



## STRESS LEVELS AND BLOOD SUGAR CONTROL IN PATIENTS WITH TYPE 2 DIABETES MELLITUS

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### ABSTRACT

The prevalence of type 2 diabetes mellitus (T2DM), a chronic condition, is on the rise around the world. Glycemic regulation, which includes unexpected blood glucose levels, is impacted by both biological and psychological influences, including stress. Specifically, studies examining the impact of stress on unforeseen glucose regulation have been under-researched in Indonesia. This research aims to fill a gap in our understanding of how stress influences individuals' ability to deliberately regulate their blood sugar levels. Those taking part in the study were monitored using a cross-sectional method. Two hundred patients with type 2 diabetes mellitus were selected from the patient registry of the Baki Community Health Center based on a list of predefined inclusion and exclusion criteria. We measured the amount of stress and then categorized it as low, medium, or high using the Perceived Stress Scale (PSS). Stress levels were measured using the Indonesian version of the Perceived Stress Scale-10 (PSS-10), which had been previously validated and demonstrated good reliability (Cronbach's Alpha  $\alpha = 0.84$ ). During data collection, a single RBG test was performed to evaluate the impact of random modulation on blood glucose levels. In both the univariate and bivariate data analyses, Pearson's Chi-Square test was employed with a significance level of  $p < 0.05$  to determine if the variables were related. We utilized Cramer's V to determine the reliability of the association. This study was authorized by the Health Research Ethics Committee of the Faculty of Medicine at Muhammadiyah University Surakarta. The study comprised 200 participants, the average age of whom was  $41.82 \pm 6.50$  years. Women comprised 67.5% of that group. On average,  $244.07 \pm 84.46$  mg/dL was recorded by 60% of those whose levels were uncontrolled and 51.5% of those who indicated moderate stress. The results of the bivariate analysis showed a significant relationship ( $\chi^2 = 81.919$ ;  $p < 0.001$ ) between the levels of stress and the random control of blood glucose. Their bond was strong. People with type 2 diabetes mellitus find it more difficult to regulate their blood glucose levels when they are under a lot of stress. A substantial and statistically significant relationship exists here. The results show that mental stress needs to be taken into account while managing blood sugar levels thoroughly.

Keywords: glycemic control; random blood glucose; stress level; type 2 diabetes mellitus

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### INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder characterized by high blood glucose levels due to insulin resistance and/or impaired insulin production. Currently, T2DM is recognized as one of the non-communicable diseases with an increasingly high prevalence worldwide, making it a serious threat to global public health. According to data released by the International Diabetes Federation, approximately 529 million adults aged 20 to 79 worldwide have diabetes, which is equivalent to nearly 10.5% of the global adult population in 2024–2025 (International Diabetes Federation, 2025). Estimates suggest that this number could jump to around 783 million people by 2050 if appropriate preventive measures are not taken (Bruce B Duncan et al., 2025). Regionally, the majority of people with diabetes come from low- and middle-income countries, with about 80% of people with diabetes living in these regions. This reflects the dual challenges of disease burden and limited health services in many developing countries. In addition to its increasing prevalence, T2DM also contributes significantly to morbidity, disability, and premature mortality worldwide. This disease not only burdens individuals and families, but also poses substantial economic and healthcare challenges due to the high costs associated with long-term treatment, complication management, and loss of productivity. The chronic nature of T2DM

requires ongoing monitoring and lifelong management, which can further increase the psychosocial burden experienced by patients.

The epidemiological situation of type 2 diabetes is also increasing in Indonesia. Information from the IDF Diabetes Atlas reveals that Indonesia is listed as one of the countries with a very high rate of diabetes globally, with an estimated 20.4 million adults (aged 20–79 years) suffering from diabetes in 2024, placing Indonesia fifth in the world for total cases. The prevalence of diabetes among adults in Indonesia is estimated to reach approximately 11.1% by the same time (International Diabetes Federation, 2025). The 2023 Indonesian Health Survey (SKI) confirms this by indicating that the number of diabetes cases based on blood sugar measurements in people aged 15 years and above reached 11.7%, while the number based on medical diagnosis was only 1.7%. This shows that a large number of diabetes cases identified through laboratory analysis are not officially diagnosed, reflecting an unseen disease burden (Kesehatan, Badan Kebijakan Pembangunan, 2023).

