
The Effect Of Pill Box Use On Medication Adherence Among Type 2 Diabetes Mellitus Patients Participating In Prolanis At Sangkrah Community Health Center, Surakarta

Iza Zulfa Salsabila¹⁾, Niken Luthfiyanti²⁾, Bangkit Riska Permata³⁾

^{1,2,3)} Program Studi Sarjana Farmasi, Fakultas Ilmu Kesehatan Universitas Duta Bangsa Surakarta

*Corresponding Author

E-mail: salsabilaizalzulfa@gmail.com

Abstract

Type 2 diabetes mellitus (T2DM) is a chronic disease with an increasing prevalence worldwide. According to the WHO, approximately 422 million people were living with diabetes in 2023. In Indonesia, the number of diabetes cases continues to increase, making medication adherence essential to achieve successful therapeutic outcomes. One strategy to improve medication adherence is the use of a pill box as a medication reminder. To determine the effect of pill box use on medication adherence and therapeutic outcomes among patients with type 2 diabetes mellitus enrolled in the Chronic Disease Management Program (PROLANIS) at Sangkrah Primary Health Center, Surakarta. This study employed a quasi-experimental pretest–posttest control group design involving 60 respondents, consisting of 30 participants in the control group and 30 in the intervention group. Medication adherence was assessed using the 8-item MMAS-8 and the Pill Count method, while therapeutic outcomes were evaluated based on HbA1c levels. Data were analyzed using univariate analysis, the Chi-square test, and the Wilcoxon Signed-Rank Test with a significance level of $p < 0.05$. The Wilcoxon Signed-Rank Test showed that pill box use significantly improved medication adherence based on both the MMAS-8 and Pill Count methods ($p < 0.001$). The proportion of adherent patients measured by Pill Count was higher in the intervention group (93.3%) than in the control group (70.0%). Bivariate analysis indicated that HbA1c, family support, and healthcare provider support were significantly associated with medication adherence ($p < 0.05$), whereas age, sex, education, occupation, duration of diabetes, comorbidities, and prescribing patterns were not significantly associated ($p > 0.05$). Therefore, a pill box can be recommended as a simple and effective medication reminder to help patients take their medications regularly and support successful therapeutic outcomes. The use of a pill box significantly improved medication adherence among patients with type 2 diabetes mellitus.

Keywords: Type 2 Diabetes Mellitus, Hba1c, Mmas-8, Pill Box, Pill Count.

INTRODUCTION

Diabetes Mellitus (DM)—often referred to as the "silent killer"—is a disease resulting from impaired glucose metabolism in the body, accompanied by metabolic abnormalities caused by hormonal dysfunction (Wahyuni et al., 2025). The disease arises from the pancreas's inability to produce sufficient insulin and the body's ineffectiveness in utilizing the insulin it does produce. Hyperglycemia resulting from uncontrolled diabetes can lead to serious, long-term damage to various bodily systems (Nurhayati et al., 2024).

The World Health Organization (WHO) *Global Status Report on Noncommunicable Diseases* (2010) reported that Non-Communicable Diseases (NCDs) accounted for 60% of deaths across all age groups worldwide (Tanty et al., 2024). According to the WHO, an estimated 422 million people worldwide were living with diabetes mellitus in 2023. The number of people with diabetes is projected to rise to 578 million by 2030 and 700 million by 2045 (Alfreyzal et al., 2024).

Diabetes mellitus management is defined by "five pillars of care," which include education, dietary planning, physical activity (exercise), medication adherence, and routine blood glucose monitoring (Hartono & Ediyono, 2024). During physical activity or exercise, muscles utilize stored glucose reserves to generate energy. When these reserves are depleted or exhausted, the body draws upon glucose from the bloodstream for energy, thereby lowering blood glucose levels (Noriah, 2024).

Non-adherence to treatment remains a significant challenge in the management of diabetes mellitus. Studies indicate that adherence rates among patients with type 1 diabetes mellitus range from 70% to 83%, while rates for type 2 diabetes mellitus range from 64% to 78%. Medication non-adherence among patients with type 2 diabetes mellitus can increase the risk of complications and

exacerbate the disease (Rismawan et al., 2023). One factor contributing to the condition is non-adherence to dietary management, which is influenced by education level, knowledge, treatment fatigue, and the desire to recover (Tanty et al., 2024).

A pill box is an intervention that can be used to improve patient medication adherence. A study by Mpila et al. (2024) demonstrated that the use of a pill box had a significant impact on improving medication adherence among elderly patients with hypertension ($p = 0.001$; $p < 0.05$). Similarly, a study by Wati et al. (2025) showed that using a pill box significantly improved medication adherence in hypertensive patients with heart failure complications; this was evidenced by a significant difference between the treatment and control groups ($p = 0.000$; $p < 0.05$). The Chronic Disease Management Program (Prolanis) is an initiative developed by BPJS Kesehatan in Indonesia to manage and provide healthcare services for participants with chronic diseases (Machfudin et al., 2025). In 2025, the Surakarta Health Office reported that the Sangkrah Community Health Center (Puskesmas) actively implements Prolanis for patients with chronic conditions such as Type 2 Diabetes Mellitus and hypertension. The program encompasses health screenings, health education, consultations, exercise sessions, and routine monitoring of patients' conditions. Given the issues outlined above, the low level of medication adherence among patients with Type 2 Diabetes Mellitus serves as a compelling reason to conduct this study on the effective use of pill boxes, as they have the potential to improve adherence to antidiabetic medication.

