Medication Adherence and Glycemic Control among Patients With Type 2 Diabetes Enrolled in a Chronic Disease Management Program in Primary Care Settings

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Abstract.

Medication adherence plays a crucial role in achieving optimal glycemic control in patients with type 2 diabetes mellitus. However, poor glycemic control remains common despite the availability of antidiabetic therapy through the Chronic Disease Management Program (Prolanis), and evidence regarding this association among program participants is still limited. This study aimed to analyze the association between antidiabetic medication adherence and glycemic control based on HbA1c levels in patients with type 2 diabetes mellitus enrolled in Prolanis. An analytical observational study with a cross-sectional design was conducted among 118 Prolanis participants at primary health care facilities in Lampung Province, Indonesia, in 2025 using consecutive sampling. A total of 118 respondents were included in the final analysis, with a mean age of 54.09 ± 10.66 years. Medication adherence was assessed using the Morisky Medication Adherence Scale-8, while glycemic control was evaluated based on HbA1c categories. Data were analyzed using the Chi-square test with a significance level of $p < 0.05$. The results showed that most respondents had moderate medication adherence (38.1%) and poor glycemic control (50.8%). A significant association was found between medication adherence and glycemic control ($p = 0.037$; Cramér's $V = 0.208$), indicating a small-to-moderate effect size. These findings highlight the need to strengthen adherence-focused interventions, including patient education, routine monitoring, and continuous support, as part of Prolanis implementation to improve long-term glycemic outcomes in primary care settings.

Keywords: *Medication adherence; HbA1c; glycemic control; type 2 diabetes mellitus and chronic disease management program.*

I. INTRODUCTION

Type 2 diabetes mellitus (DM) is a chronic metabolic disease with a continuously increasing global prevalence. This condition is characterized by chronic hyperglycemia due to impaired insulin secretion, insulin resistance, or a combination of both [1]. Prolonged hyperglycemia contributes to the development of microangiopathy and macroangiopathy complications, which impact quality of life and increase healthcare costs, particularly in low- and middle-income countries [2]. According to the 11th edition of the International Diabetes Federation (IDF) Diabetes Atlas (2025), in 2024 there were approximately 589 million adults aged 20–79 living with diabetes globally, with a prevalence of 11.1%. This number is projected to increase to 853 million by 2050 [3]. These data confirm that diabetes mellitus, particularly type 2 as the most dominant form, remains a significant public health challenge. In Indonesia, the 2024 Indonesian Health Survey (SKI) reported a diabetes prevalence of 1.7% across all age groups and 11.7% among people aged ≥15 years based on blood glucose testing [4]. Type 2 DM is the most dominant form and is most commonly found in the 65–74 age group [1,3]. At the regional level, data from the Lampung Provincial Health Office reported that the number of diabetes cases in 2024 reached 96,583 individuals, highlighting the increasing burden of the disease in this province [5].Glycated hemoglobin (HbA1c) is widely used as an indicator of long- term glycemic control because it reflects the average blood glucose level over the past two to three months [6].

Achieving HbA1c targets is the primary goal in the management of type 2 diabetes mellitus, as uncontrolled HbA1c levels are associated with an increased risk of chronic complications [1,7]. Recent studies also emphasize that HbA1c is strongly associated with both microvascular and macrovascular complications, making it an essential parameter in monitoring treatment effectiveness and guiding therapeutic decisions [2,8]. Pharmacotherapy plays a central role in glycemic control, especially in patients who do not achieve targets through lifestyle modifications alone [9].The success of pharmacotherapy is not only determined by the selection of antidiabetic drug regimens but also by patient adherence to medication as recommended [10,11]. Medication adherence affects the achievement of optimal therapeutic concentrations and directly contributes to the effectiveness of lowering blood glucose levels [11]. Non-adherence to antidiabetic therapy has been reported as one of the main determinants of glycemic control failure and an increased risk of long-term complications [10,12].Patient adherence levels are influenced by various factors, including the complexity of the therapy regimen, medication side effects, sociodemographic characteristics, education level, and health care system support [13]. Empirical evidence shows that social, behavioral, and access-to- healthcare factors play an important role in shaping adherence behavior and glycemic control outcomes.

