

Factors Influencing Adherence to Refills and Medications in Patients with Type 2 Diabetes Mellitus in Saudi Arabia: A Questionnaire-Based Study

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Background: Diabetes Mellitus is a growing public health concern in Saudi Arabia, with effective management relying on adherence to medications and lifestyle changes. However, non-adherence remains a significant challenge, particularly in regions with varying sociodemographic profiles.

Objective: This study aimed to identify factors influencing adherence to medication and refills among patients with Type 2 Diabetes Mellitus in the Al-Ahsa region using the Adherence to Refills and Medications Scale.

Methods: A cross-sectional study was conducted from May to July 2024 involving 732 T2DM patients attending governmental primary healthcare centers in Al-Ahsa. A stratified random sampling method was employed to select participants from various geographic strata. Data were collected via structured phone interviews using a validated questionnaire, and clinical data were extracted from medical records. Descriptive statistics, chi-square tests, and multivariable logistic regression were applied to assess factors associated with non-adherence.

Results: The overall adherence rate was 52.5%. Significant sociodemographic factors ($p < 0.05$) associated with adherence included income, marital status, occupation, and area of residence. Clinical factors included age at diabetes onset, diabetic complications, HbA1c level, frequency of glucose monitoring, and comorbidities. Healthcare-related factors such as physician continuity, frequency of visits, and counseling were also significant. Multivariable logistic regression identified major predictors of non-adherence: living in the Southern region (OR = 6.59, $p = 0.001$), diabetic complications (OR = 1.44, $p = 0.047$), lack of physician counseling (OR = 2.15, $p = 0.005$), and poor access to healthcare (OR = 2.34, $p = 0.003$).

Conclusion: Nearly half of T2DM patients in Al-Ahsa were non-adherent to medications and refills. Sociodemographic, clinical, and healthcare system factors significantly influenced adherence. Improving patient education, physician communication, and healthcare access may enhance adherence and outcomes.

Keywords: type 2 diabetes mellitus, medication adherence, refill adherence, diabetes management, patient compliance, chronic disease management

Introduction

Diabetes Mellitus (DM) is a chronic metabolic disorder characterized by elevated blood glucose levels due to either insulin deficiency or insulin resistance.¹ It is commonly classified into Type 1 (T1DM) and Type 2 (T2DM). T1DM is primarily caused by an autoimmune-mediated destruction of pancreatic β -cells, leading to a complete deficiency of insulin, while T2DM is characterized by insulin resistance and a progressive decline in insulin secretion.² Several risk factors increase the likelihood of developing T2DM, including a strong family history of diabetes, advancing age, obesity, and physical inactivity.³ In Saudi Arabia, the prevalence of diabetes is notably high, with 17.7% of adults living

with the condition, according to the International Diabetes Federation.⁴ Alarming, the prevalence of T2DM has risen from 15.8% in 2016 to 18.2% in 2021, and if the trend continues, it is projected to exceed 20% by 2026.⁵

Effective management of DM requires significant lifestyle modifications, including structured meal planning and regular physical activity.⁶ In patients who are overweight or obese, even a modest reduction in body weight has been shown to improve glycemic control, lipid profiles, and blood pressure regulation.⁶ However, inadequate disease management and poor adherence to prescribed treatment regimens can lead to serious chronic complications. These complications are broadly categorized into macrovascular complications, such as coronary artery disease, stroke, and myocardial infarction, and microvascular complications, including diabetic retinopathy, nephropathy, and neuropathy.⁶ Among patients with T2DM in Saudi clinics, nephropathy was the most common microvascular complication (80.2%), followed by retinopathy (32.7%) and neuropathy (8.4%).⁷ Moreover, according to an analysis from the Saudi Health Interview Survey (SHIS), 3.5% of patients with diabetes had experienced a myocardial infarction, and 1.2% had suffered a stroke.⁸

