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The Correlation Between Visceral Fat Levels And Fasting Blood Glucose In Type 2 Diabetes Patients At Primary Health Facility In Medan

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ABSTRACT
Introduction: Type 2 diabetes mellitus (T2DM) is a major metabolic disorder closely linked to visceral adiposity and insulin resistance. Visceral fat is metabolically active and contributes to inflammation and impaired glucose regulation. Evidence regarding the association between visceral fat and fasting blood glucose in primary healthcare populations remains limited. This study aimed to examine the correlation between visceral fat levels and fasting blood glucose among patients with T2DM in a primary care setting.
Methods: This cross-sectional analytic study was conducted at a primary healthcare facility in Medan between October and December 2025. Sixty adult patients with confirmed T2DM were recruited using consecutive sampling. Visceral fat levels were measured using bioelectrical impedance analysis, and fasting blood glucose was assessed after an overnight fast using standardized laboratory methods. Sociodemographic and clinical variables were recorded. Data distribution was tested using the Kolmogorov–Smirnov test, and correlation analysis was performed using Spearman's rho with a significance level of $p<0.05$.
Results: Participants had a median age of 63.5 years, and 61.7% were female. The median body mass index was 25.4 kg/m², and the median fasting blood glucose was 154 mg/dL. Both visceral fat and fasting glucose were non-normally distributed ($p<0.001$). Correlation analysis demonstrated a weak positive association between visceral fat and fasting blood glucose ($r=0.173$), which was not statistically significant ($p=0.186$).
Discussion: The findings suggest that fasting glycemic status in established T2DM is influenced by multifactorial mechanisms beyond adiposity alone, including treatment effects and disease progression.
Conclusion: Although non-significant, the positive trend supports the metabolic relevance of visceral adiposity. Assessment of visceral fat remains important for cardiometabolic risk evaluation in primary care.
Keywords: *Diabetes Mellitus, Type 2; Visceral Fat; Blood Glucose; Obesity, Abdominal*

ABSTRAK
Pendahuluan: Diabetes melitus tipe 2 (DMT2) merupakan gangguan metabolik utama yang berkaitan erat dengan adipositas viseral dan resistensi insulin. Lemak viseral bersifat metabolik aktif dan berperan dalam inflamasi serta gangguan regulasi glukosa. Bukti mengenai hubungan antara lemak viseral dan kadar

glukosa darah puasa pada populasi layanan kesehatan primer masih terbatas. Penelitian ini bertujuan untuk menganalisis korelasi antara kadar lemak viseral dan glukosa darah puasa pada pasien DMT2 di fasilitas pelayanan kesehatan primer.

Metode: Penelitian analitik observasional dengan desain potong lintang ini dilakukan di fasilitas pelayanan kesehatan primer di Medan pada Oktober–Desember 2025. Sebanyak 60 pasien dewasa dengan diagnosis DMT2 direkrut menggunakan *consecutive sampling*. Kadar lemak viseral diukur dengan *bioelectrical impedance analysis*, sedangkan glukosa darah puasa diperiksa setelah puasa semalam menggunakan metode laboratorium standar. Data sosiodemografi dan klinis dicatat. Distribusi data diuji menggunakan uji Kolmogorov–Smirnov, dan analisis korelasi dilakukan dengan uji Spearman dengan tingkat signifikansi $p<0,05$.

Hasil: Usia median partisipan adalah 63,5 tahun dan 61,7% berjenis kelamin perempuan. Indeks massa tubuh median sebesar 25,4 kg/m² dan median glukosa darah puasa 154 mg/dL. Kadar lemak viseral dan glukosa darah puasa tidak berdistribusi normal ($p<0,001$). Analisis korelasi menunjukkan hubungan positif lemah antara lemak viseral dan glukosa darah puasa ($r=0,173$) namun tidak signifikan secara statistik ($p=0,186$).

Diskusi: Temuan ini menunjukkan bahwa status glikemik puasa pada DMT2 yang telah berkembang dipengaruhi oleh faktor multifaktorial di luar adipositas saja, termasuk terapi dan progresivitas penyakit.

Kesimpulan: Meskipun tidak signifikan, tren positif mendukung relevansi metabolik adipositas viseral. Penilaian lemak viseral tetap penting untuk evaluasi risiko kardiometabolik di layanan kesehatan primer.

