The mean BMI of the patients was 27.67 kg/m², indicating that overall the patients fell within the obese category. The high proportion of patients with obesity is consistent with the concept that obesity is one of the major risk factors for type 2 diabetes mellitus, contributing to insulin resistance and impaired glucose metabolism.

Table 5. Distribution of Patients by Waist Circumference

Category	n	Female	Male	%
Normal	3	–	3	6.3
Central Obesity	45	29	16	93.7
Total	48			100

The majority of patients had abnormal waist circumference (central obesity), totaling 45 individuals (93.7%), while only 3 patients (6.3%) had a normal waist circumference, all of whom were male. All female patients (100%) had waist circumference measurements above the normal threshold (>80 cm), while 84.2% of male patients had waist circumference exceeding 90 cm. The mean waist circumference was 94.44 cm.

The high proportion of central obesity among patients with type 2 diabetes mellitus reflects the accumulation of visceral fat, which is closely associated with metabolic disturbances and insulin resistance.

Table 6. Distribution of Patients by HbA1c Levels

HbA1c Category	Frequency (n)	Percentage (%)
Controlled (<7.0%)	10	20.8
Uncontrolled (≥7.0%)	38	79.2
Total	48	100

Of the total 48 patients, the majority had uncontrolled HbA1c levels (≥7.0%), totaling 38 patients (79.2%), while only 10 patients (20.8%) had controlled HbA1c levels (<7.0%). The mean HbA1c level was 8.78%, indicating that overall glycemic control in the study population was suboptimal.

The high proportion of patients with uncontrolled HbA1c suggests the need for further evaluation of diabetes management strategies, including pharmacological therapy, lifestyle modification, and medication adherence (American Diabetes Association Professional Practice, 2024c).

Bivariate Analysis

Table 7. Results of the Spearman Correlation Test

Independent Variable	Dependent Variable	P-Value	Spearman r
Waist Circumference	HbA1c	0.339	−0.141
Body Mass Index (BMI)	HbA1c	0.611	0.075

Referring to Table 7, the results of the Spearman correlation test indicate that there was no statistically significant relationship between waist circumference and HbA1c levels ($r = -0.141$; $p = 0.339$). The correlation coefficient demonstrates a very weak negative relationship, suggesting that an increase in waist circumference tends to be associated with a decrease in HbA1c levels; however, this relationship is not statistically significant.

Similarly, no significant relationship was found between BMI and HbA1c levels ($r = 0.075$; $p = 0.611$). The correlation coefficient indicates a very weak positive relationship, implying that an increase in BMI tends to be associated with a slight increase in HbA1c levels; however, this association is also not statistically significant.

Therefore, the null hypothesis (H_0) is accepted, and the alternative hypothesis (H_1) is rejected, indicating that waist circumference and BMI are not significantly associated with HbA1c levels in the study population.

Multivariate Analysis

Table 8. Results of Ordinal Logistic Regression Analysis

Variable	OR	95% CI	p-value
Waist Circumference	0.94	0.82 – 1.07	0.359
Body Mass Index (BMI)	1.52	0.48 – 4.82	0.475

Referring to Table 8, the multivariate analysis using ordinal logistic regression shows that waist circumference did not have a significant effect on HbA1c levels (OR = 0.94; 95% CI: 0.82–1.07; p = 0.359). An OR value below 1 indicates a tendency toward an inverse association with increasing HbA1c categories. However, since the p-value is greater than 0.05 and the confidence interval crosses 1, the association is not statistically significant.

Similarly, BMI did not demonstrate a significant effect on HbA1c levels (OR = 1.52; 95% CI: 0.48–4.82; p = 0.475). An OR value above 1 suggests that BMI tends to act as a potential contributing factor to higher HbA1c categories. Nevertheless, because the p-value exceeds 0.05 and the confidence interval includes 1, BMI cannot be considered a statistically significant predictor of HbA1c levels.

Overall, both variables simultaneously did not show a significant effect on HbA1c categories in this study population.

DISCUSSION

Based on the findings of this study, the majority of patients with type 2 diabetes mellitus were female (60.4%) and belonged to the older age group, with a mean age of 58.6 years. Increasing age is associated with greater insulin resistance and a decline in the functional capacity of pancreatic beta cells, thereby increasing the risk of type 2 diabetes mellitus. Previous studies have shown that aging of adipose tissue contributes to insulin resistance, while aging of pancreatic beta cells leads to decreased insulin secretion capacity (Zhu et al., 2021).

Most patients were classified as obese according to Body Mass Index (BMI), with the majority falling into Obesity I (50.0%) and a mean BMI of 27.67 kg/m². Obesity is considered a major contributing factor to the development of type 2 diabetes mellitus, as it plays a significant role in insulin resistance and impaired glucose metabolism (Klein et al., 2022). Waist circumference measurements also showed that most patients (93.7%) had values above the normal threshold (>90 cm for men and >80 cm for women), indicating a high prevalence of central obesity. All female patients (100%) experienced central obesity, while 84.2% of male patients also had waist circumference above the normal limit (Harbuwono et al., 2020).