Medication non-adherence is a well-documented challenge in the management of chronic diseases, particularly diabetes and hypertension, with global estimates indicating that up to 50% of patients do not adhere to their prescribed regimens.⁹ In Al-Ahsa, Saudi Arabia, previous studies have reported medication non-adherence rates as high as 65% among diabetic patients receiving primary care.⁹ Poor adherence to antidiabetic medications significantly compromises glycemic control, accelerates disease progression, and increases the risk of adverse health outcomes and complications.^{9,10} Moreover, inadequate adherence is frequently associated with poor metabolic control, contributing to both immediate and long-term complications.¹¹ Despite the clinical significance of adherence, accurately assessing medication adherence remains a persistent challenge in diabetes management.¹²

The Adherence to Refills and Medications Scale (ARMS), comprising 12 items, is a widely utilized tool for assessing medication adherence. Its psychometric robustness, including reliability and validity, has been demonstrated in English-speaking populations,¹³ and it has been successfully translated and validated in several languages, such as Turkish,¹⁴ Korean,¹⁵ Chinese,¹⁶ Polish,¹⁷ and Arabic,¹⁸ particularly among patients with chronic conditions like diabetes and hypertension. Due to the lack of studies on refill adherence and the underrepresentation of certain populations, this is the first study to apply the ARMS tool to assess medication adherence among patients with T2DM in the Al-Ahsa region of Saudi Arabia. Using a stratified random sampling technique, the study aims to identify key factors influencing adherence in this population.

Methodology

Study Design and Sample Size

This is a cross-sectional study conducted over a three-month period, from May 2024 to July 2024, among T2DM patients in Al-Ahsa, Saudi Arabia. The primary aim was to assess adherence to refills and medications among patients with T2DM. Data were collected through phone call interviews using a structured questionnaire. The target population consisted of adult T2DM patients who visited governmental primary healthcare centers (PHCs), which provide free healthcare services, between October 2023 and March 2024. Patients diagnosed with T1DM and individuals who refused to participate or did not complete the study requirements were excluded.

A stratified random sampling method was employed to gather data. Initially, all PHCs in the Al-Ahsa region were categorized into four strata—Eastern, Middle, Northern, and Southern—based on their geographical locations. A specific sample size was allocated to each stratum, and participants were then randomly selected within each stratum using simple random sampling via Excel software (Figure 1). Table 1 shows the estimated sample size for each stratum, calculated using the formula with $Z = 1.96$ (95% confidence interval), $E = 0.05$ (5% margin of error), and $P = 50\%$.

Data Collection

In this cross-sectional study, questionnaires were administered through phone call interviews, while weight, height, and HbA1C measurements were obtained from system records. For illiterate participants, the survey was completed with the assistance of their relatives. The self-reported questionnaire included sections on sociodemographic characteristics (age, gender, income level, marital status, level of education, occupation, and residency) and clinical profiles (family history of DM, age of onset of DM, disease duration, type and number of medications prescribed, duration of exercise,

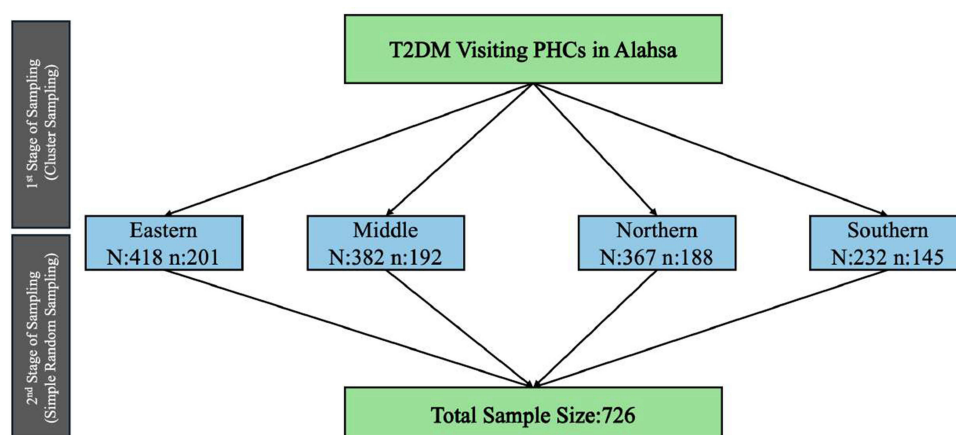


Figure 1 A Stratified Random Sampling Framework for Selecting Study Participants.