Kata kunci: Diabetes Melitus Tipe 2; Lemak Viseral; Glukosa Darah; Obesitas Abdominal

1. Introduction

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin resistance, or both. [1, 2] The global burden of diabetes continues to rise and represents a major public health challenge, particularly in low- and middle-income countries.[3] The International Diabetes Federation estimates that hundreds of millions of adults are currently living with diabetes worldwide, with substantial projected increases in the coming decades.[4] In Indonesia, the prevalence of T2DM has also increased markedly, contributing to significant morbidity, mortality, and healthcare costs.[5, 6] National and international guidelines emphasize that optimal glycemic control is essential to reduce the risk of microvascular and macrovascular complications and to improve long-term outcomes in patients with diabetes.[7]

Visceral adiposity plays a critical role in the development of insulin resistance and metabolic dysfunction.[8] Unlike subcutaneous fat, visceral fat is metabolically active and releases pro-inflammatory cytokines, free fatty acids, and adipokines that interfere with insulin signaling pathways and glucose metabolism. Excess visceral fat has been associated with increased hepatic glucose production, reduced peripheral glucose uptake, and pancreatic beta-cell dysfunction, all of which contribute to hyperglycemia.[9] The American Diabetes Association recognizes central obesity as a major determinant of insulin resistance and a key risk factor for T2DM, even among individuals with relatively normal body mass index.[10] Therefore, assessment of visceral fat may provide additional clinical value beyond conventional anthropometric measurements in evaluating metabolic risk among patients with diabetes.[11]

Fasting blood glucose is a fundamental parameter for the diagnosis and monitoring of glycemic control in individuals with T2DM, as recommended by the Perkumpulan Endokrinologi Indonesia and international diabetes care standards.[4, 5, 12] However, evidence regarding the relationship between visceral fat levels and fasting blood glucose among patients with T2DM in primary healthcare settings remains limited, particularly in Indonesian populations. Primary health facilities play an essential role in early detection and long-term management of metabolic disorders; thus, understanding this relationship may help improve risk stratification and clinical interventions. Therefore, this study aims to examine the correlation between visceral fat levels and fasting blood glucose in patients with type 2 diabetes mellitus at a primary health facility in Medan.

2. Methods

This study employed an observational analytic design with a cross-sectional approach to evaluate the correlation between visceral fat levels and fasting blood glucose among patients with type 2 diabetes mellitus (T2DM). The study was conducted at a primary healthcare facility in Medan, Indonesia, between October and December 2025. The study population consisted of adult patients diagnosed with T2DM who attended routine outpatient care during the study period. Participants were recruited using a consecutive sampling method based on eligibility criteria until the required sample size was achieved.

Inclusion criteria were patients aged ≥18 years with a confirmed diagnosis of T2DM according to the criteria of Perkumpulan Endokrinologi Indonesia, who were willing to participate and provided informed consent. Exclusion criteria included pregnancy, presence of acute infection, severe chronic illness, malignancy, edema, or any condition that could affect body composition measurements. Sociodemographic data and clinical characteristics were obtained through medical records and interviews.

Visceral fat levels were measured using bioelectrical impedance analysis (BIA) with a standardized body composition analyzer, following manufacturer instructions. Measurements were performed with participants in a fasting state, barefoot, and wearing light clothing. Fasting blood glucose levels were obtained after an overnight fast of at least 8–10 hours and were measured using venous blood samples analyzed in the facility laboratory using standardized enzymatic methods. Additional variables such as age, sex, body mass index (BMI), and duration of diabetes were also recorded as potential confounders.

Statistical analysis was performed using SPSS application. Descriptive statistics were used to summarize participant characteristics. The normality of data distribution was assessed using the Kolmogorov-Smirnov test. Correlation between visceral fat levels and fasting blood glucose was analyzed using Spearman correlation tests, depending on data distribution. A p-value <0.05 was considered statistically significant.

3. Results

A total of 60 participants with T2DM were included in this study. The median age of the subjects was 63.5 years, with a range between 39 and 80 years, indicating that most participants were older adults. Female participants constituted a higher proportion of the sample compared to males (61.7% vs 38.3%). The median body mass index (BMI) was 25.4 kg/m², with values ranging from 16.3 to 52.5 kg/m², reflecting a wide variation in nutritional status among participants.