These findings confirm that glycemic control is not solely determined by clinical factors, but also by behavioral and systemic determinants [14].A primary health care-based approach through structured programs is an important strategy in chronic disease management [9,15,16]. Self-management and multidisciplinary education programs have been shown to contribute to increased patient engagement and improved long-term glycemic control [17,18]. In Indonesia, the Chronic Disease Management Program (Prolanis) was developed as a systematic effort to improve patients' quality of life through an integrated promotive, preventive, and curative approach. This program includes routine clinical monitoring, provision of medication, and health education for patients with type 2 diabetes mellitus [16].The availability of structured programs such as Prolanis is theoretically expected to improve therapy adherence and clinical outcomes [16,18]. Variations in glycemic control among program participants are still found in various health care facilities, indicating that the existence of the system does not fully guarantee optimal metabolic control [19–21].

Scientific evidence regarding the association between medication adherence levels and HbA1c control in the context of national chronic disease management programs is still limited, particularly at the primary care level in Indonesia [22].An empirical evaluation of the association between medication adherence and glycemic control among Prolanis participants is essential to clarify how system-based chronic disease management programs translate into measurable clinical outcomes in routine practice [9,13,23]. Despite the widespread implementation of structured national chronic disease programs, evidence examining this association at the primary care level remains limited. This study therefore aims to analyze the association between adherence to antidiabetic medication and HbA1c levels among patients with type 2 diabetes mellitus participating in Prolanis at primary health care facilities. By focusing on a structured national chronic disease management program implemented in Indonesia, this study addresses an important contextual evidence gap regarding the clinical impact of medication adherence within real-world primary care settings.

II. METHODS

Research Design and Location

This study used an analytical observational design with a cross-sectional approach to evaluate the association between medication adherence levels and glycemic control at a single measurement point. Data collection was conducted from October to December 2025 among participants of the Chronic Disease Management Program (Prolanis) with a diagnosis of type 2 diabetes mellitus who were registered at primary health care facilities in Lampung Province.

Population and Sample

The target population comprised all patients with type 2 diabetes mellitus registered as active Prolanis participants in Lampung Province in 2025 (N = 1,344). The minimum sample size was estimated using a finite population formula with a 10% margin of error, resulting in 93 participants. After adding a

10% allowance for potential incomplete data, the minimum required sample increased to 102 participants. Eligible participants were recruited consecutively during the study period based on predefined criteria, and 118 respondents with complete data were included in the final analysis, exceeding the calculated minimum sample size.The inclusion criteria were: (1) diagnosis of type 2 diabetes mellitus based on medical records, (2) registered as an active Prolanis participant, and (3) having the latest HbA1c level data and complete medication adherence measurement results. Exclusion criteria included patients with conditions that could affect the accuracy of HbA1c measurements, such as advanced renal dysfunction or hematological disorders, as well as patients who were unwilling to participate or withdrew from the study.Based on this selection process, 118 respondents met all criteria and were included in the final analysis.

Research Variables

The independent variable in this study was the level of adherence to antidiabetic medication. Adherence levels were categorized as low, moderate, and high based on the MMAS-8 questionnaire score. The dependent variable was glycemic control, which was assessed based on glycated hemoglobin (HbA1c) levels using a fully automatic photometric device with HbA1c reagent kits using the High Performance Liquid-Chromatography method (HPLC) and has been standardized National Glycohematology Standardization Program (NGSP). Glycemic control is classified as good (<5.7%), moderate (5.7-6.4%), and poor (>6.5%) based on HbA1c levels [6].

Instruments and Measurements

Medication adherence is measured using the Morisky Medication Adherence Scale-8 (MMAS-8), a self-report instrument consisting of eight questions to evaluate medication use behavior. MMAS-8 scores are classified according to standard interpretation guidelines into low, moderate, and high adherence.HbA1c levels were obtained from patient medical records in the Prolanis service system and reflect the average blood glucose level over approximately the last three months prior to data collection.

Data Collection Procedure

Primary data were collected using structured questionnaires administered to respondents during the study period. The questionnaire included demographic and clinical characteristics, namely age, gender, education level, occupation, body mass index (BMI), duration of type 2 diabetes mellitus, and primary health care facility.Medication adherence was assessed using the eight-item Morisky Medication Adherence Scale (MMAS-8), a validated self-report instrument widely used in patients with chronic diseases. The Indonesian version of the MMAS-8 was used to ensure respondents' comprehension. The MMAS-8 consists of seven dichotomous [yes/no] items and one item measured on a 5-point Likert scale. The total score ranges from 0 to 8, with higher scores indicating better adherence. Adherence levels were categorized into low (<6), medium (6–7), and high (8) adherence. The questionnaire was administered through direct interviews to minimize misunderstanding and incomplete responses.Secondary data were obtained from the medical records of Prolanis participants with type 2 diabetes mellitus, including HbA1c test results performed at the Pramitra Biolab Clinical Laboratory, Way Halim, Bandar Lampung. The most recent HbA1c value recorded within the study period was used for analysis. All respondents provided informed consent prior to participation. Confidentiality and anonymity were strictly maintained throughout the research process.

