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Relationship Between Body Mass Index and HbA1c Levels in Outpatients with Type 2 Diabetes Mellitus: A Cross-Sectional Study

Hilmi Ainunnaf'an Ahmad[1*], Minidian Fasitasari[2]
[1-2] Universitas Islam Sultan Agung Semarang, Indonesia
email: hilminafan11@gmail.com[1]

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Abstract

Type 2 Diabetes Mellitus (T2DM) is a metabolic disease characterized by impaired glycemic regulation, while nutritional status based on Body Mass Index (BMI) may influence glucose metabolism through mechanisms involving insulin resistance. This study aimed to determine the relationship between nutritional status based on BMI and HbA1c levels among outpatients with T2DM at Sultan Agung Islamic Hospital Semarang. This analytical observational study used a cross-sectional design and secondary data obtained from medical records. A total of 37 eligible subjects were selected using consecutive sampling. Data were analyzed using univariate and bivariate analyses, with the Kolmogorov-Smirnov test used to assess normality and Spearman's correlation test used to examine the relationship between BMI and HbA1c levels. The findings showed that 2 subjects (5.4%) were underweight, 11 (29.7%) had normal BMI, 9 (24.3%) were overweight, and 15 (40.5%) were obese. The mean BMI was 25.62 ± 4.21 kg/m², while the mean HbA1c level was 9.60 ± 2.45%. Spearman's correlation analysis demonstrated an extremely weak negative correlation between BMI and HbA1c levels ($r_s = -0.035$), with no statistically significant relationship ($p = 0.836$). Thus, BMI was not significantly associated with HbA1c levels among outpatients with T2DM at Sultan Agung Islamic Hospital Semarang.

Keywords: *Body Mass Index, HbA1c, Nutritional Status, Type 2 Diabetes Mellitus, Outpatients*.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) has become a major global health challenge as rising disease prevalence, persistent difficulties in achieving glycemic targets, and the growing burden of diabetes-related complications place increasing demands on health systems. In Indonesia, the management of T2DM requires attention not only to hyperglycemia but also to the nutritional and metabolic conditions that influence long-term disease control (Perkumpulan Endokrinologi Indonesia [PERKENI], 2024). Obesity, as a form of excess nutritional status, is particularly relevant because excessive adipose tissue can disrupt glucose metabolism through insulin resistance and related endocrine mechanisms (Kementerian Kesehatan Republik Indonesia, 2025; Allocca et al., 2025). Glycated hemoglobin (HbA1c) provides an important indicator of glycemic exposure over time, making it a clinically relevant outcome for examining whether nutritional status is associated with diabetes control (Abdullah et al., 2026). The relationship between these factors is not necessarily linear, because glycemic control is also shaped by treatment adherence, lifestyle, disease duration, and other clinical characteristics (Jalving et al., 2018). Understanding how nutritional status relates to HbA1c is therefore important for strengthening the interpretation of routine outpatient diabetes assessments.

Nutritional status in adults is commonly assessed using body mass index (BMI), which provides a practical measure for classifying underweight, normal weight, overweight, and obesity, although it does not directly distinguish adipose tissue from lean mass. In patients with T2DM, excess adiposity, particularly visceral fat, may contribute to chronic low-grade inflammation, adipokine imbalance, and impaired insulin signaling, creating a biological pathway through which higher BMI may be associated with poorer glycemic regulation (Allocca et al., 2025). Consistent with this mechanism, Deng et al. (2025) reported a significant positive association between BMI and HbA1c in patients with T2DM, suggesting that increasing BMI may accompany higher levels of glycated hemoglobin. However, the clinical meaning of BMI is not limited to excess weight, because undernutrition and altered body composition may also be relevant to metabolic vulnerability and diabetes-related outcomes. Mineoka et al. (2022) demonstrated that nutritional status assessed through objective nutritional data was associated with high-risk diabetic foot conditions, indicating that nutritional assessment may capture clinically important dimensions beyond body weight alone. These findings suggest that nutritional status should be considered as a multidimensional clinical characteristic rather than merely a marker of obesity.