The median waist circumference was 93 cm (range 78–140 cm), suggesting that a considerable proportion of subjects had central adiposity. Meanwhile, the median fasting blood glucose level was 154 mg/dL, with values ranging from 89 to 423 mg/dL, indicating suboptimal glycemic control in many participants despite ongoing treatment.

The demographic profile of the participants reflects a population commonly encountered in primary care settings, where T2DM is more prevalent among middle-aged and older adults. The predominance of female participants may be related to healthcare utilization patterns, as women are often more likely to seek routine medical care compared to men. The median BMI in the overweight range, combined with an elevated median waist circumference, highlights the presence of central obesity, which is known to contribute to insulin resistance and cardiometabolic risk.

The median fasting blood glucose level above recommended targets suggests that many patients had inadequate glycemic control, a finding that is not uncommon in long-standing diabetes managed in primary healthcare facilities. This condition may be influenced by multiple factors, including disease duration, treatment adherence, lifestyle behaviors, and metabolic variability. Collectively, these characteristics emphasize the importance of comprehensive metabolic assessment, including body composition and central adiposity, to support more targeted and individualized diabetes management strategies.

Table 1. Characteristics of Study Subjects

Characteristics	Amount
Number of subjects, n (%)	60 (100%)
Age (years), Median (Min-Max)	63.5 (39-80)
Gender, n (%)	
Man	23 (38.3%)
Woman	37 (61.7%)
Body Mass Index, Median (Min-Max)	25.4 (16.3-52.5)
Waist Circumference, Median (Min-Max)	93 (78-140)
Fasting Blood Glucose, Median (Min-Max)	154 (89-423)

The normality test using the Kolmogorov–Smirnov method demonstrated that both visceral fat level and fasting blood glucose were not normally distributed ($p < 0.001$ for both variables). Therefore, a non-parametric correlation analysis was performed using Spearman test.

Table 2. Normality Test of Visceral Fat Level and Fasting Blood Glucose

Variable	Normality Test	*p*-value
Visceral Fat Level	0.155	<0.001
Fasting Blood Glucose	0.191	<0.001

The correlation analysis showed a weak positive relationship between visceral fat level and fasting blood glucose ($r = 0.173$); however, this association was not statistically significant ($p = 0.186$). These findings indicate that higher visceral fat levels tended to be associated with higher fasting blood glucose values, although the relationship did not reach statistical significance in this study population.

Table 3. Correlation Between Visceral Fat Level and Fasting Blood Glucose

Variable	Correlation Tets	*p*-value
Visceral Fat Level - Fasting Blood Glucose	0.173	0.186

From a clinical perspective, the absence of a statistically significant correlation suggests that visceral fat level alone may not be a strong independent determinant of fasting blood glucose among patients with established T2DM in primary care settings.

4. Discussion

This study examined the relationship between visceral fat levels and fasting blood glucose among patients with T2DM treated at primary healthcare facilities. Although correlation between visceral adiposity and fasting glucose was observed, the association did not reach statistical significance. These findings suggest that while visceral fat may contribute to glycemic variability, fasting glucose levels in established T2DM are influenced by multiple interacting factors beyond adiposity alone, including pancreatic beta-cell function, medication use, and disease duration.[13, 14]

Glycemic control in individuals with diabetes is influenced by multiple factors, including duration of disease, pancreatic beta-cell function, medication adherence, dietary intake, physical activity, and comorbidities. Consequently, although visceral adiposity is mechanistically linked to insulin resistance, its direct relationship with fasting glucose may be attenuated in treated diabetic populations. The weak positive trend observed in this study still supports the biological plausibility that increased visceral fat contributes to metabolic dysregulation. Clinically, assessment of visceral fat remains relevant for comprehensive cardiometabolic risk evaluation rather than as a sole predictor of glycemic status. These findings highlight the importance of a multifactorial approach in diabetes management, particularly in primary healthcare settings where early risk identification and lifestyle interventions play a central role.[15]