The prevalence of diabetes mellitus in Sukoharjo Regency is relatively high; according to the 2023 Sukoharjo Regency Health Profile, the number of DM cases reported reached around 17,000–17,600 cases in that year, reflecting a significant burden of non-communicable diseases in this regency (Dinas Kesehatan Kabupaten Sukoharjo, 2023). At the subdistrict level, the Baki Community Health Center reported a similarly high number of DM patients; research data and local reports indicate that in 2025 there were approximately 631 DM patients in the Baki Subdistrict working area, with a higher proportion of women than men. This data shows that diabetes is not only a clinical problem, but also a public health priority at the national and regional levels. The high number of undiagnosed cases indicates that many individuals may be living with uncontrolled blood sugar levels without receiving appropriate treatment or counseling. This condition increases the risk of complications such as cardiovascular disease, neuropathy, nephropathy, and retinopathy, which can further reduce quality of life and increase long-term healthcare costs. Therefore, efforts to understand the various factors associated with blood glucose control, including psychological and behavioral components, are highly relevant in the context of Indonesia's healthcare system.

Managing blood sugar levels is crucial to preventing various acute and long-term health issues in DMT2. Commonly used measuring tools include Fasting Blood Sugar, Random Blood Sugar (RBS), and Glycated Hemoglobin (HbA1c), each of which shows glycemic conditions over different periods of time. For example, HbA1c provides average information about glycemic control over the past three months and serves as an independent indicator of the risk of microvascular and macrovascular complications (World Health Organization, 2025). In addition to biological factors and lifestyle patterns, psychosocial aspects such as emotional stress and diabetes distress have been shown to affect glucose control in individuals with type 2 diabetes. The body's response to stress can activate the hypothalamic pituitary adrenal (HPA) axis and the sympathetic nervous system, which in turn increases the release of hormones such as cortisol and adrenaline that contribute to insulin resistance and elevated blood sugar levels (American Diabetes Association, 2025). Psychological stress can arise from various sources, including the burden of illness, demands for treatment compliance, lifestyle changes, financial concerns, and anxiety about future health outcomes. Over time, prolonged stress can interfere with self-care behaviors such as medication adherence, diet management, and physical activity, which are important components of diabetes management. Therefore, stress affects glycemic control not only through biological pathways but also through behavioral and emotional mechanisms.

Recent research in hospitals shows that higher levels of stress and discomfort are associated with poorer HbA1c values in patients with type 2 diabetes. For example, an observational study of adult patients with type 2 diabetes found a significant positive correlation between emotional discomfort scores and HbA1c values, indicating the role of psychosocial factors in glucose control (Gugun et al., 2025). However, many clinical studies still focus on parameters such as GDP and HbA1c, while the relationship between stress levels and more dynamic parameters such as GDS, which reflect

daily glucose fluctuations, is still rarely studied, especially in the Indonesian context. Short-term glucose fluctuations are important in glycemic control, which can affect the risk of complications and quality of life for patients (Wang & Cao, 2025). In addition, most existing studies tend to emphasize long-term glycemic indicators, which may not fully capture short-term variations influenced by daily routines, emotional states, and environmental stress factors. Random Blood Sugar (RBS) or GDS measurements, on the other hand, can provide a more immediate picture of glycemic response in real-life conditions. Therefore, analyzing the relationship between psychological stress and GDS has the potential to provide new insights into how daily stress experiences relate to short-term glucose regulation.

Given several shortcomings in previous studies, particularly those related to the lack of studies that specifically evaluate the relationship between mental stress levels and current blood sugar levels (GDS) in people with type 2 diabetes, this study was designed to examine this relationship in more detail. This study seeks to assess how stress experienced by individuals can be related to the body's ability to control GDS as an indicator of short-term glycemic control in individuals with T2DM. In addition, this study is expected to provide more comprehensive empirical evidence regarding the role of psychosocial factors in daily blood sugar management. It is hoped that the findings will not only enrich the limited scientific literature in this field, but also serve as a basis for the development of a more comprehensive approach to health services. Thus, the results of this study are expected to support the application of a biopsychosocial approach to T2DM management, in which psychological, behavioral, and clinical aspects are considered comprehensively to improve the quality of glycemic control and patient health outcomes.

In the long term, a better understanding of this relationship could contribute to the integration of psychological screening, stress management interventions, and patient-centered education programs into routine diabetes care. These approaches have the potential to increase patient engagement, encourage healthier self-management behaviors, and ultimately support more optimal glycemic outcomes in individuals living with type 2 diabetes (T2DM). Therefore, the purpose of this study was to examine the relationship between stress levels and short-term blood sugar control, as measured using Random Blood Glucose (GDS), in patients with Type 2 Diabetes Mellitus. This study is expected to provide empirical evidence regarding the role of psychosocial factors, particularly psychological stress, in glycemic regulation and support the application of a biopsychosocial approach in diabetes management.