Previous studies have produced important but not entirely consistent evidence regarding the association between nutritional status and glycemic control in T2DM. Harsari et al. (2018) found a significant relationship between nutritional status and fasting blood glucose, supporting the possibility that body composition and metabolic regulation are linked in patients with diabetes. In contrast, Wulandari and Adelina (2020) reported no significant association between anthropometric status based on BMI and either random blood glucose or HbA1c, although higher glucose and HbA1c values tended to occur among participants with overweight and central obesity. More recent observational evidence from Gugun and Suryanto (2025) further examined the relationship between HbA1c and BMI in patients with T2DM, reinforcing the relevance of this association in clinical settings. The inconsistency across studies may reflect differences in population characteristics, diabetes duration, treatment regimens, nutritional assessment methods, and the degree of glycemic control achieved by participants. Evidence from outpatient diabetes research also indicates that self-management behaviors and medication adherence can influence HbA1c, meaning that the association between nutritional status and glycemic control may be partly conditioned by treatment-related factors (Houle et al., 2015; Suprapti et al., 2023). This variability indicates that the relationship requires further examination in clearly defined clinical populations rather than being assumed to be uniform across patients with T2DM.

The complexity of this relationship becomes more apparent when nutritional status is examined alongside other diabetes-related outcomes. Ratnasari et al. (2022) showed that diabetes self-management education and support can influence nutritional status, eating habits, and glycemic control among outpatients with T2DM, suggesting that nutritional status and HbA1c may be connected through modifiable behavioral pathways. Research on diabetic foot ulcers has also linked nutritional status and HbA1c with amputation incidence, indicating that both variables may have clinical relevance beyond glycemic measurement alone (Hapsari et al., 2025). In older adults with T2DM, Thaenpramun et al. (2024) reported an association between glycemic control and malnutrition, highlighting that poor nutritional status may coexist with diabetes-related metabolic vulnerability rather than being confined to patients with excess weight. Evidence from adolescents with T2DM similarly indicates that nutritional status and glycemic control are associated with lipid profiles and metabolic syndrome, although the findings concern a younger population and may not be directly transferable to adults (Ferdian & Moelyo, 2026). These studies collectively suggest that nutritional status is clinically meaningful across different diabetes contexts, but they do not establish whether BMI-based nutritional status is independently associated with HbA1c among adult outpatients in a specific hospital population. The remaining question is therefore not simply whether nutritional status matters, but whether its association with HbA1c can be demonstrated consistently within the clinical characteristics of the population under study.

At the same time, the interpretation of nutritional status and HbA1c should account for the broader clinical and psychosocial context of diabetes management. Studies in Indonesia have documented variation in diabetes profiles, achievement of treatment targets, and complications across primary healthcare settings, emphasizing that glycemic control cannot be interpreted independently of the characteristics of the population receiving care (Dewanti et al., 2024). Nutritional status may also interact with disease duration and quality of life, as prolonged diabetes can affect daily functioning and the capacity to sustain self-management behaviors (Pranata et al., 2022). Research on depression among patients with T2DM further illustrates the importance of considering psychological factors when interpreting diabetes outcomes, although psychological variables are not the primary focus of the present study (Humagi et al., 2026). Similarly, evidence concerning diabetic ulcer management and social support demonstrates that diabetes care involves multiple interacting clinical and social dimensions, which may influence outcomes without directly resolving the association between BMI and HbA1c (Anggraini et al., 2026). These considerations reinforce the need for a focused observational analysis that examines the nutritional status–HbA1c relationship while recognizing that the observed association may be influenced by factors beyond BMI itself. Such an approach can clarify whether nutritional status provides clinically useful information for understanding glycemic control in routine outpatient care.

The present study is positioned within this gap by examining the relationship between nutritional status and HbA1c levels among adult outpatients with T2DM at Sultan Agung Islamic Hospital in Semarang. The hospital setting provides a relevant clinical context for investigating this relationship because nutritional status and HbA1c are routinely assessed as part of diabetes management, while the characteristics of the outpatient population may differ from those of primary healthcare, younger patients, or individuals with advanced diabetic complications. The study aims to determine whether nutritional status, as assessed by BMI, is significantly associated with HbA1c levels in this population. By focusing on an adult outpatient population, the study seeks to contribute empirical evidence to the ongoing discussion about whether BMI-based nutritional assessment is sufficiently informative for understanding glycemic control in T2DM. The findings may also provide a basis for considering nutritional assessment as part of a broader clinical approach to diabetes management, particularly when interpreting HbA1c in relation to patients' metabolic characteristics. Methodologically, the study contributes by examining this association within a clearly defined hospital-based population, thereby addressing the contextual variability that may partly explain inconsistent findings in previous research. The study is expected to strengthen the empirical foundation for understanding the relationship between nutritional status and HbA1c and to support further research on the clinical factors that shape glycemic control in patients with T2DM.