Data Analysis

Data were analyzed descriptively and analytically. Categorical variables were summarized using frequencies and percentages. The association between medication adherence level and glycemic control category was examined using the Chi-square test of independence. Given the 3×3 contingency table structure, effect size was estimated using Cramér's V to quantify the strength of association, interpreted as small (0.10–0.29), moderate (0.30–0.49), and strong (≥0.50). A p-value < 0.05 was considered statistically significant. Considering the sample size and cell distribution across categories, multivariable analysis was not performed to minimize the risk of model instability and overfitting. All analyses were conducted using IBM SPSS Statistics version 27.

Ethical Considerations

This study received ethical approval from the Health Research Ethics Committee of the Faculty of Medicine, University of Lampung (No. 6686/UN26.18/PP.05.02.00/2025). All respondents were informed about the study objectives and procedures and provided written informed consent prior to participation. The confidentiality and privacy of all participants were strictly maintained throughout the study.

III. RESULT AND DISCUSSION

Result

A total of 118 respondents with a diagnosis of type 2 diabetes mellitus who met the inclusion criteria and had complete data were included in the final analysis. The mean age of respondents was 54.09 ± 10.66 years, with an age range of 29 to 77 years. The mean glycated hemoglobin (HbA1c) level was 7.57 ± 2.55%, with a minimum value of 3.90% and a maximum value of 15.00%. The body mass index (BMI) had a mean of 26.10 ± 2.05 kg/m² with a range of 17.20 to 32.00 kg/m². This general description shows a fairly wide variation in clinical characteristics among the population participating in the chronic disease management program.

Respondent characteristics based on sociodemographic and clinical variables are presented in Table 1.

Table 1. Frequency Distribution of Respondent Characteristics (n = 118)

Characteristics	Number	
	n	%
Age		
<45 years	21	17,8
≥45 years	97	82,2
Gender		
Male	28	23,7
Female	90	76,3
Education		
No Schooling	3	2,5
Elementary	26	22,0
Junior High School	24	20,3
Senior High School	44	37,3
Higher Education	21	17,8
Type of Work		
Not working	34	28,8
Laborer/Farmer	10	8,5
Self-employed	19	16,1
Civil servant	10	8,5
Housewife	45	38,1
Body Mass Index (BMI)		
Underweight	2	1,7
Normal Weight	32	27,1
Overweight	22	18,6
Obesity I	50	42,4
Obesity II	12	10,2
Duration of Type 2 Diabetes Mellitus		
<3 years	35	29,7
3-5 years	48	40,7
>5 years	35	29,7
Primary Care Facility		
Tanjung Sari Community Health Center	16	13,6
Dira Medika Clinic	23	19,5
Way Panji Community Health Center	40	33,9
Trimulyo Community Health Center	39	33,1
Total	118	100,0

Note: BMI is classified based on WHO Asia-Pacific criteria.

Based on Table 1, the majority of respondents were aged ≥45 years (82.2%) and female (76.3%). The distribution of educational levels showed the largest proportion in the high school category (37.3%), while based on occupation, the majority of respondents were housewives (38.1%). Based on body mass

index, most respondents were classified as obese I (42.4%), indicating that the study population had a significant metabolic risk profile. The duration of type 2 diabetes mellitus was most commonly in the range of 3–5 years (40.7%). Respondents in this study came from various primary health care facilities, including community health centers and clinics, reflecting the diversity of primary health care sources.The distribution of medication adherence levels and glycemic control categories based on HbA1c levels is presented in Table 2.