RESEARCH METHODS

This study employs an experimental research design, specifically a pretest-posttest control group design. Measurements were taken both before and after the intervention (Purwantiningsih et al., 2021).

The collected data were statistically analyzed using the Statistical Product and Service Solutions (SPSS) software, involving univariate and bivariate analyses as follows (Hasibuan & Manurung, 2020; Kristianto et al., 2021; Sanaky et al., 2021; Rahmani et al., 2025):

- a) Validity test
- b) Reliability test
- c) Univariate analysis
- d) Bivariate analysis

RESULTS AND DISCUSSION

Research Results

In this study, data collection was conducted by distributing questionnaires and retrieving medical records of type 2 diabetes mellitus patients participating in the *Prolanis* program at the Sangkrah Community Health Center (Puskesmas) in Surakarta during April–May 2026. A sample of 60 respondents diagnosed with type 2 diabetes mellitus at the Sangkrah Community Health Center met the inclusion and exclusion criteria. Validity and Reliability Tests: Table 1 presents the validity test results for the 8-item MMAS-8 questionnaire; the results met the required criteria, specifically a Corrected Item-Total Correlation value of ≥ 0.20 (Murti, 2016). These results are shown in the following table:

Table 1 MMAS-8 Validity Test

No.	Item MMAS-8	Corrected Item-Total Correlation	Information
1.	Do you sometimes forget to take your anti-diabetes medication?	0,592	Valid
2.	Think about the past two weeks: were there any days when you did not take your anti-diabetes medication?	0,397	Valid
3.	Have you ever reduced or stopped your medication without telling your doctor because you felt healthier while taking it?	0,596	Valid
4.	When traveling, do you sometimes forget to bring your anti-diabetes medication?	0,402	Valid
5.	Did you take your anti-diabetes medication yesterday?	0,383	Valid
6.	When you feel your blood pressure is under control, have you ever stopped your medication?	0,362	Valid
7.	Have you ever felt annoyed or fed up with your routine medication schedule?	0,366	Valid
8.	How difficult is it for you to remember to take all your medications?	0,846	Valid

Table 2 presents the reliability test results for the 8-item MMAS-8 questionnaire, showing that the results met the requirement of a Cronbach’s Alpha value ≥ 0.60 (Murti, 2016). These results are shown in the following table:

Table 2 MMAS-8 Reliability Test

Variable	Number of Items	Cronbach’s Alpha	Information
Medication Adherence (MMAS-8)	8	0,768	Reliable

Table 3 presents the results of the initial validity test for the 10-item family support questionnaire. Two items—items 8 and 10—were found to be invalid, with values below 0.20, whereas the remaining items yielded valid results (Murti, 2016). These results are shown in the following table:

Table 3 Initial Validity Test for Family Support

No.	Statement of Family Support	Corrected Item-Total Correlation	Information
1.	My family reminds me to take my anti-diabetes medication.	0,543	Valid
2.	The family helps provide anti-diabetic medication.	0,354	Valid
3.	My family reminded me to go to a healthcare facility for a check-up.	0,373	Valid
4.	My family helps me maintain a healthy diet.	0,366	Valid
5.	Family provides encouragement during treatment.	0,457	Valid
6.	My family doesn't care whether I take my medication or not.	0,555	Valid
7.	I rarely receive support from those closest to me in maintaining my health.	0,553	Valid
8.	No one reminds me to get regular health check-ups.	0,194	Invalid
9.	My family did not pay attention to the treatment I was undergoing.	0,421	Valid

10.	I feel like I am not receiving support from those closest to me while undergoing treatment.	0,075	Invalid
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Table 4 presents the results of the initial reliability test for the family support questionnaire; the instrument is considered reliable based on the Cronbach’s Alpha result, as it meets the criterion of a value ≥ 0.60 (Murti, 2016). These results are shown in the following table:

Table 4 Initial Reliability Test for Family Support

Variable	Number of Items	Cronbach’s Alpha	Information
Family Support	10	0,731	Reliable

Table 5 presents the results of the re-conducted validity test on eight items; the results indicate that the family support questionnaire met the validity criteria, with values ≥ 0.20 (Murti, 2016). These results are shown in the following table:

Table 5 Final Validity Test for Family Support

No.	Statement of Family Support	Corrected Item-Total Correlation	Information
1.	My family reminds me to take my anti-diabetes medication.	0,615	Valid
2.	The family helps provide anti-diabetic medication.	0,399	Valid
3.	My family reminded me to go to a healthcare facility for a check-up.	0,418	Valid
4.	My family helps me maintain a healthy diet.	0,419	Valid
5.	Family provides encouragement during treatment.	0,492	Valid
6.	My family doesn't care whether I take my medication or not.	0,479	Valid
7.	I rarely receive support from those closest to me in maintaining my health.	0,527	Valid
8.	My family did not pay attention to the treatment I was undergoing.	0,379	Valid