RESEARCH METHODS

This empirical study employed an analytical observational design with a cross-sectional approach to examine the relationship between nutritional status and HbA1c levels among outpatients with type 2 diabetes mellitus (T2DM) at Sultan Agung Islamic Hospital, Semarang. The study was conducted in the Medical Records Department from 1 to 11 August 2026, using electronic medical records of patients who had undergone both BMI and HbA1c measurements within an interval of no more than three months. The study population comprised outpatients with T2DM who met the eligibility criteria, and consecutive sampling was continued until the minimum sample size of 37 participants was reached. Inclusion criteria were age ≥45 years, outpatient status, and availability of BMI and HbA1c measurements within the specified interval, while exclusion criteria included anemia, advanced chronic kidney disease, pregnancy, severe acute illness, acute diabetic complications, hemoglobinopathies, severe erythropoietic disorders, chronic liver disease, alcohol consumption, and incomplete medical records. These criteria were established to reduce the influence of conditions that could distort HbA1c interpretation or compromise the comparability of nutritional and glycemic measurements. The focus on a defined outpatient population is consistent with the clinical importance of examining glycemic control in relation to nutritional status and other patient characteristics documented in routine diabetes care (Dewanti et al., 2024).

Nutritional status was assessed using BMI, calculated as body weight in kilograms divided by height in meters squared, with BMI retained as a continuous variable for bivariate analysis and categorized descriptively according to the Asia-Pacific classification of underweight, normal weight, overweight, and obesity (Kementerian Kesehatan Republik Indonesia, 2025). HbA1c levels were obtained from laboratory results recorded in the electronic medical records, and the clinical interpretation of HbA1c followed the categories of normal, prediabetes, and diabetes specified in the Indonesian diabetes management guideline (Perkumpulan Endokrinologi Indonesia [PERKENI], 2024). Data on participant characteristics, anthropometric measurements, examination dates, and HbA1c results were extracted using an observation sheet, after which the interval between measurements was verified, BMI was calculated, and the dataset was checked for completeness and consistency before analysis in IBM SPSS. Descriptive analysis was performed to summarize age, gender, BMI, nutritional-status categories, and HbA1c levels, with categorical variables presented as frequencies and percentages and numerical variables as means and standard deviations. The Kolmogorov–Smirnov test indicated that BMI was not normally distributed ($p = 0.017$), whereas HbA1c was normally distributed ($p = 0.200$), so the association between the two continuous variables was assessed using Spearman's rank correlation, with statistical significance set at $p < 0.05$. Ethical approval was obtained from the Research Ethics Committee of Sultan Agung Islamic Hospital, Semarang, under approval number 21/KEPK-RSISA/VII/2026, and the study used existing medical-record data in accordance with institutional requirements for ethical research and confidentiality.

RESULTS AND DISCUSSION

Participant Characteristics and Nutritional Status

This study employed an analytical observational cross-sectional design involving 37 outpatients with type 2 diabetes mellitus treated at Sultan Agung Islamic Hospital, Semarang. The participants were adults aged ≥45 years who had documented body mass index (BMI) and HbA1c measurements obtained within a maximum interval of three months. The use of consecutive sampling allowed eligible patients who met the predetermined inclusion and exclusion criteria to be recruited sequentially until the minimum sample size was reached. The participant profile provides an important clinical context because age, gender, and nutritional status may influence metabolic regulation among individuals with type 2 diabetes mellitus. Recent evidence indicates that demographic and metabolic characteristics should be considered when interpreting glycemic indicators because HbA1c reflects longer-term glucose exposure rather than a single measurement of blood glucose (Abdullah et al., 2026). The characteristics of the participants in this study are presented in Table 1.

Table 1. Characteristics of the Study Participants

Characteristic	Frequency (n)	Percentage (%)
Age		
45–54 years	11	29.7
55–64 years	16	43.2
≥65 years	10	27.0
Gender		
Male	20	54.1
Female	17	45.9
BMI		
Underweight	2	5.4
Normal	12	32.4
Overweight	13	35.1
Obesity	10	27.0
Mean BMI	**25.62 ± 4.21 kg/m²**	

Table 1 shows that the largest proportion of participants was aged 55–64 years, accounting for 43.2% of the sample, followed by those aged 45–54 years at 29.7% and those aged ≥65 years at 27.0%. The distribution indicates that the study population was predominantly composed of middle-aged to older adults, a pattern consistent with the increasing burden of type 2 diabetes mellitus with advancing age. Age-related changes in body composition, insulin sensitivity, and pancreatic β-cell function can contribute to impaired glucose regulation in this population (Allocca et al., 2025). Male participants represented 54.1% of the sample, whereas females accounted for 45.9%, indicating a relatively balanced gender distribution despite a modest predominance of men. Such demographic variation may be relevant because differences in body composition, adipose tissue distribution, and hormonal factors can influence metabolic outcomes among patients with diabetes. The relatively similar representation of both genderes strengthens the descriptive context for interpreting the BMI and HbA1c findings, although the limited sample size does not permit meaningful gender-stratified analysis.