Table 2. Distribution of Medication Adherence Levels and Glycemic Control Based on HbA1c (n = 118)

Variable	Number (n)	Percentage (%)
Medication Adherence Level		
Low	39	33,1
Moderate	45	38,1
High	34	28,8
Glycemic Control (HbA1c)		
Poor	60	50,8
Moderate	30	25,4
Good	28	23,7
Total	118	100

Majority of participants were classified as having moderate medication adherence (38.1%), followed by low (33.1%) and high adherence (28.8%). More than half of the respondents (50.8%) exhibited poor glycemic control based on HbA1c levels, indicating that a substantial proportion of patients had not achieved recommended glycemic targets despite participation in a structured chronic disease management program. The analysis of the association between medication adherence levels and glycemic control is presented in Table 3.

Table 3. Association Between Medication Adherence Levels and Glycemic Control Based on HbA1c in Type 2 Diabetes Mellitus Patients (n = 118)

Medication Adherence Level	Glycemic Control (HbA1c)			Total n (%)	p-value
	Poor	Moderate	Good		
	n (%)	n (%)	n (%)		
Low	25 (64,1)	9 (23,1)	5 (12,8)	39 (100)	0,037
Moderate	15 (33,3)	15 (33,3)	15 (33,3)	45 (100)	
High	20 (58,8)	6 (17,6)	8 (23,5)	34 (1000	
Total	60 (50,8)	30 (25,4)	28 (23,7)	118 (100)	

The distribution revealed notable differences in glycemic control across adherence categories. The highest proportion of poor glycemic control was observed in the low adherence group (64.1%), while the moderate adherence group showed a comparatively lower proportion (33.3%). Interestingly, a substantial proportion of poor glycemic control was also observed in the high adherence group (58.8%).The Chi-square test demonstrated a statistically significant association between medication adherence and glycemic control ($\chi^2(4) = 10.19$, $p = 0.037$). The effect size was small, as indicated by Cramér's V = 0.208. These findings indicate that although adherence is statistically related to glycemic outcomes, it accounts for only a limited proportion of the variability in HbA1c levels. The persistence of poor glycemic control within the high adherence group further suggests that additional clinical and contextual factors may contribute to HbA1c variation.

Discussion

This study shows a significant association between medication adherence and glycemic control in type 2 diabetes mellitus patients participating in Prolanis. This association confirms that adherence is a central component in the success of pharmacological therapy, as reflected in HbA1c levels as an indicator of long-term glycemic control [24,25]. In the context of modern diabetes management, HbA1c not only represents the average blood glucose level but also serves as a predictor of the risk of microvascular and macrovascular complications [26]. The association between adherence and HbA1c has substantial clinical implications in efforts to prevent long-term complications and reduce the burden of morbidity in populations with chronic diseases [24,26]. Achieving optimal therapeutic effects requires consistent use of medication according to the prescribed dose and schedule. Irregular consumption, missed doses, or discontinuation of therapy without medical indication can prevent drug levels from reaching an effective steady state, resulting

in suboptimal blood glucose control [27,28]. This condition contributes to glucotoxicity, which accelerates pancreatic beta cell dysfunction and worsens disease progression [26]. The findings of this study are in line with previous reports showing that patients with high compliance have lower HbA1c levels than those with low compliance [29]. The consistency of these results reinforces the position of compliance as an important determinant in the success of type 2 diabetes mellitus therapy.Some respondents with high adherence levels still exhibited poor glycemic control, with a clinically significant proportion.

This finding provides an important analytical dimension in interpreting the results. In a clinical context, adherence can be viewed as a necessary condition, but not always sufficient to achieve optimal glycemic control [11]. Clinical factors such as longer disease duration, progressive pancreatic beta cell dysfunction, severe insulin resistance, the need for therapy intensification, and regimen complexity, including the use of combination drugs, can limit glycemic response despite high adherence [29,30]. The quality of dose adjustment and the timing of therapy intensification at the primary care level may also influence the achievement of HbA1c targets [12,27].The characteristics of the respondents in this study provide additional context to this phenomenon. The relatively high proportion of obesity and the dominance of the adult to elderly age group have the potential to increase the degree of insulin resistance and exacerbate the metabolic burden [30]. These conditions can reduce the response to standard therapy even though medication adherence is relatively good. The distribution of educational levels, which is dominated by the middle category, may also influence variations in self-management abilities, particularly in terms of consistency in dietary modifications and physical activity [11]. The integration of these findings suggests that glycemic control is determined not only by pharmacotherapy adherence but also by the patient's metabolic risk profile and self-management capacity.