From a pathophysiological perspective, visceral adipose tissue plays a central role in metabolic dysregulation due to its higher lipolytic activity compared with subcutaneous fat.[16] Increased free fatty acid flux from visceral depots into the portal circulation promotes hepatic insulin resistance, gluconeogenesis, and impaired glucose uptake in peripheral tissues.[17–20] Visceral fat is also metabolically active and secretes pro-inflammatory cytokines such as tumor necrosis factor-α and interleukin-6, which interfere with insulin signaling pathways and contribute to chronic low-grade inflammation.[21, 22] These mechanisms provide biological plausibility for the observed trend toward higher glucose levels in individuals with greater visceral adiposity.[23]

Previous studies have reported inconsistent findings regarding the strength of the association between visceral fat and glycemic control, particularly in populations with established diabetes.[24] Visceral adiposity is strongly linked with insulin resistance and diabetes risk during the early stages of metabolic dysfunction; however, once diabetes develops, glycemic markers may reflect beta-cell failure rather than adiposity alone.[25] This may explain the modest correlation observed in the present study. Similarly, investigations involving body composition and glycemic outcomes have demonstrated that anthropometric measures alone do not fully capture metabolic heterogeneity among individuals with T2DM.[26]

Another explanation for the lack of statistical significance may be related to clinical management factors. Participants were recruited from primary healthcare settings, where most were receiving glucose-lowering pharmacological therapy, which can substantially influence fasting blood glucose levels independent of adiposity status, thereby attenuating the observed association. In addition, dietary composition, particularly fatty acid quality, may affect insulin sensitivity and glucose metabolism; higher linoleic acid intake, for instance, has been associated with improved insulin sensitivity and reduced diabetes risk through mechanisms involving adiponectin regulation and lipid metabolism. Furthermore, the use of a single fasting blood glucose measurement may have contributed to the non-significant findings, as visceral adipose tissue accumulates gradually over time, whereas fasting glucose levels are more dynamic and subject to short-term variability..[18, 27]

The demographic characteristics of the study population may also contribute to the findings. The median age of participants was above 60 years, suggesting a cohort with long-standing metabolic disease. Aging is associated with progressive beta-cell dysfunction, sarcopenia, and altered fat distribution, all of which influence glycemic regulation independently of visceral fat accumulation.[28] Furthermore, the predominance of female participants may affect fat distribution patterns, as hormonal factors influence adipose tissue deposition and insulin sensitivity.[29–31]

Despite the absence of a statistically significant association, the clinical relevance of visceral adiposity should not be underestimated. Visceral fat is strongly associated with cardiometabolic complications, including dyslipidemia, hypertension, and cardiovascular disease, which are major contributors to morbidity in T2DM populations.[32] International guidelines emphasize the importance of assessing central obesity as part of comprehensive metabolic risk evaluation.[33] Therefore, monitoring visceral adiposity remains clinically important even when direct correlations with glycemic parameters appear modest.[34, 35]

This study has several strengths, including direct assessment of visceral fat using body composition analysis in a real-world primary care population. However, several limitations should be acknowledged. The cross-sectional design precludes causal inference, and unmeasured confounders such as medication regimens, duration of diabetes, physical activity, and dietary intake were not fully controlled. Additionally, fasting blood glucose reflects short-term glycemic status and may not represent overall glycemic control as accurately as HbA1c.

Future research should incorporate longitudinal designs and include comprehensive metabolic markers, such as insulin resistance indices, inflammatory biomarkers, and beta-cell function parameters. Evaluating the interaction between visceral adiposity, lifestyle factors, and therapeutic interventions may provide a more complete understanding of metabolic heterogeneity in T2DM populations.

5. Conclusion

This study found a weak and non-significant positive correlation between visceral fat and fasting blood glucose among patients with T2DM in a primary care setting, indicating that glycemic status in established diabetes is influenced by multiple factors beyond body fat distribution alone. Despite this, the high prevalence of visceral adiposity observed remains clinically relevant due to its strong association with cardiometabolic risk. These findings highlight the potential value of assessing visceral fat as part of comprehensive metabolic risk evaluation in primary care. Further longitudinal studies with broader metabolic parameters are warranted to better elucidate the role of visceral adiposity in glycemic control and guide personalized management strategies.

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7. Conflict of Interest

All the authors declare no conflict of interest.

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