Table 6 presents the reliability test results for the family support questionnaire; the results are considered reliable based on the Cronbach’s Alpha value, as they meet the criterion of ≥ 0.60 (Murti, 2016). These results are shown in the following table:

Table 6 Final Reliability Test for Family Support

Variabel	Jumlah Item	Cronbach’s Alpha	Information
Family Support	8	0,763	Reliabel

Table 7 presents the validity test results for the 10-item healthcare worker support questionnaire. One item—Item 9—was found to be invalid, with a value of < 0.20 , whereas the other items yielded valid results (Murti, 2016). These results are shown in the following table:

Table 7 Initial Validity Test for Healthcare Worker Support

No.	Statement of Support from Healthcare Workers	Corrected Item-Total Correlation	Information
1.	The healthcare worker clearly explains how to use the diabetes medication.	0,547	Valid
2.	Healthcare workers provide information on the importance of medication adherence.	0,547	Valid
3.	Healthcare workers remind patients of their routine check-up schedules.	0,497	Valid
4.	Healthcare workers provide motivation to undergo treatment.	0,497	Valid
5.	Healthcare professionals are easily accessible when I need information.	0,325	Valid
6.	Healthcare professionals rarely provide explanations regarding the diabetes treatment I am undergoing.	0,408	Valid

7.	Healthcare workers did not provide sufficient information on how to use the medication.	0,382	Valid
8.	The healthcare workers did not pay attention to whether or not I was adhering to my medication regimen.	0,431	Valid
9.	The healthcare professional did not provide advice on how to manage my diabetes.	0,140	Invalid
10.	I feel that healthcare workers are not sufficiently concerned about my health condition.	0,320	Valid

Table 4.8 above presents the reliability test results for the healthcare worker support questionnaire; the Cronbach’s Alpha value indicates reliability, thereby meeting the requirement of ≥ 0.60 (Murti, 2016). These results are shown in the following table:

Table 8 Initial Reliability Test for Healthcare Worker Support

Variable	Number of Items	Cronbach’s Alpha	Information
Healthcare Worker Support	10	0,705	Reliable

Table 9 presents the results of the re-conducted validity test on nine items regarding healthcare worker support; the results meet the validity criteria, with values of ≥ 0.20 (Murti, 2016). These results are shown in the following table:

Table 9 Final Validity Test for Healthcare Worker Support

No.	Statement of Support from Healthcare Workers	Corrected Item-Total Correlation	Information
1.	The healthcare worker clearly explains how to use the diabetes medication.	0,560	Valid
2.	Healthcare workers provide information on the importance of medication adherence.	0,560	Valid
3.	Healthcare workers remind patients of their routine check-up schedules.	0,504	Valid
4.	Healthcare workers provide motivation to undergo treatment.	0,504	Valid
5.	Healthcare professionals are easily accessible when I need information.	0,345	Valid
6.	Healthcare professionals rarely provide explanations regarding the diabetes treatment I am undergoing.	0,397	Valid
7.	Healthcare workers did not provide sufficient information on how to use the medication.	0,387	Valid
8.	The healthcare workers did not pay attention to whether or not I was adhering to my medication regimen.	0,394	Valid
9.	I feel that healthcare workers are not sufficiently concerned about my health condition.	0,349	Valid

Table 10 presents the final reliability test results for the healthcare worker support questionnaire; the results are considered reliable based on the Cronbach’s Alpha value, as they meet the criterion of ≥ 0.60 (Murti, 2016). These results are shown in the following table:

Table 10 Final Reliability Test for Healthcare Worker Support

Variable	Number of Items	Cronbach’s Alpha	Information
Healthcare Worker Support	9	0,722	Reliable

Univariate Analysis

Sociodemographic Characteristics

Based on Table 11, the majority of type 2 diabetes mellitus patients in the intervention group were aged 50–59 years, female, and had an elementary school education (or equivalent) or no formal schooling; the control group showed similar proportions regarding age, gender, and education, though the total number of participants was smaller. The most common employment status in both groups

was unemployed, followed by self-employed and farmers/laborers. The study included a total of 60 respondents; the 50–59 age group was the largest (36 patients), while the 20–30 age group was the smallest (3 respondents). These results are presented in the following table:

Table 11 Sociodemographic Characteristics

Characteristics	Control Percentage (%) N=30	Intervention Percentage (%) N=30
Age (Year)		
20-30 year	1 (3,3)	2 (6,7)
40-49 year	13 (43,3)	8 (26,7)
50-59 year	16 (53,3)	20 (66,7)
Gender		
Man	5 (16,7)	10 (33,3)
Woman	25 (83,3)	20 (66,7)
Education		
No school	7 (23,3)	5 (16,7)
Elementary school/equivalent	9 (30,0)	13 (43,3)
Junior high school/equivalent	10 (33,3)	6 (20,0)
Senior high school/equivalent	4 (13,3)	6 (20,0)
Occupation		
Unemployed	14 (46,7)	17 (56,7)
Farmer/laborer	4 (13,3)	4 (13,3)
Self-employed	12 (40,0)	9 (30,0)