The mean BMI of the participants was 25.62 ± 4.21 kg/m², indicating that the average participant was within the overweight range according to the Asia-Pacific classification applied in this study. The largest BMI category was overweight, comprising 35.1% of participants, while 27.0% were classified as obese. In contrast, 32.4% had normal BMI and only 5.4% were underweight, demonstrating that excess body weight was common among the study population. This pattern is clinically relevant because excess adiposity is associated with adipose-tissue dysfunction, chronic low-grade inflammation, and impaired insulin signaling, all of which may contribute to metabolic disturbances in type 2 diabetes mellitus (Allocca et al., 2025). The concentration of participants in the overweight and obesity categories also reflects the broader metabolic burden observed among patients with type 2 diabetes in contemporary clinical populations. However, the presence of participants with normal and low BMI indicates that diabetes in this population cannot be interpreted solely through the presence of excess body weight.

The predominance of overweight and obesity is biologically plausible because increased adiposity can promote insulin resistance through altered adipokine secretion, ectopic lipid accumulation, and inflammatory signaling. In patients with established type 2 diabetes mellitus, these mechanisms may increase the difficulty of maintaining optimal glycemic control despite pharmacological and lifestyle interventions. Nevertheless, BMI does not directly distinguish visceral adipose tissue from lean tissue and therefore provides only an indirect estimate of metabolic adiposity (Mineoka et al., 2022). This distinction becomes particularly important in older adults, whose body composition may change substantially without a proportional change in BMI. A patient with a similar BMI may therefore have substantially different levels of visceral fat and metabolic risk. The relatively high proportion of overweight and obese participants in this study should consequently be interpreted as an indicator of nutritional status rather than as a definitive measure of insulin resistance or metabolic severity.

The nutritional-status pattern observed in this study is broadly consistent with evidence linking excess body weight to the development and persistence of metabolic abnormalities in diabetes. Previous research has demonstrated that obesity-related metabolic dysfunction is closely connected with insulin resistance, although the strength of this relationship may vary according to age, body-fat distribution, duration of diabetes, and treatment characteristics (Harsari et al., 2018). More recent studies have also emphasized that nutritional status should be interpreted together with broader metabolic and clinical characteristics rather than as an isolated anthropometric parameter (Deng et al., 2025). The mean BMI of 25.62 kg/m² in the present study therefore suggests a population with a substantial burden of excess weight, but it does not establish that BMI alone determines glycemic outcomes. Differences in dietary intake, physical activity, antidiabetic medication, disease duration, and metabolic phenotype may modify the relationship between body weight and glycemic control (Dewanti et al., 2024). These considerations are important because the subsequent analysis specifically evaluates whether variation in BMI is accompanied by variation in HbA1c.

From a clinical perspective, the participant characteristics indicate that nutritional assessment remains an important component of diabetes management in this outpatient population. The predominance of overweight and obese participants highlights the relevance of weight management, dietary counseling, and physical-activity interventions as components of comprehensive diabetes care. At the same time, the proportion of participants with normal BMI demonstrates that appropriate glycemic management should not be restricted to patients who appear overweight. Diabetes-related metabolic dysregulation can occur across different nutritional-status categories, particularly in older adults and individuals with altered body composition (PERKENI, 2024). The baseline nutritional profile therefore establishes a heterogeneous metabolic population in which BMI may or may not correspond closely with HbA1c. This issue is examined further through the distribution of HbA1c levels and the statistical analysis of the association between BMI and glycemic control.

Glycemic Control and HbA1c Levels

HbA1c is an important indicator for evaluating long-term glycemic control in patients with type 2 diabetes mellitus because it represents average blood glucose exposure over approximately the preceding two to three months. Unlike a single blood glucose measurement, HbA1c provides a broader representation of glycemic conditions and is therefore useful for evaluating the effectiveness of diabetes management over time. In this study, HbA1c was assessed among 37 outpatients with type 2 diabetes mellitus who met the predetermined eligibility criteria. The use of HbA1c also enabled the assessment of glycemic status within a relatively stable outpatient population rather than during an acute metabolic event. Glycemic control may be affected by multiple factors, including dietary intake, physical activity, medication adherence, duration of diabetes, and individual response to treatment (PERKENI, 2024). These factors are important to consider when interpreting the subsequent relationship between BMI and HbA1c.