## **METHOD**

This study applied an analytical observational design using a cross-sectional method. It aimed to assess how stress levels relate to the ability to control blood sugar levels in people with type 2 diabetes mellitus (Bosdriesz.JR et al., 2020). The cross-sectional design was chosen because it is suitable for describing the relationship between variables at a specific point in time, as well as for revealing the relationship between stress levels and clinical outcomes observed in the study population. This design has been widely used in studies on the relationship between stress and blood glucose levels in other clinical contexts (Saputra & Rosyid, 2024). This study used a cross-sectional approach and purposive sampling technique, which is in line with the general methodology used in epidemiological studies in the field of diabetes. This approach involved data collection through a questionnaire containing questions about health perceptions and education, which was used to evaluate risk factors and subjects' understanding of diabetes mellitus (Rahayu et al., 2025). In addition, the cross-sectional design is considered appropriate because it allows researchers to analyze the distribution of stress levels and glycemic control status simultaneously within the same observation period. This is particularly relevant in studies involving psychosocial factors, where exposure and outcomes are often experienced simultaneously in everyday life. Although this design does not establish causality, it provides an important initial picture of association patterns that can serve as a basis for further research using longitudinal or experimental approaches.

The study population consisted of patients with Type 2 Diabetes Mellitus registered at the Baki Community Health Center, with a total of 200 respondents. The sampling method used was purposive sampling, which involved selecting respondents based on predetermined criteria. The criteria used to include respondents were patients who had been diagnosed with Type 2 Diabetes Mellitus, were aged 18 years and above, and had complete GDS examination data during the observation period. Meanwhile, the criteria used to exclude respondents included patients who had severe acute complications and conditions that interfered with their ability to complete the research instrument. The use of purposive sampling in this context aims to ensure that the respondents included in the study truly represent patients who meet the clinical and administrative characteristics relevant to the research objectives. This sampling approach is often applied in health research that uses medical record data and psychosocial assessment tools, especially when the target population consists of patients who have been diagnosed and are actively receiving health services. In addition, the inclusion of complete GDS data is necessary to ensure the validity of glycemic control measurements at the time of data collection.

The independent variable in this study was stress level, measured using the Perceived Stress Scale (PSS), which has been tested for assessing subjective stress perception in adults. Stress scores were then divided into three categories (low, medium, high) according to the tertile distribution of PSS scores, following the method used in descriptive studies related to stress and blood glucose levels. The PSS-10 used in this study is a standard measurement tool that has been widely verified in various populations and has demonstrated good psychometric properties in previous studies. The reliability test reported in previous validation studies showed a Cronbach's Alpha value of  $\alpha = 0.84$ , indicating good internal consistency of the measurement tool. The dependent variable in this study was fasting blood glucose control, which was determined from a single GDS measurement when the research data was collected. The GDS measurement was carried out simultaneously with the completion of a questionnaire on stress levels, thereby reflecting the glycemic condition of the respondents at a single point of observation, in line with the characteristics of a cross-sectional research design (Sinaga et al., 2025). The use of the PSS tool is considered relevant because it measures the level of stress felt in recent weeks, which is consistent with the period during which behavioral and physiological responses to stress can affect blood glucose fluctuations. Stress levels are grouped to facilitate statistical analysis and interpretation of the distribution of respondents in each stress group. Meanwhile, the use of GDS as a glycemic control indicator provides an overview of short-term blood glucose responses, which may be more sensitive to daily stress exposure than long-term indicators such as HbA1c.

Data analysis was performed using SPSS. Descriptive analysis (univariate) presented the characteristics of respondents, stress level distribution, and GDS control status using frequency, percentage, mean, and standard deviation. Furthermore, the relationship between stress levels and GDS control was analyzed using Pearson's Chi-Square test for categorical variables, with a significance level of  $p < 0.05$  set as the statistical significance threshold. To evaluate the strength of the relationship, Cramer's V association measure was used, which is appropriate for nominal variables. This statistical approach is in line with many cross-sectional studies in diabetic populations that report a positive relationship between stress and blood glucose levels (Tarwadi et al., 2025). This study was approved by the Health Research Ethics Committee (KEPK) of the Faculty of Medicine, UMS, with number No. 5892/B.1/KEPK-FKUMS/X/2025. Prior to hypothesis testing, data cleaning and verification were performed to ensure completeness and consistency between questionnaire responses and medical record data. Assumptions for the Chi-Square test, including the minimum expected cell frequency, were also checked to ensure that the analysis met statistical feasibility criteria. In addition, findings were interpreted with caution, considering the cross-sectional nature of this study, so that the identified relationships were understood as associations rather than causal effects. Ethical considerations were maintained throughout the research process, including the confidentiality of respondent identities, the use of data for research purposes only, and compliance with institutional research ethics guidelines.

