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Analysis of the Relationship Between Providing Drug Information, Medication Adherence, and Glycemic Control in Type 2 Diabetes Outpatients at the North Denpasar Health Center

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ABSTRACT

Medication adherence among patients with type 2 diabetes mellitus (T2DM) continues to be a difficult challenge. Providing drug information (PDI) at health centers can enhance medication adherence and help patients achieve glycemic control. A cross-sectional study was conducted in February-April 2024 at the North Denpasar Health Center. Inclusion criteria were patients >18 years old either with or without comorbidities, receiving the same antidiabetic treatment for ≥3 months. Exclusion criteria were patients who withdrew from the study, changed their care, or had unstable health conditions. Medication adherence data were collected using the Probabilistic Medication Adherence Scale (ProMAS) questionnaire, PDI data and fasting blood glucose (FBS) examination results in medical records using data collection documents. Correlation analysis between PDI and medication adherence and glycemic control used the Kendall's tau-b/c test. Results showed patients were mostly male (53.84%), age ≥65 (43.20%), elementary school education (35.50%), unemployed (63.90%), no family history (70.41%), disease duration <5 years (62.72%), with comorbidities (65.09%), and FBS achieved (81.66%). The antidiabetic used was a combination of metformin and glimepiride (54.43%). A total of 81.65% obtained routine PDI with high medication adherence (48.52%). The conclusion of the study was that there was a significant relationship between PDI with medication adherence (p=0.000; r=0.253) and glycemic control (p=0.000; r=0.447).

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a global health problem affecting millions of people worldwide with an impact on quality of life and overall health. The prevalence of people with DM continues to increase every year and is estimated to reach 643 million in 2030 and 783 million in 2045. This spiking prevalence pattern is also happening in Indonesia; there were 19.5 million people with DM in 2021, and it is expected to significantly increase to 28.6 million in 2045, with the majority (90-95%) who have T2DM (International Diabetes Federation, 2021). According to the Basic Health Research Data report, the number of DM cases in all provinces in Indonesia has already significantly increased (Rikesdas, 2019). In 2022, the number of DM cases in Bali was 50,211 cases, with the highest number of contributors in Denpasar City (14,444 cases) (Denpasar City Health Office, 2023).

Medication adherence is an attitude and responsibility that patients must carry out to follow instructions from health workers regarding the use of drugs given and is an essential factor in achieving the glycemic control target for patients with T2DM (Nanda *et al.*,

2018). If patients with DM are not adherent to the medication given, it can have a negative impact of poorer glycemic control, increasing the risk of both acute and chronic complications, hospitalization, morbidity, mortality, and medical costs (Pratiwi *et al*., 2022). The low medication adherence of patients with T2DM is still a growing problem today. Among several reasons, one of the causes is saturation in taking drugs for an extended period of time (Bidulang *et al*., 2021; Husna *et al*., 2022; Kurniati *et al*., 2023).

One of the first-level health facilities that provide outpatient care for people with T2DM is the local Health Center in Indonesia. There are standards of pharmaceutical services at the Health Centers to improve medication adherence and support rational medication by Providing Drug Information (PDI) in the form of a checklist sheet regarding accurate, precise and unbiased medication instructions, which include name, dosage form, dosage, how to use, storage, indications, contraindications, stability, side effects, and drug interactions (Ministry of Health, 2016). Araswati (2022) found that drug information services have a significant influence on the level of patient medication adherence ($p<0.05$). Supported by the findings of Putri (2020), there is a significant relationship between PDI and the level of medication adherence ($p=0.000$) in patients with T2DM. Increased medication adherence will positively affect the glycemic control of patients with DM. A study conducted at the Andalas Padang Health Center found that the providing of PDI significantly affected the achievement of fasting blood glucose (FBS) levels in patients with T2DM ($p>0.1$; $p>0.05$).

Based on preliminary studies at the research site, the number of patients with T2DM at the North Denpasar Health Center was recorded at 3,223 cases in 2022 and no studies nor evaluations have been conducted regarding the relationship between PDI and the level of medication adherence and its effect on glycemic control in patients with T2DM (Denpasar City Health Office, 2023). Based on this background, it is necessary to conduct a study that analyzes the relationship between PDI and the level of patient medication adherence and the relationship between PDI and glycemic control of patients with T2DM.