Based on HbA1c levels, the majority of patients **(**79.2%**)** were categorized as having uncontrolled glycemic levels (≥7.0%)**,** with a mean HbA1c level of 8.78%**.** HbA1c reflects the average blood glucose concentration over the previous two to three months and is influenced by multiple factors, including disease duration, antidiabetic therapy, medication adherence, and patient lifestyle (Nistita, 2026).

It is important to understand that glycemic control in type 2 diabetes mellitus is not determined solely by the degree of obesity, but rather represents the result of interactions among various pathophysiological mechanisms involving multiple organs, known as the "Egregious Eleven." Dysfunction of pancreatic beta cells directly affects the body's ability to regulate blood glucose levels. Overactivity of pancreatic alpha cells increases glucagon production and stimulates hepatic glucose output. Adipose tissue becomes less responsive to the antilipolytic effects of insulin, resulting in increased lipolysis and elevated free fatty acid levels, which promote hepatic gluconeogenesis and insulin resistance, a phenomenon known as lipotoxicity (Perkeni, 2021).

Insulin resistance also occurs in skeletal muscle due to impaired tyrosine phosphorylation of insulin receptors, preventing GLUT4 translocation to the cell membrane. In the liver, insulin resistance accelerates gluconeogenesis. In the brain, insulin resistance reduces appetite suppression. Gut microbiota dysbiosis can trigger low-grade systemic inflammation. The small intestine produces incretin hormones (GLP-1 and GIP), which are rapidly degraded by the DPP-4 enzyme. In the kidneys, increased expression of SGLT-2 leads to excessive glucose reabsorption. In type 2 diabetes mellitus, chronic low-grade inflammation activates immune cells that release proinflammatory cytokines, disrupting insulin signaling in peripheral tissues (Perkeni, 2021).

These mechanisms can operate independently of the degree of obesity, which helps explain why anthropometric parameters such as BMI and waist circumference do not always correlate with HbA1c levels.

Association Between Waist Circumference and HbA1c

No significant association was found between waist circumference and HbA1c concentration among patients with type 2 DM at Haji General Hospital Medan ($r = -0.141$; $p = 0.339$). The ordinal regression analysis also showed an odds ratio (OR) of 0.94 (95% CI: 0.82–1.07; $p = 0.359$). These findings are consistent with the study conducted by Indrawati et al., which examined the relationship between HbA1c and waist circumference, waist-to-height ratio, and BMI among overweight and obese adolescent girls, indicating that waist circumference is not always significantly associated with HbA1c concentration (Indrawati et al., 2019).

Theoretically, waist circumference is an anthropometric parameter that reflects the accumulation of visceral fat in the abdominal cavity. Visceral fat has high metabolic activity and plays a role in producing various pro-inflammatory cytokines such as TNF-α and Interleukin-6, which can trigger insulin resistance. In conditions of central obesity, adiponectin production decreases, thereby reducing insulin sensitivity in muscle and hepatic tissues. In addition, adipose tissue releases excessive free fatty acids and resistin into the bloodstream, triggering lipotoxicity and damaging muscle, liver, and pancreatic cells. The combination of decreased adiponectin, lipotoxicity, increased gluconeogenesis, and inflammation ultimately leads to hyperglycemia (Sofiyah & Putriningtyas, 2025).

Thus, based on pathophysiological concepts, an increase in waist circumference should theoretically be associated with higher HbA1c levels. A study by Sucitawati et al. reported a significant association between central obesity and HbA1c concentration among individuals aged 30–50 years (Sucitawati et al., 2019). However, differences in findings may be influenced by the use of pharmacological therapy that directly lowers blood glucose levels without necessarily reducing body fat. As a result, patients with high waist circumference but controlled HbA1c levels may still be observed. Lifestyle factors such as regular physical activity and a diet with a low glycemic index can also improve insulin sensitivity without necessarily reducing waist circumference.

The duration of obesity also plays a crucial role. In the early phase of central obesity, pancreatic beta cells are still capable of compensating by increasing insulin production to maintain euglycemia. Therefore, a large waist circumference may not necessarily be a single predictor of elevated HbA1c. Waist circumference also has limitations in precisely distinguishing between subcutaneous fat and visceral fat, meaning that individuals with the same waist circumference may have different metabolic risk profiles (Harbuwono et al., 2020)

Association Between Body Mass Index (BMI) and HbA1c

The results of the Spearman correlation test showed no significant association between BMI and HbA1c concentration ($r = 0.075$; $p = 0.611$). In the multivariate analysis, BMI had an odds ratio (OR) of 1.52 (95% CI: 0.48–4.82; $p = 0.475$). Although the OR value > 1 indicates a tendency for BMI to act as a triggering factor for an increase in HbA1c categories, the p-value > 0.05 and the confidence interval crossing the value of 1 indicate that BMI cannot be considered statistically significant.