**RESULT**

Table 1.  
Demographic and Clinical Characteristics of Respondents (N = 200)

Respondent characteristics	Category	n(%) / Mean ± SD
Age		41.82 ± 6.50
Gender	Male	65 (32.5)
	Female	135 (67.5)
Education	Uneducated	3 (1.5)
	Elementary school	5 (2.5)
	Junior high school	32 (16.0)
	Senior high school	117 (58.5)
	Bachelors degree	43 (21.5)
Occupation	Unemployed	43 (21.5)
	Entrepreneur	67 (33.5)
	Farmer	33 (16.5)
	Laborer	22 (11.0)
	Civil servant	25 (12.5)
	Private employee	10 (5.0)
Duration of DMT2	< 5 years	98 (49.0)
	5 – 10 years	95 (47.5)
	>5 years	7 (3.5)
Body Mass Index (kg/m <sup>2</sup> )		25.96 ± 3.89

Table 1 shows that 200 people participated in this study. The average age of participants was 41.82 ± 6.50 years. The majority of them were women (67.5%), while only 32.5% were men. The highest level of education achieved by most participants was high school (58.5%), followed by college (21.5%) and junior high school (16%). In terms of occupation, 33.5% of participants worked as entrepreneurs, 21.5% were unemployed, 15.5% were farmers, 11% were traders, 12.5% were civil servants, and 5% were entrepreneurs. The most common duration of diabetes mellitus (DM) was 10 years. The average body mass index (BMI) was recorded at 25.96 ± 3.89 kg/m.

Table 2.  
Stress Level and Blood Guucose Control Levels of Respondents

Variable	Category	Frequency (n)	Percentage (%)	p-value
Stress Level	Low	20	10.0	0.000
	Moderate	103	51.5	
	High	77	38.5	
	Total	200	100	
Random Blood Glucose Control	Controlled	80	40.0	0.000
	Uncontrolled	120	60.0	
	Total	200	100	

Chi-square test and  $p < 0.000^*$

Based on Table 2, most respondents were in the moderate stress category, namely 103 people (51.5%), followed by 77 people (38.5%) in the high stress category and 20 people (10.0%) in the low stress category. In terms of blood sugar level control, most respondents had uncontrolled blood sugar levels, namely 120 people (60.0%), while respondents with controlled blood sugar levels numbered 80 people (40.0%). The Chi-square test results showed a  $\chi^2$  value of 81.919 with degrees of freedom (df) = 2 and a p-value < 0.000. This indicates a significant relationship between stress levels and the ability to control GDS levels among the respondents.

**DISCUSSION**

This study shows that there is a statistically significant relationship between stress levels and the ability of patients with Type 2 Diabetes Mellitus to control their GDS levels ( $p < 0.001$ ). These

results indicate that variations in stress levels are significantly related to the GDS control status of the study respondents. The strength of the relationship, measured using Cramer's V with a value of 0.640, indicates a strong association, suggesting that stress levels play a significant role in glycemic control. These findings reinforce the evidence that psychological stress plays an important role in changes in blood sugar levels in people with diabetes, in addition to other medical and behavioral factors (Ramji, 2022). The strong relationship observed in this study suggests that stress may play a role as a relevant psychosocial factor in short-term glycemic variation, especially when blood glucose levels are measured using the GDS parameter, which is sensitive to daily physiological responses. This finding is important because short-term glucose fluctuations are often overlooked in clinical monitoring, even though they may reflect patients' metabolic responses to emotional and environmental stressors in daily life.

These results are consistent with previous studies showing that stress levels are associated with increased blood sugar levels in people with diabetes. Research in the form of cross-sectional studies in various health care settings reported that increased stress was associated with increased blood sugar levels, both in parametric and non-parametric statistical analyses (such as Spearman or Chi-Square) in the context of type 2 diabetes mellitus, including in the Indonesian population (Suri et al., 2024). Physiologically, chronic stress triggers the activation of the stress hormone system through increased secretion of cortisol and catecholamine hormones, which can increase gluconeogenesis and insulin resistance. Biologically, this condition can make blood sugar difficult to control, especially in diabetic patients who already have glucose metabolism disorders. This is also supported by reports that the hormonal response to stress can affect blood glucose regulation (Abubakar et al., 2025). In addition to neuroendocrine responses, stress can also affect the balance of the autonomic nervous system, which impacts peripheral glucose uptake and liver metabolism. Repeated activation of the sympathetic pathway can contribute to fluctuations in glucose levels, especially in individuals with limited metabolic compensation capacity. Therefore, stress not only functions as an external psychological stimulus, but can also interact with existing metabolic vulnerabilities in patients with type 2 diabetes (T2DM).