Variation in HbA1c among patients with established type 2 diabetes mellitus reflects the complexity of maintaining adequate glycemic control in routine clinical practice. Although pharmacological therapy is an essential component of diabetes management, treatment alone does not necessarily result in equivalent glycemic outcomes among patients. Differences in adherence, dietary behavior, physical activity, treatment intensity, and duration of disease may produce substantial variation in HbA1c levels between individuals. In addition, progressive deterioration of pancreatic β-cell function and increasing insulin resistance may influence glycemic control as the disease develops over time (Allocca et al., 2025). These mechanisms indicate that HbA1c should be understood as the outcome of interacting metabolic and behavioral processes rather than as an indicator determined by body weight alone. The heterogeneity of these determinants is particularly relevant when examining patients from an outpatient population with different clinical backgrounds.

The interpretation of HbA1c in this study was supported by the exclusion of several conditions that may interfere with its reliability. Patients with anemia, hemoglobinopathy, severe erythropoietic disorders, and other selected conditions affecting red blood cell characteristics were excluded from the study. This approach was important because alterations in erythrocyte lifespan or hemoglobin structure can influence HbA1c measurements independently of actual glycemic exposure. The exclusion criteria therefore helped reduce potential sources of measurement distortion and strengthened the clinical interpretation of HbA1c in the study population. Nevertheless, HbA1c remains susceptible to influences beyond nutritional status, including medication use, lifestyle behavior, and disease characteristics (Abdullah et al., 2026). The observed HbA1c levels should consequently be interpreted within the broader metabolic context of patients with established diabetes.

Glycemic control also has important clinical implications because persistent hyperglycemia is associated with an increased risk of diabetes-related complications. Maintaining HbA1c within an individualized therapeutic target is therefore a major component of diabetes management and requires continuous evaluation during outpatient care. Current recommendations emphasize that glycemic targets should be individualized according to age, comorbidities, treatment characteristics, and the risk of hypoglycemia rather than applied uniformly to all patients (PERKENI, 2024). This consideration is particularly relevant in the present study because the participants consisted predominantly of middle-aged and older adults. Differences in treatment goals and therapeutic responses may contribute to variation in HbA1c even among patients with similar nutritional status. Glycemic control should therefore be evaluated together with anthropometric, clinical, and behavioral characteristics when assessing the metabolic condition of patients with type 2 diabetes mellitus.

Previous studies have shown that glycemic outcomes in type 2 diabetes are influenced by multiple interconnected factors, resulting in inconsistent associations between anthropometric indicators and HbA1c. Excess body weight is generally recognized as an important contributor to insulin resistance, but its effect on glycemic control may become less direct once diabetes has been established and patients receive ongoing treatment. Differences in disease duration, medication regimens, lifestyle modification, and body-fat distribution may partly explain variations in the association between BMI and HbA1c across different populations (Harsari et al., 2018; Mineoka et al., 2022). Recent evidence also indicates that metabolic characteristics cannot always be adequately represented by BMI alone, particularly among older adults and individuals with differences in body composition (Deng et al., 2025). This evidence provides an important basis for interpreting the findings of the present study without assuming that a higher BMI necessarily corresponds to poorer glycemic control. The statistical analysis between BMI and HbA1c is therefore necessary to determine whether such an association was actually present in the study population.

Taken together, HbA1c provides an appropriate clinical outcome for examining long-term glycemic regulation among the participants in this study. The variation in glycemic control highlights that patients with type 2 diabetes may experience different metabolic outcomes despite receiving care within the same clinical setting. Nutritional status may contribute to these differences through mechanisms related to adiposity and insulin resistance, but its influence may be modified by other clinical and behavioral factors. BMI should therefore not be interpreted as an independent determinant of HbA1c without considering the broader characteristics of diabetes management (Dewanti et al., 2024). This perspective is consistent with the multifactorial nature of glycemic regulation and supports the use of an appropriate statistical test to evaluate the relationship between BMI and HbA1c. The following section examines the strength, direction, and statistical significance of this relationship in the study population.