Theoretically, an increase in BMI is associated with an increase in adipose tissue, which may lead to insulin resistance and impaired glycemic control. In individuals with obesity, the accumulation of body fat increases the concentration of free fatty acids in the bloodstream, which reduces insulin sensitivity. Excess fat inhibits glucose oxidation, causing skeletal muscle tissue to preferentially utilize free fatty acids as an energy source. This condition interferes with glycogen synthase activity and results in the accumulation of glucose in the blood circulation (Klein et al., 2022).

A study by Deng et al. reported a significant association between BMI and glycemic control in patients with type 2 diabetes mellitus (Deng et al., 2025). However, this finding differs from the results of the present study, possibly due to differences in the characteristics of the study subjects, including sample size, demographic background, and disease management. Nevertheless, the findings of this study are consistent with studies conducted by Irawan ($p = 0.063$), Purwaningsih ($p = 0.447$), and Suandy ($p = 0.987$) (Irawan et al., 2022; Suandy et al., 2022). These findings indicate that in some populations, BMI is not always a strong predictor of HbA1c concentration.

The absence of a significant association may be explained by several factors. First, HbA1c reflects long-term glycemic control (2–3 months), which is strongly influenced by treatment adherence and the duration of the disease. Patients with obesity who adhere to insulin therapy or oral antidiabetic medication tend to have better HbA1c concentrations compared with patients with normal BMI who are non-adherent to treatment (American Diabetes Association Professional Practice, 2024a).

Second, BMI has limitations as a parameter because it cannot distinguish between lean body mass (muscle mass) and body fat mass specifically. Although a patient may have a high BMI value, this does not necessarily reflect a high accumulation of pro-inflammatory visceral adipose tissue. Insulin sensitivity and metabolic risk are more strongly influenced by the quality and distribution of adipose tissue (such as ectopic and visceral fat) rather than simply the total body weight measured by BMI. This explains why patients categorized as obese by BMI but who have good muscle mass or predominantly peripheral (subcutaneous) fat distribution may still have relatively well-controlled HbA1c levels.

Third, physical activity influences glycemic control independently. According to research by McGee and Hargreaves, physical activity is a major stimulator of the translocation of glucose transporter type 4 (GLUT4) to the membrane of skeletal muscle cells. This mechanism is particularly important in patients with type 2 diabetes because the process of GLUT4 translocation to uptake blood glucose during physical activity remains relatively normal, even in patients with severe insulin resistance due to obesity. Increased expression of the GLUT4 protein enables muscle cells to reduce blood glucose levels without relying entirely on insulin sensitivity (McGee & Hargreaves, 2024). This explains why patients in this study may have maintained controlled HbA1c levels despite having BMI and waist circumference values in the higher categories.

Study Limitations

The findings of this study should be interpreted with consideration of several limitations. First, the cross-sectional design does not allow causal conclusions to be drawn. Second, the relatively small sample size (n = 48) may not provide sufficient statistical power.

Third, confounding factors such as the duration of diabetes, type and adherence to antidiabetic medications, dietary patterns, and physical activity were not analyzed. Fourth, the use of waist circumference as a proxy for visceral fat without imaging confirmation may be less accurate. Finally, this study was conducted at a single healthcare center; therefore, the generalizability of the findings should be interpreted with caution.

CONCLUSION

This study demonstrates that patients with type 2 diabetes mellitus at Haji General Hospital Medan were predominantly female, were generally in the older age group, and showed a high prevalence of both general obesity and central obesity, accompanied by predominantly uncontrolled HbA1c levels. However, despite the high proportion of obesity-related anthropometric abnormalities in the study population, neither waist circumference nor Body Mass Index (BMI) was significantly associated with HbA1c levels. These findings suggest that glycemic control in patients with type 2 diabetes mellitus may not be explained solely by anthropometric indicators, but is likely influenced by broader metabolic, behavioral, and therapeutic factors.

The scientific contribution of this study lies in its context-specific evidence showing that two widely used anthropometric measures, namely waist circumference and BMI, did not demonstrate a significant relationship with HbA1c levels in this clinical population. By examining both indicators simultaneously in patients with established type 2 diabetes mellitus in an outpatient hospital setting, this study adds empirical insight to the ongoing debate regarding the usefulness of simple obesity-related markers in reflecting glycemic status. The findings also reinforce the view that the relationship between obesity and glycemic control is complex and may vary depending on patient characteristics and clinical context.

Nevertheless, this study has several limitations. The cross-sectional design does not allow causal inferences to be established, and the relatively small sample size may have limited the statistical power to detect significant associations. In addition, important confounding factors such as duration of diabetes, treatment adherence, type of antidiabetic therapy, dietary pattern, and physical activity were not included in the analysis. Therefore, future studies are recommended to use larger samples, longitudinal designs, and more comprehensive clinical and behavioral variables in order to better clarify the relationship between anthropometric measures and glycemic control in patients with type 2 diabetes mellitus.

Recommendation

Based on the findings of this study, it is recommended that future research be conducted with a larger sample size and a longitudinal study design. Additionally, future studies should include other variables associated with HbA1c control, such as duration of the disease, physical activity, treatment adherence, and the type of therapy used.

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