Clinical Factors

Based on Table 12, the majority of respondents in both the control group (46.7%) and the intervention group (56.7%) had suffered from diabetes mellitus for less than 5 years. Most respondents in both groups had comorbid hypertension: 80.0% in the control group and 73.3% in the intervention group. The most common prescribing pattern was a combination of metformin 500 mg and glimepiride 2 mg, observed in 46.7% of the control group and 40.0% of the intervention group. Regarding clinical outcomes, the majority of respondents (66.7%) had controlled HbA1c levels. These results are presented in the following table:

Table 12 Clinical Characteristics

Characteristics	Control Percentage (%) N=30	Intervention Percentage (%) N=30
Long-standing diabetes mellitus		
<5 year	14 (46,7)	17 (56,7)
5-10 year	12 (40,0)	5 (16,7)
>10 year	4 (13,0)	8 (26,7)
Comorbidities		
No comorbidities	2 (6,7)	3 (10,0)
Hypertension	24 (80,0)	22 (73,3)
Dyslipidemia	2 (6,7)	3 (10,0)
Heart disease	2 (6,7)	2 (6,7)
Prescribing Patterns		
Monotherapy		
a. Metformin 500 mg	1 (3,3)	2 (6,7)
b. Glibenclamide 5 mg	1 (3,3)	1 (3,3)
Combination		
a. Metformin 500 mg + Glibenklamid 5 mg	12 (40,0)	13 (43,3)
b. Metformin 500 mg + Glimepiride 2 mg	14 (46,7)	12 (40,0)
Combination and insulin		
a. Metformin 500 mg + Glibenklamid 5 mg + Insulin Glargine 100 IU/mL	1 (3,3)	2 (6,7)
b. Metformin 500 mg + Glimepiride 2 mg + Insulin Glargine 100 IU/mL	1 (3,3)	0 (0)

Outcome DM Tipe 2		
HbA1c controlled	14 (46,7)	20 (66,7)
HbA1c not controlled	16 (53,3)	10 (33,3)

Social Factors

Based on the data regarding family support statements in Table 13, it can be concluded that the majority of patients in the intervention group received more active family support compared to the control group. This is evidenced by high percentages in the "often" and "always" categories, particularly regarding assistance with medication provision, reminders for medical check-ups, dietary management, and encouragement throughout the treatment process. These results are presented in the following table:

Table 13 Family Support Questionnaire Statements

No.	Statement of Family Support	Group	Seldom (%) N=30	Often (%) N=30	Always (%) N=30	Never (%) N=30
1.	My family reminds me to take my anti-diabetes medication.	Control	10 (33,3)	12 (40,0)	8 (26,7)	0 (0)
		Intervention	3 (10,0)	16 (53,3)	11 (36,7)	0 (0)
2.	My family helps provide anti-diabetic medication.	Control	9 (30,0)	12 (40,0)	9 (30,0)	0 (0)
		Intervention	5 (16,7)	17 (56,7)	8 (26,7)	0 (0)
3.	My family reminds me to go for check-ups at a healthcare facility.	Control	5 (16,7)	17 (56,7)	8 (26,7)	0 (0)
		Intervention	6 (20,0)	16 (53,3)	8 (26,7)	0 (0)
4.	My family helps me maintain a healthy diet.	Control	4 (13,3)	16 (53,3)	10 (33,3)	0 (0)
		Intervention	5 (16,7)	19 (63,3)	6 (20,0)	0 (0)
5.	My family encourages me as I undergo treatment.	Control	6 (20,0)	15 (50,0)	9 (30,0)	0 (0)
		Intervention	7 (23,3)	13 (43,3)	10 (33,3)	0 (0)
6.	My family does not care whether I take my medication or not.	Control	14 (46,7)	9 (30,0)	0 (0)	7 (23,3)
		Intervention	18 (60,0)	4 (13,3)	0 (0)	8 (26,7)
7.	I rarely receive support from those closest to me in maintaining my health.	Control	13 (43,3)	9 (30,0)	0 (0)	8 (26,7)
		Intervention	17 (56,7)	2 (6,7)	0 (0)	11 (36,7)
8.	My family pays no attention to the treatment I am undergoing.	Control	16 (53,3)	8 (26,7)	0 (0)	6 (20,0)
		Intervention	19 (63,3)	2 (6,7)	0 (0)	9 (30,0)

Based on Table 14 regarding healthcare provider support, the majority of respondents in both the control and intervention groups rated the support provided by healthcare professionals as good—particularly concerning information on medication use, the importance of medication adherence, routine follow-up schedules, treatment motivation, and ease of access to consultations. These results are presented in the following table:

Table 14 Statements on Healthcare Provider Support

No.	Statement by Healthcare Personnel	Group	Seldom (%) N=30	Often (%) N=30	Always (%) N=30	Never (%) N=30
1.	The healthcare professional clearly explains how to use the diabetes medication.	Control	4 (13,3)	16 (53,3)	10 (33,3)	0 (0)
		Intervention	4 (13,3)	14 (46,7)	12 (40,0)	0 (0)
2.	The healthcare professional provides information on the importance of medication adherence.	Control	4 (13,3)	16 (53,3)	10 (33,3)	0 (0)
		Intervention	2 (6,7)	16 (53,3)	12 (40,0)	0 (0)
3.	The healthcare professional reminds me of the schedule for routine check-ups.	Control	3 (10,0)	15 (50,0)	12 (40,0)	0 (0)
		Intervention	1 (3,3)	20 (66,7)	9 (30,0)	0 (0)
4.	The healthcare professional offers motivation to continue with the treatment.	Control	4 (13,3)	19 (63,3)	7 (23,3)	0 (0)
		Intervention	4 (13,3)	18 (60,0)	8 (26,7)	0 (0)
5.	The healthcare professional is easily accessible when I need information.	Control	6 (20,0)	17 (56,7)	7 (23,3)	0 (0)
		Intervention	3 (10,0)	19 (63,3)	8 (26,7)	0 (0)
6.	The healthcare professional rarely explains the diabetes treatment I am undergoing.	Control	19 (63,3)	5 (16,7)	0 (0)	6 (20,0)
		Intervention	20 (66,7)	4 (13,3)	0 (0)	6 (20,0)
7.	The healthcare professional does not provide sufficient information on how to use the medication.	Control	18 (60,0)	4 (13,3)	0 (0)	8 (26,7)
		Intervention	19 (63,3)	2 (6,7)	0 (0)	9 (30,0)
8.	The healthcare professional does not pay attention to whether or not I am adhering to the medication regimen.	Control	16 (53,3)	6 (20,0)	0 (0)	8 (26,7)
		Intervention	19 (63,3)	3 (10,0)	0 (0)	8 (26,7)
9.	I feel the healthcare professional is not sufficiently concerned about my health condition.	Control	15 (50,0)	6 (20,0)	0 (0)	9 (30,0)
		Intervention	14 (46,7)	4 (13,3)	0 (0)	12 40,0)

MMAS-8 Adherence

Based on Table 15 (MMAS-8 Pretest), it can be concluded that the majority of respondents demonstrated varying levels of adherence to diabetes treatment. These results are presented in the following table:

Table 15 MMAS-8 Pretest

No.	Item MMAS-8	Group	Yes (%) N=30		No (%) N=30
1.	Do you sometimes forget to take your antidiabetic medication?	Control	12 (40,0)		18 (60,0)
		Intervention	6 (20,0)		24 (80,0)
2.	Think about the past two weeks; was there a day when you didn't take your antidiabetic medication?	Control	9 (30,0)		21 (70,0)
		Intervention	8 (26,7)		22 (73,3)
3.	Have you ever reduced or stopped your medication without telling your doctor because you felt better?	Control	5 (16,7)		25 (83,3)
		Intervention	4 (13,3)		26 (86,7)
4.	When traveling, do you sometimes forget to take your antidiabetic medication?	Control	10 (33,3)		20 (66,7)
		Intervention	9 (30,0)		21 (70,0)
5.	Did you take your antidiabetic medication yesterday?	Control	27 (90,0)		3 (10,0)
		Intervention	25 (83,3)		5 (16,7)
6.	When you feel your blood pressure is under control, have you ever stopped your medication?	Control	6 (20,0)		24 (80,0)
		Intervention	9 (30,0)		21 (70,0)
7.	Have you ever felt distracted or bored with your regular medication schedule?	Control	8 (26,7)		22 (73,3)
		Intervention	8 (26,7)		22 (73,3)
8.	How difficult is it for you to remember to take all your medications?	Control	0 (0)	6 (20,0)	11 (36,7)
		Intervention	1 (3,3)	7 (23,3)	9 (30,0)

Based on Table 16 (MMAS-8 Post-test), it can be seen that the majority of respondents in both the control and intervention groups demonstrated good adherence to antidiabetic medication. These results are presented in the following table:

Table 16 MMAS-8 Post-test

No.	Item MMAS-8	Group	Yes (%) N=30		No (%) N=30
1.	Do you sometimes forget to take your antidiabetic medication?	Control	0 (0)		30 (100)
		Intervention	0 (0)		30 (100)
2.	Think about the past two weeks; was there a day when you didn't take your antidiabetic medication?	Control	8 (26,7)		22 (73,3)
		Intervention	7 (23,3)		23 (76,7)
3.	Have you ever reduced or stopped your medication without telling your doctor because you felt better?	Control	3 (10,0)		27 (90,0)
		Intervention	2 (6,7)		28 (93,3)
4.	When traveling, do you sometimes forget to take your antidiabetic medication?	Control	4 (13,3)		26 (86,7)
		Intervention	1 (3,3)		29 (96,7)
5.	Did you take your antidiabetic medication yesterday?	Control	26 (86,7)		4 (13,3)
		Intervention	29 (96,7)		1 (3,3)
6.	When you feel your blood pressure is under control, have you ever stopped your medication?	Control	4 (13,3)		26 (86,7)
		Intervention	2 (6,7)		28 (93,3)
7.	Have you ever felt distracted or bored with your regular medication schedule?	Control	7 (23,3)		23 (76,7)
		Intervention	1 (3,3)		29 (96,7)
8.	How difficult is it for you to remember to take all your medications?	Control	0 (0)	7 (3,3)	9 (30,0)
		Intervention	0 (0)	1 (3,3)	13 (43,3)