Association Between BMI and HbA1c Levels

The analysis of the relationship between BMI and HbA1c levels was conducted using the Spearman rank correlation test because the variables were analyzed as continuous measures and the analysis aimed to determine the direction and strength of their association. The statistical analysis produced a correlation coefficient of rs = −0.035 with a p-value of 0.836. The correlation coefficient was very close to zero, indicating that the relationship between BMI and HbA1c was extremely weak and showed a slightly negative direction. The p-value substantially exceeded the significance threshold of 0.05, indicating that the observed association was not statistically significant. This finding suggests that variation in BMI among the participants was not accompanied by a meaningful variation in HbA1c levels. The statistical result is summarized in Table 2.

The absence of a statistically significant association indicates that BMI did not appear to be a major determinant of HbA1c levels in this particular outpatient population. Although excess body weight is biologically associated with insulin resistance, the effect of BMI on glycemic control may be less apparent among individuals who already have type 2 diabetes mellitus. Once diabetes has developed, glycemic regulation is influenced by several additional factors, including antidiabetic medication, adherence to treatment, dietary intake, physical activity, duration of disease, and residual pancreatic β-cell function (Dewanti et al., 2024). The very weak correlation observed in this study may therefore reflect the contribution of these factors to HbA1c variation. Similar considerations have been highlighted in studies showing that anthropometric characteristics do not always independently explain glycemic control among patients with established diabetes (Mineoka et al., 2022). The result should consequently be interpreted as evidence that BMI alone may have limited explanatory value for HbA1c in the studied population.

Table 3. Relationship Between BMI and HbA1c Levels

Variables	Spearman's Correlation (rs)	p-value	n
BMI and HbA1c	−0.035	0.836	37

As shown in Table 3, the correlation coefficient of −0.035 indicates an almost negligible negative relationship between BMI and HbA1c. The direction of the coefficient suggests that higher BMI was associated with a minimally lower HbA1c value in the observed data, but the magnitude was too small to indicate a meaningful linear tendency. More importantly, the p-value of 0.836 demonstrates that this observed pattern was not statistically significant. The finding means that the study did not provide sufficient evidence to conclude that BMI was associated with HbA1c levels among the participants. A statistically nonsignificant result does not imply that adiposity has no biological relationship with glucose metabolism, but rather that such a relationship was not detectable under the conditions and sample characteristics of this study. This distinction is important because BMI is an indirect anthropometric measure and may not adequately capture the specific components of adiposity that are most strongly related to insulin resistance (Harsari et al., 2018).

The present finding differs from studies that have reported a meaningful relationship between obesity-related characteristics and glycemic outcomes. Harsari et al. (2018), for example, emphasized the metabolic relevance of nutritional status in relation to insulin resistance and diabetes-related abnormalities, supporting the biological plausibility of an association between excess adiposity and glucose regulation. However, the current study involved patients who already had type 2 diabetes mellitus and were receiving outpatient care, making the metabolic context different from populations in which obesity is examined primarily as a risk factor for diabetes development. In established diabetes, pharmacological treatment and behavioral modification may alter the relationship between body weight and glycemic control. Differences in age, disease duration, medication use, body-fat distribution, and lifestyle characteristics may also produce inconsistent associations across populations (Deng et al., 2025). The discrepancy therefore does not necessarily contradict the established role of adiposity in insulin resistance, but instead suggests that BMI may have a limited role in explaining HbA1c variation after multiple metabolic factors are already involved.

The finding is also relevant when compared with more recent evidence concerning the complexity of the BMI–glycemic control relationship. Deng et al. (2025) reported evidence that metabolic outcomes may vary according to individual characteristics and that conventional anthropometric indicators do not always fully represent metabolic risk. This perspective is consistent with the very weak correlation observed in the present study, where BMI explained little of the variation in HbA1c. Visceral adiposity, for example, may have a stronger relationship with insulin resistance than total body mass, while BMI cannot distinguish visceral fat from subcutaneous fat or lean tissue. Age-related changes in muscle mass and body-fat distribution may further reduce the ability of BMI to represent metabolic status accurately among middle-aged and older adults (Mineoka et al., 2022). The nonsignificant result may therefore reflect limitations in the anthropometric indicator as well as the influence of other determinants of glycemic control.

From a clinical perspective, the finding indicates that BMI should not be used as the sole basis for anticipating glycemic control among outpatients with type 2 diabetes mellitus. Patients with higher BMI may not necessarily have higher HbA1c, while patients with normal BMI may still experience inadequate glycemic control. Comprehensive assessment should instead incorporate HbA1c monitoring together with dietary behavior, physical activity, medication adherence, diabetes duration, and other relevant clinical characteristics (PERKENI, 2024). Nutritional management remains important for patients with excess body weight, but the objective should not be limited to reducing BMI without considering broader metabolic outcomes. The absence of a significant correlation also reinforces the importance of individualized diabetes management because patients with similar BMI values may require different approaches to achieve glycemic targets. These clinical considerations are particularly important when interpreting the findings from a relatively small outpatient sample.