METHODS

This observational study used a cross-sectional design. Data were collected over three months, from February to April 2024, at Health Centers I, II, and III in North Denpasar. The study was conducted with permit number 070/12349/Dikes and was ethically reviewed and approved by the Research Ethics Commission of STIKES Bina Usada Bali in December 2023 under the number 602/EA/KEPK-BUB-2023. A total of 276 samples were collected using purposive sampling techniques and calculated with the Slovin formula (Hatmawan and Riyanto, 2020). Inclusion criteria involved patients with T2DM aged 18 years or older with or without complications or comorbidities, who had been using the same oral antidiabetic medication for at least 3 months, agreed to participate by signing informed consent forms, and had complete medical record data. Exclusion criteria included patients who withdrew from the study, changed their care, or had unstable health conditions.

The data collection method used in the study involved conducting interviews with patients. First, the patients were provided with an informed consent sheet. After signing that form, the patients were given a Probabilistic Medication Adherence Scale (ProMAS) questionnaire. Data on fasting blood glucose (FBS), PDI, demographic characteristics (such as gender, age, last education, occupation, family history of DM, and duration of illness), drug use, and other laboratory data were collected retrospectively from medical records within the last three months. The ProMAS questionnaire consists of 18 question items, with each question scored as one (1) for a correct answer and zero (0) for a wrong answer. The questionnaire has 4 assessment categories low (0-4), medium-low (5-9), medium-high (10-14), and high (15-18). The validity and reliability of the ProMAS questionnaire were tested on chronic disease patients in the Netherlands, with a validity value of 0.72 using the Separation Reliability test and a Cronbach's alpha test value of 0.81 (Kleppe *et al*., 2015). Additionally, a face validity test, consisting of 8 question items, was conducted with 30 respondents, and a value of >85% indicated that the ProMAS questionnaire can be used to measure the medication adherence of patients with T2DM at the North Denpasar Health Center.

The PDI data were divided into two categories: routine and non-routine. If a patient receives drug information 3 times or more for 3 months, they are classified as being in the routine category. Conversely, if a patient receives drug information less than 3 times for 3 months, they are placed in the non-routine category. Glycemic control was also divided into two categories: achieved and not achieved. Patients fall into the

achieved category if their glucose level is between 80 mg/dL and ≤126 mg/dL. If their glucose level exceeds 126 mg/dL during the last month of the study, they are categorized as not achieved.

The study analyzed demographic profile characteristics, clinical picture, description of antidiabetic use, description of PDI, and level of medication adherence. Demographic profile characteristics such as gender, age, last education, occupation, family history of DM, and duration of disease were expressed as percentages calculated using Microsoft Excel (Microsoft Corp., Redmond, Wash., USA). The relationship between PDI and medication adherence was analyzed using Kendall's Tau C test for ordinal data, and the relationship between PDI and glycemic control was analyzed using Kendall's Tau B test for ordinal data.

RESULTS AND DISCUSSION

Demographic characteristics

In February-April 2024, a study at the general and elderly polyclinics of the North Denpasar Health Center involved 169 respondents who were patients with T2DM. According to Table 1, more male patients (53.84%) were observed. This finding is consistent with a study by Gebermariam *et al*., (2020) in Ethiopia, which also reported a higher percentage of male patients with T2DM (53%). Similar profiles were found in three other studies, with more than 50% of patients with T2DM being male with 59.14%, 60.00%, 60.03%, respectively (Geng *et al*., 2023; Huang *et al*., 2021; Song *et al*., 2021).

The risk of developing T2DM is influenced by various factors, including gender, although the impact of gender is not as direct or strong as other factors such as lifestyle and genetics. The prevalence of T2DM in men is linked to factors such as smoking, low physical activity, obesity (measured by increased body mass index), and the presence of visceral fat. Visceral fat, which accumulates in certain organs of the body, particularly in the abdominal area, can lead to the release of tumor necrosis factor-alpha (TNF-α) and greater expression of cytokine signaling suppressor-3, contributing to insulin resistance (Nordstrom *et al*., 2016).