Bivariate Analysis
Association of Sociodemographic, Clinical, and Social Characteristics with MMAS-8 Adherence

Table 17 presents the association between sociodemographic, clinical, and social characteristics and MMAS-8 adherence in the control and intervention groups. These results are shown in the following table:

Table 17 Association of Sociodemographic Characteristics with MMAS-8

Sociodemographic Variables	Bivariate (Chi-square)					
	Control Group			Intervention Group		
	COR	CI95%	p	COR	CI95%	p
Age (Years) 20–40 years 40–59 years	0,390	0,039-4,712	0,666	7,458	0,511-108,934	0,139
Gender Male Female	1,240	0,081-19,059	0,518	1,212	0,152-9,664	0,398
Education No school School	0.366	0,031-4,341	0,518	0,183	0,013-2,586	0,109
Employment Not employed Employed	0,103	0,009-1,163	0,050	0,489	0,063-3,774	0,127
Clinical Variables	COR	CI95%	p	COR	CI95%	p
Duration of DM <5 years >5 years	0,534	0,026-11,054	0,526	2,016	0,110-36,994	0,469
Comorbidities None Present	0,095	0,004-2,518	0,666	0,828	0,059-11,545	0,397
Prescribing Patterns Monotherapy Combination	0,641	0,014-29,453	0,933	0,386	0,006-23,637	0,593
Type 2 Diabetes Outcome Uncontrolled HbA1c Controlled HbA1c	0,008	0,000-0,220	0,000	0,016	0,001-0,246	0,000
Social Variables	COR	CI95%	p	COR	CI95%	p
Family Support Adequate Good	0,153	0,016-1,478	0,003	0,156	0,028-0,865	0,001
Healthcare Worker Support Adequate Good	0,128	0,013-1,243	0,029	0,030	0,004-0,256	0,001

Note: COR = Crude Odds Ratio; 95% CI = 95% Confidence Interval; p = significance value (Chi-square test result). The association is considered significant if p < 0.05 (Murti, 2016).

Association of Sociodemographic, Clinical, and Social Characteristics with Pill Count Adherence

Table 18 presents the association between sociodemographic, clinical, and social characteristics and pill count adherence in the control and intervention groups. These results are shown in the following table:

Table 18 Association of Study Characteristics with Pill Count Adherence

Sociodemographic Variables	Bivariate (Chi-square)					
	Control Group			Intervention Group		
	COR	CI95%	p	COR	CI95%	p
Age (Years) 20–40 years 40–59 years	0,492	0,064-3,774	0,709	8,529	0,606-120,102	0,139
Gender Male Female	1,149	0,132-9,975	0,481	1,536	0,196-12,020	0,398
Education						

No school	0,145	0,013-1,577	0,113	0,120	0,008-1,835	0,109
School						
Employment						
Not employed	0,309	0,055-1,728	0,232	1,379	0,190-10,040	0,469
Employed						
Clinical Variables	COR	CI95%	p	COR	CI95%	p
Duration of DM						
<5 years	1,199	0,158-9,119	0,296	3,688	0,293-46,461	0,936
>5 years						
Comorbidities						
None	0,708	0,044-11,333	0,576	0,505	0,051-5,026	0,397
Present						
Prescribing Patterns						
Monotherapy						
Combination	0,718	0,027-19,384	0,661	2,193	0,128-37,682	0,593
Type 2 Diabetes Outcome						
Uncontrolled HbA1c						
Controlled HbA1c	0,027	0,002-0,347	0,000	0,042	0,004-0,458	0,002
Social Variables	COR	CI95%	p	COR	CI95%	p
Family Support						
Adequate						
Good	0,167	0,033-0,853	0,025	0,118	0,020-0,686	0,011
Healthcare Worker Support						
Adequate						
Good	0,100	0,018-0,561	0,005	0,039	0,004-0,393	0,001

Note: COR = Crude Odds Ratio; 95% CI = 95% Confidence Interval; p = significance value (Chi-square test result). The association is considered significant if p < 0.05 (Murti, 2016).

Relationship Between Pretest and Posttest Scores for the MMAS-8 and Pillbox Intervention

Table 19 presents the results of the normality test, showing that the p-values for both the pretest and posttest were ≤ 0.05. This indicates that the distribution of the pillbox adherence data was not normal; therefore, a comparative analysis was conducted using the non-parametric Wilcoxon Signed-Rank Test. The results are shown in the following table:

Table 19 Normality Test for Pillbox Pretest and Posttest Scores

Variable	p-value	Information
Pretest Pill box	0,015	Abnormal
Posttest Pill box	0,000	Abnormal

Note: A p-value > 0.05 indicates that the data are normally distributed, whereas a p-value ≤ 0.05 indicates that the data are not normally distributed (Murti, 2016).