Although this study shows that stress levels are closely and strongly related to the ability to control blood sugar levels, the clinical relevance of these findings is very important to note in the management of Type 2 Diabetes Mellitus. Previous studies have reported that stress management interventions, such as stress management training and psychosocial approaches, can improve glycemic control, as evidenced by reductions in HbA1c levels and other blood glucose parameters (Ngan et al., 2021). Various studies in the field of nursing have also reported that stress management interventions, including psychosocial approaches and nursing education, can contribute to improved glycemic control in diabetic patients. The role of stress in blood sugar control is not only mediated through neuroendocrine mechanisms, but also through changes in patient behavior in terms of discipline in undergoing therapy and lifestyle, so that interventions focused on nursing play a vital role in the management of Type 2 Diabetes Mellitus (Rosyid et al., 2023). These findings also indicate that integrating psychosocial assessment into routine diabetes care can help identify patients at higher risk of poor glycemic control due to psychological burden. Stress level screening can support early intervention, especially in primary care facilities where most diabetes patients receive long-term monitoring. In addition, involving family support systems and counseling-based patient education can strengthen patients' ability to cope with the emotional stress associated with the disease.

In addition to stress factors, various studies highlight that blood sugar control is also influenced by other behavioral factors such as diet, physical activity, therapy compliance, and other psychosocial factors such as social support and self-efficacy. In addition, complications such as diabetic neuropathy are also influenced by behavioral factors and patient self-management in DM (Rosyid et al., 2020). These factors can explain the variation in glycemic results among respondents, even though the relationship between stress and GDS in this study is statistically strong. Other studies also recommend a comprehensive approach that includes stress management as part of a

multidimensional intervention in diabetes management (Mawadah et al., 2025). Therefore, although stress contributes significantly to glycemic outcomes, this should be interpreted as part of a broader network of interacting determinants. Patients with adequate social support and high self-management capacity may experience better glycemic outcomes despite moderate stress exposure, whereas individuals with poor compliance or limited health literacy may be more vulnerable to stress-related glycemic instability. These interactions highlight the importance of holistic diabetes care that considers medical, behavioral, and psychosocial aspects simultaneously.

This study shows a significant relationship between stress levels and blood glucose control in patients with Type 2 Diabetes Mellitus, with a strong relationship based on Cramer's V value. These findings confirm that psychological factors, such as stress, have a clinical role in glycemic management, although they are not the only determinant. Psychosocial aspects are also reported to influence other health aspects in DM patients. For example, sleep quality related to stress levels has been found to have a significant relationship in the T2DM population in another study that emphasizes the need for attention to patients' psychological conditions in nursing practice (Febriani, 2024). Overall, the findings of this study reinforce the idea that stress management should be considered an integral component of diabetes care, rather than merely a complementary intervention. However, given the cross-sectional design of the study, the relationships identified in this study cannot be interpreted as causal. Future research using longitudinal or cohort designs is recommended to explore temporal patterns between stress exposure and blood glucose fluctuations. Experimental or intervention studies may also be useful to determine whether structured stress reduction programs can produce sustained improvements in GDS and overall glycemic outcomes in T2DM patients.

## **CONCLUSION**

This study concludes that there is a significant relationship between psychological stress levels and blood sugar control in patients with Type 2 Diabetes Mellitus. The results of the analysis show that individuals with higher stress levels tend to have poorer glycemic control than those with low stress levels. These findings reinforce the understanding that psychological stress not only plays a role as an emotional response to chronic disease, but is also an important factor related to clinical outcomes in diabetic patients, especially in the context of daily blood sugar control. However, blood sugar control remains a multifactorial process, in which various other aspects such as clinical status, adherence to treatment, diet, physical activity, social support, and psychosocial and behavioral factors contribute to variations in glycemic control in each individual. Therefore, the relationship found in this study is understood as an association, not a direct cause-and-effect relationship, thus requiring caution in interpretation and support from further research with a stronger design. Overall, these findings emphasize the importance of incorporating psychological aspects, particularly stress management, into the approach to treating patients with Type 2 Diabetes Mellitus. The integration of psychosocial interventions such as health education, counseling, adaptive coping reinforcement, and family support has the potential to become part of a more comprehensive diabetes management strategy that is oriented toward individual needs.

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