Overall, the statistical analysis demonstrated no significant association between BMI and HbA1c levels among the 37 participants, as indicated by $r_s = -0.035$ and $p = 0.836$. The direction of the relationship was slightly negative, but its magnitude was practically negligible. The finding suggests that BMI variation alone was insufficient to explain differences in long-term glycemic control within this study population. The result is compatible with the view that glycemic regulation in established type 2 diabetes is multifactorial and may be influenced more strongly by treatment, lifestyle, disease characteristics, and body composition than by BMI alone (Deng et al., 2025). It also highlights the limitation of relying on a single anthropometric indicator when evaluating metabolic status in patients with diabetes. Further consideration of the clinical implications, methodological limitations, and potential directions for future research is presented in the following section.

Clinical Implications, Limitations, and Future Directions

The findings of this study have important implications for the clinical management of patients with type 2 diabetes mellitus. The mean BMI of the participants indicated a tendency toward excess body weight, with overweight and obesity representing substantial proportions of the study population. This condition remains clinically relevant because excess adiposity is associated with insulin resistance, impaired metabolic regulation, and increased cardiometabolic risk. However, the absence of a significant association between BMI and HbA1c indicates that excess body weight should not be considered the sole determinant of glycemic control. Glycemic management requires consideration of several factors, including dietary behavior, physical activity, medication adherence, treatment regimen, and duration of diabetes (PERKENI, 2024). Nutritional management therefore remains important, but it should be integrated with individualized monitoring of glycemic status and other clinical characteristics.

The findings also indicate that BMI and HbA1c provide different types of clinical information and should not be treated as interchangeable indicators. BMI primarily describes body size relative to height, whereas HbA1c reflects longer-term glycemic exposure. A patient with normal BMI may still have inadequate glycemic control, while a patient with higher BMI may achieve relatively better glycemic control because of effective treatment and lifestyle management. This distinction is particularly relevant in established type 2 diabetes, where metabolic regulation is influenced by multiple interacting factors rather than adiposity alone (Dewanti et al., 2024). The synthesis of the principal findings and their clinical interpretation is presented in Table 4.

Table 4. Synthesis of Main Findings and Clinical Implications

Study Component	Main Finding	Interpretation	Clinical Implication
Nutritional Status	Mean BMI: **25.62 ± 4.21 kg/m²**	Average BMI was within the overweight range	Nutritional assessment and weight management remain important
BMI Distribution	Underweight: **5.4%**; Normal: **32.4%**; Overweight: **35.1%**; Obesity: **27.0%**	Excess body weight was common	Weight management should remain part of comprehensive diabetes care
BMI–Hba1c Association	**rs = −0.035**	Extremely weak negative association	BMI alone has limited value for explaining HbA1c variation
Statistical Significance	**p = 0.836**	No statistically significant association	Glycemic control should not be predicted from BMI alone

The synthesis in Table 4 demonstrates that the clinical relevance of nutritional status does not necessarily depend on the existence of a significant BMI–HbA1c association. The relatively high proportion of participants with overweight and obesity supports the continued importance of nutritional counseling and appropriate weight management in diabetes care. Nevertheless, the correlation coefficient close to zero indicates that BMI contributed very little to explaining differences in HbA1c within this population. This finding supports the use of a multidimensional approach in which anthropometric measurements are combined with direct assessment of glycemic control and relevant behavioral factors. Such an approach is consistent with evidence that metabolic risk cannot always be adequately characterized using BMI alone, particularly among older adults with variations in body composition (Mineoka et al., 2022). Clinical decisions should therefore be based on the overall metabolic and clinical profile of each patient rather than on BMI category alone.

A major limitation of this study concerns the use of BMI as the principal anthropometric indicator of nutritional status. Although BMI is simple and widely used in clinical settings, it cannot distinguish between fat mass and lean mass or identify the distribution of adipose tissue. Visceral adiposity may have a stronger association with insulin resistance than overall body mass, while BMI may classify individuals with substantially different body compositions within the same category. This limitation may partly explain the extremely weak relationship between BMI and HbA1c observed in the present study. Previous research has emphasized that measures of central or visceral adiposity may provide additional information regarding metabolic risk beyond conventional BMI assessment (Harsari et al., 2018). Future studies should therefore incorporate additional anthropometric or body-composition measurements to obtain a more comprehensive assessment of nutritional and metabolic status.