The management of type 2 diabetes mellitus is multifactorial, so the association between adherence and HbA1c needs to be understood within the framework of interactions between biological, therapeutic, and clinical management quality factors [23,31].Socio-demographic and psychosocial dimensions also shape adherence behavior and clinical outcomes. Educational level contributes to health literacy, the ability to understand medical instructions, and the capacity for self- monitoring and lifestyle modification [8,11]. Higher education is reported to be associated with better self- management practices and more optimal glycemic control [8]. Family support strengthens adherence through monitoring medication intake, reinforcing motivation, and providing guidance on diet and physical activity [32]. Cultural, spiritual, and religious beliefs shape perceptions of chronic disease and long-term medication use, which ultimately influence patients' therapeutic decisions [33]. Evidence shows that social support and health education are associated with increased adherence and improved glycemic control [11,17]. The integration of educational, family, and culturally sensitive approaches is an important component of effective intervention strategies [8,32,33].Health system factors provide a structural context for individual adherence behavior. Full coverage policies for essential medicines have been shown to increase the proportion of patients with high adherence in chronic diseases, including diabetes mellitus [34,35].

Reforms in financing schemes within health insurance systems are also associated with increased adherence and treatment persistence [35]. Prolanis is designed to strengthen routine clinical monitoring, drug availability, and health education at the primary care level. The high proportion of poor glycemic control in this study indicates that increased access to services has not been fully accompanied by optimized clinical outcomes. Similar phenomena have been reported in other developing countries, where non-adherence remains a challenge despite increased access to health services [11,14]. These findings emphasize that structural access needs to be balanced with strengthening the quality of program implementation, systematic monitoring of adherence, and periodic evaluation of therapeutic response.The clinical implications of these research findings point to the need for a comprehensive approach that goes beyond the aspect of pharmacotherapy selection. Optimizing adherence needs to go hand in hand with evaluating the effectiveness of regimens and adjusting therapy based on individual targets [6,9]. Interventions can be carried out through risk-based individual counseling, simplification of treatment regimens, periodic monitoring, and the use of digital health technology for reminders and monitoring [36,37]. These strategies have the potential to improve treatment effectiveness, especially in primary health care, where continuity of care and active

patient involvement are key to the successful management of chronic diseases [9].Interpretation of the research findings should consider both the strengths and limitations of this study. This study has several strengths, including a sample size that exceeded the minimum requirement, the use of the standardized Morisky Medication Adherence Scale-8 (MMAS-8), and HbA1c-based assessment reflecting long-term glycemic status.

In addition, the study was conducted among participants of a Chronic Disease Management Program in primary health care settings, enhancing the practical relevance of the findings for real-world type 2 diabetes mellitus management within the national health system.Nevertheless, several limitations should be acknowledged. The cross-sectional design precludes causal inference between medication adherence and glycemic control. Self-reported adherence measurement may introduce information bias and overestimation of adherence levels [38]. In addition, multivariable analysis was not performed. Therefore, potential confounding factors such as age, duration of diabetes, and body mass index could not be fully controlled. Other clinical and behavioral determinants of HbA1c were not explored in depth, leaving the possibility of residual confounding. Future longitudinal and multivariate studies are needed to better clarify causal associations and strengthen the evidence base.Overall, this study strengthens the empirical evidence that medication adherence is an important determinant in the management of type 2 diabetes mellitus [6,11]. This association is influenced by the interaction of clinical, sociodemographic, cultural, and health system policy factors [8,33,34]. Integrating adherence improvement strategies into the framework of chronic disease management programs in primary health care is a strategic step to optimize glycemic control, reduce the risk of complications, and improve patients' quality of life.

IV. CONCLUSION

This study shows a significant association between medication adherence levels and glycemic control based on HbA1c levels in type 2 diabetes mellitus patients participating in the Chronic Disease Management Program (Prolanis) in primary health care. Although the strength of the association obtained was classified as small to moderate, these findings indicate that medication adherence is an important factor related to achieving glycemic control. This confirms that the success of diabetes management is not only determined by the availability of pharmacological therapy, but also by patient behavior in following the prescribed treatment regimen.The implications of this study emphasize the importance of integrating strategies to improve adherence into chronic disease management programs, particularly through continuous education, adherence monitoring, and support from health workers in primary care facilities. A multidisciplinary approach involving medical personnel, pharmacists, and patients' families has the potential to strengthen the success of glycemic control and improve patients' quality of life. Further research with a longitudinal design and analysis of other factors influencing glycemic control is needed to gain a more comprehensive understanding and support the development of more effective interventions.

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