Based on Table 20, the Wilcoxon test results indicate a significant difference between pretest and posttest adherence scores regarding the use of a pill box. There was an improvement in adherence following the pill box intervention, as evidenced by a p-value < 0.001. The results are presented in the following table:

Table 20 Pill Box Pretest and Posttest

Variable		p-value	Information
Pretest vs Posttest Pill box		< 0,001	There is a significant difference.

Note: A p-value ≤ 0.05 indicates a significant difference between the pretest and posttest, whereas a p-value > 0.05 indicates no significant difference (Murti, 2016).

Research Discussion

Validity and Reliability Testing

Validity and Reliability of the MMAS-8

This study began with validity and reliability testing of the questionnaire to be used. The MMAS-8 instrument is widely utilized to measure patient adherence to regular medication intake. To ensure the tool is appropriate for use with Type 2 Diabetes Mellitus patients, a psychometric evaluation—specifically validity and reliability testing—was required. In this study, the MMAS-8 questionnaire (comprising 8 items) was tested on 30 respondents; the results demonstrated that each question item had a sufficiently strong correlation with the total score, indicating its validity for measuring medication adherence among patients participating in the Chronic Disease Management Program (Prolanis) (Rahmadani et al., 2024).

Validity and Reliability of the Social Factors Questionnaire

Measuring family social support is a crucial aspect of research on the health behaviors of Type 2 Diabetes Mellitus patients, particularly within chronic disease management programs like Prolanis. Instrument validity testing was conducted to ensure that each question item accurately reflected the intended concept of family support. Based on the validity test results for the family support questionnaire shown in Table 3, the majority of items exhibited a corrected item-total correlation value of ≥ 0.20 , thereby confirming their validity (Murti, 2016).

Univariate Analysis

Sociodemographic Characteristics

Based on Table 11, the majority of respondents in both the control and intervention groups fell within the 50 to 59 age range. The control group included 16 respondents (53.3%), while the intervention group included 20 respondents (66.7%). These results indicate that the majority of Type 2 diabetes patients participating in the Prolanis program in this study were in the late adulthood stage. In a study by Fauzia & Urfiyya (2025) involving Type 2 diabetes patients in the Prolanis program at Community Health Centers (Puskesmas) in Bantul Regency, age was identified as a factor analyzed in relation to fasting blood sugar levels. Advancing age can affect the body's ability to control blood glucose; therefore, the late adulthood group requires more regular health monitoring through Prolanis activities.

Clinical Factors

Based on Table 12, the duration of Type 2 diabetes in the control group was predominantly in the "less than 5 years" category, comprising 14 (46.7%) respondents. Similarly, the intervention group also showed the highest frequency in the "less than 5 years" category, with 17 (56.7%) respondents. These results indicate that most respondents were still in the early to intermediate stages of the disease's progression. This condition is significant because patients with a shorter disease duration still have a greater opportunity to be guided toward better disease management through education, regular medication, routine check-ups, and blood sugar monitoring. These findings differ from the study by Ardhiani & Ningrum (2025), which found that the majority (56.9%) of Type 2 diabetes patients in the "reverse referral" program had been diagnosed for more than five years. Such differences may arise from variations in study settings, referral systems, and patient adherence to health services across different regions.

Social Factors

Table 13 shows strong family support in several forms of direct support in the intervention group. Family members frequently reminded 16 (53.3%) respondents to take their medication and consistently reminded 11 (36.7%) respondents. Family members also frequently helped provide medication for 17 (56.7%) respondents, and frequently helped maintain a healthy diet for 19 (63.3%). These data indicate that family support encompasses not only attention but also concrete actions in the daily care of type 2 diabetes patients. These results align with research by Diah et al. (2025), which explains that families need to support patients through education, a healthy environment, medication reminders, positive reinforcement, and open communication to improve treatment adherence.

The results of the family support item also show that families play a significant role in maintaining regular patient check-ups. In the intervention group, family members frequently reminded 16 (53.3%) respondents to visit a healthcare facility and consistently reminded 8 (26.7%) respondents. This indicates that most respondents received family encouragement to continue monitoring their health. This situation supports the success of Prolanis because type 2 diabetes patients require regular check-ups to monitor blood sugar, medication, and the risk of complications. Research by Suryati et al. (2024) also found a significant relationship between knowledge and family support and regular check-ups in diabetes sufferers, with a p-value of 0.043.

MMAS-8 Compliance

Based on Table 16, pretest results indicate that the intervention group already had a fairly good adherence profile before receiving the pill boxes. For the item about forgetting to take antidiabetic medication, the majority of respondents answered no (24 respondents (80.0%)). For the item about not taking medication in the past two weeks, 22 (73.3%) respondents answered no. For the item about reducing the dose and stopping treatment without notifying the doctor, 26 (86.7%) respondents answered no. These results indicate that, prior to the intervention, the majority of patients in the intervention group already demonstrated a good baseline level of adherence behavior. This situation may be attributed to the fact that the respondents were participants in the Prolanis program, through which they received regular monitoring, education, and periodic healthcare services. Medication adherence is a crucial aspect of managing patients with type 2 diabetes, particularly because diabetes treatment requires long-term consistency (Pratiwi et al., 2023).