The majority of patients with T2DM are 45 years old (63.38±8.50) and above, with a higher prevalence in those aged 65 years and older (43.20%). Dalal *et al*., (2024) and Hagi *et al*., (2023) supported that the age group most at risk of developing T2DM is 45 years and older (53.9-62.10%). Other studies in Spain and Ethiopia also found that more than 50% of patients with T2DM are 45 years and older (75.77-79.7%) (Aguado *et al*., 2020; Gebermariam *et al*., 2020). The chronic disease T2DM is common in individuals aged over 45 years due to the aging process, which can lead to a decrease in muscle mass and influence glucose metabolism. A decline in muscle mass can reduce the body's ability to regulate blood sugar until insulin resistance occurs (David *et al*., 2021).

Demographic results showed that many respondents only had basic education (35.50%). A study conducted at a hospital in Taiwan and China revealed that between 51.03% and 47.6% of patients with T2DM had a basic education level (Huang *et al*., 2021; Liao *et al*., 2023). It was found that DM patients with lower education levels may have a limited understanding of medical information. Conversely, patients with higher education levels tend to respond more positively to their disease due to their broader knowledge (Bidulang *et al*., 2021).

Table 1. Demographic characteristics of patients with T2DM

Variable	Characteristics	n=169 (%)
Gender	Female	78 (46.16)
	Male	91 (53.84)
Age (years)	31-45	3 (1.77)
	46-55	28 (16.56)
	56-65	65 (38.47)
	≥65	73 (43.20)
Education level	No education	12 (7.10)
	Elemantary school	60 (35.50)
	Junior-senior high school	78 (46.16)
	Diploma/bachelor degree	19 (11.24)
Occupation	Working	61 (36.10)
	Not working	108 (63.90)
Family history	Yes	50 (29.59)
	No	119 (70.41)
Duration of disease	<5 years	88 (52.08)
	≥5 years	81 (47.92)

In this study, the employment status of patients with T2DM was mostly unemployed (63.90%). This finding is in line with a study conducted by Pham and Eggleston (2016), which found that most individuals with T2DM participate in household activities. It also indicated that light physical activity can raise the risk of diabetes by leading to minimal energy expenditure, which contributes to fat storage and potentially results in obesity (Arania *et al*., 2021).

According to Table 1, 70.41% of patients have no history of T2DM. This finding aligns with a recent study by Gebermariam *et al*. (2020), which reported that 71.1% of patients also have no history of T2DM. Similar results were found in studies conducted in Chinese and Arab health facilities, where 71.02-71.40% of patients were reported to have no history of T2DM (Alrashed *et al*., 2024; Song *et al*., 2021). Research conducted by Santosa *et al*. (2017) at Prof. Dr. Margono Soekarjo Purwokerto Hospital indicated that individuals who have one or more family members with DM are 2 to 6 times more likely to develop DM themselves compared to those without a family history of the condition (Santosa *et al*., 2017).

The duration of the disease in patients with T2DM refers to the period starting from when the patient was first diagnosed with T2DM until the time of the study (Hayashino *et al*., 2017). In the study conducted by Hayashino *et al*. (2017), patients with the highest duration of T2DM were found in the category of <5 years, accounting for 62.72% of the cases. Similarly, studies conducted by Shuvo *et al*., (2023) and Bidulang *et al*., (2021) found that the duration of suffering and medication was <5 years (60.6-75%). The duration of the disease is a significant factor in the development of complications, both macrovascular and microvascular. According to Hu *et al*., (2021), the longer a patient experiences T2DM, the higher the risk of developing complications.

Clinical Features

In this study, 65.09% of patients had a history of comorbidities, with the highest percentage being hypertension (82.72%) (Table 2). Several studies have found similar results where hypertension ranks first as the most common comorbidity experienced by individuals with T2DM (Aguado *et al*., 2020; Cicek *et al*., 2021; Shuvo *et al*., 2023). Hypertension in T2DM occurs due to decreased coronary vasodilator activity of nitric oxide in blood vessels, resulting in vasoconstriction (Bahadoran *et al*., 2023).

In most cases, patients with T2DM have achieved good glycemic control (81.66%). This finding is consistent with a study conducted at the Yogyakarta Health Center, which reported that 85% of patients with T2DM had achieved good glycemic control results. However, other studies in Ethiopia (60.0%), Nigeria (74.7%), and Saudi Arabia (67.1%) showed most of the patients with T2DM did not reach their blood glucose targets. This pattern was evidenced by the average blood glucose examination results of good glycemic control (152.5-176.0 mg/dL) and HbA1c (8.8%) (Alaqil *et al*., 2020; Sendekie *et al*., 2022; Yimam *et al*., 2020).