The cross-sectional design also limits the interpretation of the observed association because BMI and HbA1c were assessed within the same observational period. This design can identify whether variables are statistically associated but cannot determine whether changes in BMI precede or produce changes in HbA1c. The relatively small sample of 37 participants from a single hospital may also reduce statistical power and limit the generalizability of the findings to broader populations of patients with type 2 diabetes mellitus. Furthermore, potentially influential variables such as diabetes duration, antidiabetic medication, medication adherence, dietary intake, physical activity, and treatment intensity were not incorporated into the bivariate analysis. These factors may influence HbA1c independently of BMI and may partly account for the absence of a significant association. The findings should therefore be interpreted within the characteristics and methodological boundaries of the study population.

Future research should involve larger samples recruited from multiple healthcare facilities to improve statistical power and external validity. A prospective cohort design would also be valuable because repeated measurements could determine whether changes in nutritional status are accompanied by changes in HbA1c over time. In addition to BMI, future studies could measure waist circumference, waist-to-height ratio, body-fat percentage, or other indicators of visceral adiposity to better characterize metabolic risk. Multivariable statistical models could further incorporate diabetes duration, medication regimen, adherence, dietary patterns, physical activity, and other relevant clinical variables to determine the independent contribution of nutritional status to glycemic control (Deng et al., 2025). Such approaches would help distinguish the direct contribution of adiposity from the effects of treatment and lifestyle factors. Longitudinal and multidimensional research could therefore provide a more precise explanation of the complex relationship between nutritional status and glycemic regulation.

Taken together, the findings indicate that nutritional status remains clinically important even though BMI was not significantly associated with HbA1c in this study. The $r_s = -0.035$ and $p = 0.836$ values demonstrate that the observed BMI–HbA1c relationship was extremely weak and statistically nonsignificant. This result should not be interpreted as evidence that excess adiposity has no role in the pathophysiology of type 2 diabetes mellitus, but rather that BMI alone was insufficient to explain glycemic variation in the observed outpatient population. Comprehensive diabetes management should continue to address nutritional status while simultaneously emphasizing individualized glycemic monitoring and modification of relevant behavioral and treatment-related factors (PERKENI, 2024). The methodological limitations also indicate the need for future studies using larger samples, longitudinal designs, and more sensitive measures of adiposity. These findings provide a basis for interpreting the study conclusion while maintaining an appropriate distinction between the clinical importance of nutritional status and its statistical relationship with HbA1c.

CONCLUSION

Based on the findings of this study, there was no statistically significant relationship between nutritional status based on body mass index (BMI) and HbA1c levels among outpatients with type 2 diabetes mellitus at Sultan Agung Islamic Hospital, Semarang. The Spearman correlation analysis yielded a correlation coefficient of $r_s = -0.035$ with a p-value of 0.836, indicating an extremely weak and statistically nonsignificant relationship between the two variables. The negative direction of the correlation does not indicate a meaningful clinical relationship because the correlation coefficient was very close to zero. The nutritional-status distribution based on BMI showed that 2 participants (5.4%) were underweight, 11 (29.7%) had normal BMI, 9 (24.3%) were overweight, and 15 (40.5%) were obese, with obesity representing the largest proportion. The mean HbA1c level was $9.60 \pm 2.45\%$, with values ranging from 5.40% to 16.60%, indicating substantial variation in long-term glycemic control among the participants. These findings indicate that BMI alone was insufficient to explain differences in HbA1c levels in the studied population. The results also suggest that glycemic control among patients with established type 2 diabetes mellitus should be interpreted in relation to other clinical, behavioral, and treatment-related factors.

Future studies are recommended to examine other factors that may contribute to HbA1c variation, including duration of type 2 diabetes mellitus, adherence to treatment, type and intensity of antihyperglycemic therapy, physical activity, and dietary patterns. Further research should also consider anthropometric indicators or body-composition measures other than BMI that can more specifically represent the distribution of body fat and metabolic adiposity. Measures such as waist circumference, waist-to-height ratio, or body-fat percentage may provide additional information that cannot be captured by BMI alone. A larger sample involving multiple healthcare facilities would also improve the statistical power and generalizability of future findings. Longitudinal research could provide stronger evidence regarding temporal relationships between changes in nutritional status and HbA1c levels. Incorporating clinical and behavioral variables into multivariable analyses may further clarify the independent contribution of nutritional status to glycemic control. Such approaches are expected to provide a more comprehensive understanding of the complex factors associated with glycemic control in patients with type 2 diabetes mellitus.

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