complications of DM, frequency of blood sugar monitoring, whether the physician provided information about medications, whether the physician provided adequate care, availability of assistance with medication, reasons for non-adherence to medication, number of doctor visits per year, and comorbid conditions and medications prescribed). The final section utilized the ARMS to assess medication adherence.¹⁸ Internal validity was evaluated using Cronbach's alpha ($\alpha = 0.74$), indicating acceptable internal consistency and reliability of the questionnaire within the study population.

Statistical Analysis

Data analysis for this study was conducted using SPSS version 27 (IBM Corp., 2020). Descriptive statistics were used to display the characteristics of the study population, including demographic, diabetes-related, health profile, and adherence-related variables. Continuous variables such as age and duration of diabetes were described using mean and standard deviation, while categorical variables such as gender, region, marital status, and diabetes treatment were summarized using frequency and percentage. For the analysis of factors influencing medication adherence and refill behaviors, bivariate tests, including Pearson's Chi-square test, were used to examine relationships between independent variables (for example, demographics, diabetes control, and healthcare access) and the dependent variable of adherence. Significant associations were further explored using multiple logistic regression to identify the predictors of non-adherence to medication and refill behavior. Adjusted Odds ratios (OR) and confidence intervals (CI) were reported to assess the strength and direction of these associations. A P-value less than 0.05 was considered for statistical significance.

Ethical Statement

The confidentiality of all participants will be strictly maintained. Ethical approval has been obtained from the King Fahad Hospital-Al-Hofuf Ethics Committee (IRB-KFHH No. H-05-HS-065). The study will be thoroughly explained to potential respondents, and an informed consent will be obtained from all participants. The study will adhere to the principles outlined in the Declaration of Helsinki.

Table 1 Calculated Sample Size for Each Geographic Stratum

Geographic Cluster	Population (N)	Sample Size (n)
Eastern	418	201
Middle	382	192
Northern	367	188
Southern	232	145

Results

Table 2 presents the bio-demographic characteristics of 732 type 2 diabetic patients in Saudi Arabia. Geographically, the study population was relatively evenly distributed across the regions, with the Eastern region at 27.9% (No=204), the Middle region at 26.5% (No=194), the Northern region at 25.7% (No=188), and the Southern region at 19.9% (No=146). Regarding gender, exact of 378 (51.6%) were females. The age distribution showed 223 (30.5%) aged 50–59 years and a mean age of 54.5 ± 12.7 years. In terms of body mass index, the majority of participants were either obese class I (30.7%, No=225) or overweight (27.7%, No=203), while only 15.0% (No=110) were within the normal weight range.

Table 2 Bio-Demographic Characteristics of the Study Type 2 Diabetic Patients in Saudi Arabia (N=732)

Bio-Demographics	No	%
Region		
Eastern	204	27.9%
Middle	194	26.5%
Northern	188	25.7%
Southern	146	19.9%
Gender		
Male	354	48.4%
Female	378	51.6%
Age in years		
< 40	88	12.0%
40–49	151	20.6%
50–59	223	30.5%
60–69	194	26.5%
70+	76	10.4%
Mean $\pm$ SD	54.5 $\pm$ 12.7	
Body mass index		
Normal weight	110	15.0%
Overweight	203	27.7%
Obesity class I	225	30.7%
Obesity class II	105	14.3%
Obesity class III	89	12.2%
Monthly income		
< 5000 SR	489	66.8%
5000–10000 SR	157	21.4%
10,000–20000 SR	81	11.1%
> 20000 SR	5	7%
Marital status		
Single	46	6.3%
Married	625	85.4%
Divorced / widow	61	8.3%
Educational level		
Illiterate	129	17.6%
Basic education	288	39.3%
Secondary / diploma	141	19.3%
University / above	174	23.8%

(Continued)

Table 2 (Continued).