Based on the American Diabetes Association (ADA) guidelines (2023), blood glucose tests for people with T2DM include glycosylated hemoglobin (HbA1c), fasting blood glucose (FBS), random blood glucose (RBG), and post-prandial blood glucose examinations . In this research, the glycemic control of T2DM patients was assessed using the FBS test. The FBS test is used to measure blood glucose levels, and it is the second option after HbA1c, which is considered the gold standard (ADA, 2023). FBS testing is performed to monitor plasma blood sugar levels after the patient has fasted for 8-10 hours. The results of the FBS test provide an accurate picture of a person's blood glucose levels without any nutritional intake. FBS tests

Table 2. Clinical features of patients with T2DM

Variable	Clinical features	n (%)
Comorbidities (n=169)	With comorbidities	110 (65.09)
	Hypertension	91 (82.72)
	Dyslipidemia	39 (35.45)
	Gout	29 (26.37)
	Without comorbidities	59 (34.91)
FBS (n=169)	Achieved	138 (81.66)
	Not-achieved	31 (18.34)

*FBS: fasting blood glucose

Table 3. Overview of the use of antidiabetic drugs

Drug class	Type of drug	n (%)
	Monotherapy	
Biguanides	Metformin 500 mg	34 (20.11)
	Metformin 500 mg	28 (16.57)
	Metformin 500 mg	8 (4.73)
Sulfonylureas	Glimepiride 1mg	4 (2.36)
	Glimepiride 2 mg	2 (1.19)
	Glimepiride 2 mg	1 (0.60)
	Combination therapy	
Biguanides and sulfonylureas	Metformin 500 mg and Glimepiride 1 mg	5 (2.96)
		16 (9.47)
		4 (2.37)
	Metformin 500 mg and Glimepiride 2 mg	3 (1.78)
		42 (24.85)
		22 (13.01)

are conducted regularly every month at the Health Centers to assess the effects of DM medication therapy.

Description of Antidiabetic Use

Description of the antidiabetics used by respondents included a combination of two types of oral antidiabetics, metformin and glimepiride, comprising 54.43% of usage (Table 3). Several studies have found that 77.5-88.9% of patients with T2DM consume these two types of oral antidiabetics (Lailaturrahmi *et al*., 2022; Wishesa and Kamil, 2023). According to the ADA (2023) and Perkeni (2021) guidelines, the management of therapy for people with T2DM begins with giving oral antidiabetics, specifically metformin. If the patient has received monotherapy for 3 months but cannot reach the blood glucose target, then combination therapy of metformin plus another drug with a different mechanism of action is continued. Furthermore, if within 3 months the target has not been reached, a combination therapy of three antidiabetics or the use of intensive therapy with insulin is given. The use of combination antidiabetics aims to increase the effectiveness of therapy in controlling the glycemic target of patients with T2DM.

The use of combination antidiabetic medications aims to enhance the effectiveness of therapy in managing glycemic targets for patients with T2DM. Sulfonylureas can be combined with biguanides due to their complementary mechanisms of action, which create a synergistic antihyperglycemic effect (Perkeni, 2021). Metformin, as a first-line oral antidiabetic, has several advantages such as it does not cause hypoglycemia and helps reduce cardiovascular events. Additionally, metformin is widely available, relatively low-cost, and covered by the Social Security Administering Health Agency (Fitria *et al*., 2023).

Glimepiride is commonly used as a second-line combination therapy alongside metformin. Its primary function is to increase insulin secretion from pancreatic beta cells, resulting in a significant hypoglycemic effect and a reduction in microvascular complications (Perkeni, 2021). The advantages of glimepiride include its ability to lower HbA1c levels by 0.8% to 2.0% and reduce glucose levels by 60 to 70 mg/dL (Khairinnisa *et al*., 2020). Unlike other sulfonylureas, glimepiride does not adversely affect the ischemic condition of cardiac myocytes or the myocardial response to ischemia, which helps limit heart tissue damage. Therefore, glimepiride is considered safer and is an ideal choice for patients with cardiovascular comorbidities (Trerattanavong and Tadi, 2021).