Bivariate Analysis

Relationship between Sociodemographic Characteristics and MMAS-8 Adherence

Bivariate analysis was conducted to determine the relationship between respondent characteristics and the success of pillbox usage in improving medication adherence. The Crude Odds Ratio (COR) indicates the likelihood of the outcome occurring in a specific group compared to a reference group. The 95% Confidence Interval (CI) represents the estimated range of the OR, while the p-value is used to determine statistical significance, with a threshold of $\alpha = 0.05$.

Based on the study results presented in Table 17, most sociodemographic variables—such as age, gender, education, and occupation—did not show a significant relationship with medication adherence (as measured by the MMAS-8) in either the control or intervention groups. This is evidenced by p-values greater than 0.05 for all sociodemographic variables. These results indicate that medication adherence among patients with Type 2 diabetes is not solely determined by baseline respondent characteristics; it can also be influenced by other factors such as medication-taking habits, understanding of the disease, family support, support from healthcare professionals, and the use of aids like pillboxes. These findings align with the study by Junaedi and Azmi, which showed no significant association between age, gender, or education and medication adherence among Type 2 diabetes patients at community health centers (Puskesmas). However, these results differ from the study by Agustina et al. (2023), which found that age and education were associated with diabetes medication adherence, whereas gender was not. Such discrepancies may arise from differences in sample characteristics, sample size, study location, and patient support protocols across the various healthcare facilities (Junaedi & Azmi, 2024).

Relationship between Clinical Factors and MMAS-8 Adherence

Regarding clinical variables, the duration of diabetes, comorbidities, and prescribing patterns did not show a significant relationship with MMAS-8 adherence in either group. For the duration of diabetes, the p-values were 0.526 for the control group and 0.469 for the intervention group; ...comorbidities in the control group ($p=0.666$) and the intervention group ($p=0.397$); meanwhile, for prescribing patterns, the values were $p=0.933$ for the control group and $p=0.593$ for the intervention group. These results indicate that the duration of diabetes mellitus (DM), the presence of comorbidities, and the use of monotherapy versus combination therapy were not significantly associated with adherence in this study. This finding aligns with the study by Wibowo et al. involving type 2 DM patients participating in the Prolanis program at several community health centers in Banyumas Regency, which explained that the relationship between adherence and clinical outcomes can be influenced by numerous factors and is not always straightforward in a single analysis (Wibowo et al., 2021).

The use of pill boxes has a positive impact on medication adherence. In addition to serving as medication containers, pill boxes serve as visual reminders that help improve regular medication intake, reduce missed doses, and facilitate therapy monitoring by family and healthcare professionals (Luthfiyanti et al., 2026).

Primary prevention of diabetes is achieved through adopting a healthy lifestyle, such as consuming a balanced diet with plenty of vegetables and fruit, limiting fat and simple carbohydrates, maintaining ideal body weight, engaging in appropriate physical activity, and avoiding medications that can increase blood glucose levels. Secondary prevention is carried out through early detection of DM, especially in high-risk individuals, as well as disease control to prevent chronic complications in the form of microangiopathy, macroangiopathy, and neuropathy (Rahmasari et al., 2023).

CONCLUSION

Based on the research findings regarding the use of pill boxes and their impact on medication adherence and therapeutic outcomes among type 2 diabetes mellitus patients participating in the Prolanis program at the Sangkrah Community Health Center (Puskesmas) in Surakarta, the following conclusions can be drawn:

1. The sociodemographic and clinical profile of the type 2 diabetes mellitus patients—who were aged 50–59, predominantly female, had an elementary school education or equivalent, were mostly unemployed, had suffered from diabetes for less than 5 years, had comorbid hypertension, and were using combination oral antidiabetic therapy—showed that the majority in the control group had uncontrolled HbA1c levels.
2. There was an improvement in medication adherence following the use of pill boxes. Wilcoxon test results indicated a significant difference between adherence scores before and after the intervention, as measured by both the MMAS-8 method and the Pill Count method ($p<0.05$). This demonstrates that the use of pill boxes can improve medication adherence among type 2 diabetes mellitus patients.
3. The use of pill boxes influenced the improvement of medication adherence among type 2 diabetes mellitus patients. Bivariate analysis revealed that the clinical factor of HbA1c outcomes had a significant relationship with medication adherence, as measured by both the MMAS-8 and Pill Count methods ($p<0.05$). Additionally, social factors—specifically family support and support from healthcare professionals—were significantly associated with the patients' level of adherence.
4. In the control group that did not use pill boxes, no significant changes in medication adherence were observed during the study period. Bivariate analysis results indicated that most sociodemographic factors and clinical characteristics—such as age, gender, education, occupation, duration of diabetes, comorbidities, and prescribing patterns—were not significantly associated with medication adherence ($p>0.05$). However, HbA1c levels continued to show a significant

relationship with patient adherence.

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