Providing Drug Information (PDI)

Table 4 shows that the majority of patients received PDI for a full 3 months (81.65%). Studies conducted at the Makasar City Health Center, Ciasem Subang Health Center, and Surabaya hospital revealed that not all drug information was effectively communicated through drug information services. Some essential information, such as drug side effects and proper drug storage, was not conveyed optimally (Anggriani *et al*., 2022; Santoso *et al*., 2023).

Table 4. Providing drug information (PDI)

Category	Frequency of drug information providing	n (%)
Not a routine	1 time/3 months	5 (2.96)
	2 time/3 months	26 (15.39)
Routine	≥3 time/3 months	138 (81.65)

Table 5. Types of information in PDI

Types of information	Providing drug information (PDI)	
	Yes (n (%))	No (n (%))
Name of drug	169 (100)	0 (0)
Dosage form	169 (100)	0 (0)
Dose	169 (100)	0 (0)
How to use	169 (100)	0 (0)
Indication	169 (100)	0 (0)
Side effects	53 (31.37)	116 (68.63)
Drug interaction	39 (23.08)	130 (76.92)
Storage	35 (20.71)	134 (79.29)
Stability	32 (18.93)	137 (81.07)
Contraindications	20 (11.83)	149 (88.17)

The data in Table 5 indicate that PDI at Health Centers I, II, and III in North Denpasar have been implemented. However, there are some aspects of drug information that have not been effectively communicated to patients. The information regarding drug names and indications has been fully conveyed to patients (100%). Pharmacists always ensure that the drugs received by the patient match the drug prescription when providing drug name information. Additionally, PDI regarding the dosage form and how to use the drug has been effectively communicated (100%). In this study, no patients with T2DM used insulin preparations, so the drug dosage forms received by patients were mostly in tablet form. The provision of drug dosage information was effectively communicated (100%). Drug dosage is a specific amount or dose of a drug that affects a disease. It is crucial to ensure that the patient receives the correct dose of the drug for proper and regular intake (Nuraini *et al*., 2023).

The survey found that only 31.37% of patients received information about the side effects of their medication. This suggests that many patients may not be fully informed about the potential negative effects of their medication. It's important for patients to be aware of both the benefits and potential drawbacks of their medications. For example, hypoglycemia is a common side effect of DM medication, and prolonged hypoglycemia can lead to serious complications such as allergies, coma, seizures, and even death (Rusdi, 2020). Additionally, only 23.08% of patients were informed about potential drug interactions. Drug interactions can occur when multiple medications are taken at the same time, or when certain foods or drinks interact with the medication. The more medications a patient takes, the higher the risk of interactions, which can reduce the effectiveness of the drugs or cause unwanted side effects (Dina, 2020).

The information on how to store drugs has been conveyed to patients but is still not optimal (20.71%). Most pharmacists assume that patients already understand about drug storage. It is important to convey how to store drugs as a regulation for drugs received so that they are safe, free from physical or chemical damage, and their quality is guaranteed (Nuraini *et al*., 2023).

The provision of information related to stability that has been realized is 18.93%. The stability of a preparation is very important in determining the quality, efficacy, and safety of a product because a stable product can determine the success of medication (Pramestyani *et al*., 2023). PDI related to contraindications received

the lowest value among other types of information (11.83%). Clarity about PDI related to contraindications aims to prevent patients from using their drugs if they have contraindications. However, in this study, PDI regarding contraindications in patients with T2DM was not optimal.

Overview of Medication Adherence

Based on the data in Table 6, it is evident that most of patients answered the questions correctly (78.98%). However, there were 6 out of 18 question items where wrong answers dominated and showed low medication adherence, specifically questions 1, 2, 3, 4, 8, and 15. According to the results of the researcher's interviews with patients who answered incorrectly, reasons for incorrect answers included forgetting antidiabetic medication schedules, intentional skipping of medication, busy activities, traveling, boredom, laziness, and fatigue. It is crucial for patients to receive family support and motivation, such as reminders about their medication and treatment schedules. Maximizing family support can enhance patient medication adherence, leading to more optimal outcomes in the medication of T2DM (Ernawati *et al*., 2020; Triastuti *et al*., 2020).

Table 6. ProMAS questionnaire answers

Item	Questions	Yes (n=169(%))	No (n=169(%))
1	It has happened at least once that I forgot to take (one of) my medicines.	76 (44.98%)*	93 (55.02%)
2	It happens occasionally that I take (one of) my medicines at a later moment than usual.	64 (37.87%)*	105 (62.13%)
3	I have never (temporarily) stopped taking (one of my) medicines.	103 (60.94%)	66 (39.06%)*
4	It has happened at least once that I did not take (one of) my medicines for a day.	88 (52.08%)*	81 (47.92%)
5	I am positive that I have taken all the medication that I should have taken in the previous year.	153 (90.53%)	16 (9.47%)
6	I take my medicines exactly at the same time every day.	141 (83.43%)	28 (16.57%)
7	I have never changed my medicine use myself.	154 (91.12%)	15 (8.88%)
8	In the past month, I forgot to take my medicine at least once.	67 (39.64%)*	102 (60.36%)
9	I faithfully follow my doctor's prescription concerning the moment of taking my medicines.	147 (86.99%)	22 (13.01%)
10	I sometimes take (one of) my medicines at a different moment than prescribed (eg, with breakfast or in the evening).	25 (14.80%)	144 (85.20%)
11	In the past, I once stopped taking (one of) my medicines completely.	22 (13.01%)	147 (86.99%)
12	When I am away from home, I occasionally do not take (one of) my medicines.	31 (18.34%)	138 (81.66%)
13	I sometimes take less medicine than prescribed by my doctor.	1 (0.60%)	168 (99.40%)
14	It has happened (at least once) that I changed the dose of (one of) my medicines without discussing this with my doctor.	8 (4.73%)	161 (95.27%)
15	It has happened (at least) once that I was too late with filling a prescription at the pharmacy.	57 (33.72%)*	112 (66.28%)
16	I take my medicines every day.	161 (95.27%)	8 (4.73%)
17	It has happened (at least once) that I did not start taking a medicine that was prescribed by my doctor.	9 (5.32%)	160 (94.98%)
18	I sometimes take more medicines than prescribed by my doctor.	4 (2.37%)	165 (97.63%)

*Question items indicating medication non-adherence.

Table 7. Description of the level of medication adherence of patients with T2DM

Medication adherence level category	n (%)
Low (0-4)	0
Medium-low (5-9)	11 (6.50)
Medium-high (10-14)	76 (44.98)
High (15-18)	**82 (48.52)**

Table 8. Correlation of PDI with medication adherence

Category	Level of medication adherence				*p*-value*	r-value*
	Low	Medium-low	Medium-high	High		
Not a routine	0 (0)	11 (6.50%)	1 (0.60%)	0 (0)		
Routine	0 (0)	0 (0)	75 (44.38%)	82 (48.52%)	0.000[a]	0.253[b]
Total	0 (0)	**11 (6.50%)**	**76 (44.98%)**	**82 (48.52%)**		

* The *p* and r values are derived from the results of the Kendall's Tau-c test.
[a] *p*-value of less than 0.05 indicates a significant relationship.
[b] The relationship has a positive direction, but it is weak in strength

Based on the results of the medication adherence questionnaire, scoring was conducted to assess the level of patient medication adherence with the medication they received. Out of 82 patients, 48.52% exhibited a high level of medication adherence, with an average score of 16 (15.39%) points on the ProMAS questionnaire (Table 7). Additionally, a study conducted by Agustin (2022) at the Wonorejo Samarinda Health Center using the ProMAS questionnaire revealed that over 73.5% of T2DM patients demonstrated a high level of medication adherence. Similar results were found in other studies, with the majority of patients with DM exhibiting high or moderate levels of medication adherence (ranging from 82.3% to 63%) (Anshari *et al*., 2023; Pharamita, 2023).

In this study, it was found that patients with T2DM who had no disease complications and had been diagnosed for less than 5 years were more likely to comply with medication. According to a study by Almira *et al*., (2019), patients who do not experience complications tend to take fewer drugs than those who do, leading to higher medication adherence. Moreover, Jasmine *et al*., (2020) found that patients diagnosed with a disease for more than 5 years tend to take medication more frequently, resulting in more complex medication or therapy.

Correlation of PDI with Medication Adherence

In this study, the relationship between PDI and the level of medication adherence with T2DM patients' medication was determined using the Kendall's Tau-c test (Table 8). The obtained p value was 0.000 ($p<0.05$), indicating a significant relationship between PDI and the level of medication adherence with T2DM patients. Additionally, a correlation coefficient (r) value of 0.253 was obtained, indicating a weak degree of relationship between PDI and the level of medication adherence with T2DM patients. The positive correlation direction suggests that more routine administration of PDI increases medication adherence with T2DM patients' medication. These results align with previous studies that also found a significant relationship between PDI and the level of medication adherence with T2DM patients' medication ($p<0.05$). Educational efforts in the form of media such as videos and leaflets have been found to improve patient understanding (Araswati, 2022; Jumrotul *et al*., 2023; Putri, 2020).

Undergoing medication as per the prescribed instructions is crucial for the success of patient therapy. Knowledge plays a vital role in this aspect, as it measures the extent to which an individual comprehends the medication instructions provided by pharmaceutical personnel. Equipping patients with drug information increases their understanding of the importance of adhering to medication guidelines, which is essential for maintaining stable blood glucose levels and preventing complications (Rahmawati *et al*., 2023). Patients who consistently receive PDI tend to exhibit higher

medication adherence levels, while those who do not may struggle due to a lack of understanding

Table 9. Correlation of PDI with glycemic control

Category	Glycemic control		*p*-value*	r-value*
	Not-achieved	Achieved		
Not a routine	25 (14.79%)	6 (3..55%)		
Routine	35 (20.71%)	103 (60.94%)	0.000[a]	0.447[b]
Total	**60 (35.50%)**	**109 (64.50%)**		

* The *p* and r values are derived from the results of the Kendall's Tau-b test.
[a] *p*-value of less than 0.05 indicates a significant relationship.
[b] The relationship is positive, but the strength of the relationship is moderate.

and knowledge about their medication (Jumrotul *et al*., 2023).

Several studies have indicated a correlation between the age of patients with DM and their adherence to antidiabetic medications (Almira, 2019). Additionally, Hestiana's (2017) research found a connection between age and compliance in managing dietary restrictions for T2DM. In elderly patients, there tends to be a decline in physiological functions, including memory and cognitive abilities, which increases the likelihood of misunderstanding the instructions provided by healthcare professionals.

Correlation of PDI with Glycemic Control

The results of the statistical tests in Table 9 using Kendall's Tau-b test showed a *p*-value of 0.000, indicating a significant relationship between PDI and glycemic control in T2DM patients, with a correlation coefficient value of 0.447. This finding suggests a moderate level of closeness between PDI and glycemic control. The positive correlation relationship indicates that the more regularly PDI is administered, the better the glycemic control of patients with T2DM will be.

The results of this study align with several previous studies that found at Djamil Padang Hospital, drug information services in the form of education and counseling significantly impacted the success of FBS therapy in T2DM patients (Arifin *et al*., 2020; Rahmawaty and Anggraeni, 2023). However, this finding differs from the research of Lailaturrahmi *et al*., (2022) and Araswati (2022) at the Andalas Padang Health Center, which found that drug information services did not have a significant effect on the achievement of FBS in patients with T2DM ($p>0.1$ and $p>0.05$).

The findings of this study suggest that the achievement of blood glucose levels is linked to the level of medication adherence in patients with T2DM (Alaqil *et al*., 2020). The relationship implies that when patients adhere to their medication, they are more likely to attain the target glycemic control. Conversely, if patients do not comply with their medication, the likelihood of uncontrolled blood glucose levels increases (Listyana *et al*., 2021). This study has found that the level of medication adherence among T2DM patients is high (48.52%), and it significantly impacts the achievement of glycemic control. The limitations of this study include the patient's comorbid conditions, which can affect glycemic control, and the increase in the number of medications consumed, potentially impacting medication adherence.

CONCLUSIONS

The study shows a significant relationship between PDI and medication adherence ($p=0.000$; $r=0.253$), as well as PDI and glycemic control in patients with T2DM ($p=0.000$; $r=0.447$). These findings suggest that health services at the Health Center can be improved, particularly for patients with chronic diseases such as T2DM. By focusing on PDI, efforts can be made to enhance patient medication adherence, leading to better glycemic control, reduced complications, less severe disease outcomes, and improved quality of life.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest with any party involved in conducting this research.

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