Bio-Demographics	No	%
Occupation		
Not working / student	347	47.4%
Non-medical field	218	29.8%
Medical field	4	5%
Retired	163	22.3%
Residence		
Rural area	196	26.8%
Immigration area	13	1.8%
Downtown	523	71.4%
Family history of Diabetes mellitus		
Yes	634	86.6%
No	98	13.4%

A significant proportion of the participants reported a monthly income of less than 5000 SR (66.8; 489). The vast majority were married, accounting for 85.4% (No=625). Educational levels were varied, with basic education being the most common at 39.3% (No=288). Occupationally, nearly half were not working or were students, at 47.4% (No=347). Most participants resided in downtown areas, representing 71.4% (No=523). Notably, a substantial 86.6% (No=634) reported a family history of diabetes mellitus.

Table 3 shows the distribution of diabetes-related variables among 732 type 2 diabetic patients in Saudi Arabia. The age of diabetes onset was most frequently 50 years or older, comprising 31.4% (No=230) of the cases, while the lowest frequency was observed in those with onset between 30–39 years at 18.9% (No=138). Regarding treatment, oral pills were the most common modality, utilized by 48.2% (No=353) of patients, whereas diet and exercise alone represented the lowest at 0.7% (No=5). As for the duration of diabetes, the highest percentage being less than 5 years at 31.4% (No=230). About glycemic control, well-controlled HbA1c levels (<7%) were observed in 36.2% (No=265) of patients, while poor control (>8%) was seen in 31.6% (No=231). The most frequent blood glucose monitoring was more than once

Table 3 Distribution of Diabetes-Related Variables Among Type 2 Diabetic Patients in Saudi Arabia (N=732)

Diabetes Data	No	%
Age of onset of diabetes		
< 30 years	141	19.3%
30–39 years	138	18.9%
40–49 years	223	30.5%
50 / more years	230	31.4%
Mean ± SD	40.4 ± 15.2	
Type of diabetes treatment received		
Oral pills	353	48.2%
Oral pills, Insulin injection	148	20.2%
Oral pills, Diet + exercise	84	11.5%
Insulin injection	66	9.0%
Oral pills, Insulin injection, Diet + exercise	52	7.1%
Insulin injection, Diet + exercise	24	3.3%
Diet + exercise	5	7%

(Continued)

Table 3 (Continued).

Diabetes Data	No	%
Duration of diabetes in years		
< 5 years	230	31.4%
5–9 years	155	21.2%
10–15 years	170	23.2%
> 15 years	177	24.2%
Mean $\pm$ SD	10.7 $\pm$ 9.2	
Diabetic control based on last HbA1c%		
Well-Controlled (<7%)	265	36.2%
Fairly Controlled (7–8%)	236	32.2%
Poor-Controlled (> 8%)	231	31.6%
Mean $\pm$ SD	7.8 $\pm$ 1.9	
How frequently do you monitor your blood glucose levels?		
More than once daily	210	28.7%
Once daily	110	15.0%
More than once weekly	49	6.7%
Once weekly	142	19.4%
Monthly	6	8%
Every 3 months	3	4%
Others	29	4.0%
Unknown / Do not remember	183	25.0%
Diabetic complications you have		
None	423	57.8%
Retinopathy	229	31.3%
Neuropathy	186	25.4%
Cardiovascular diseases	21	2.9%
Peripheral vascular diseases	19	2.6%
Nephropathy	20	2.7%
Stroke	13	1.8%

daily, at 28.7% (No=210), and the least frequent was every 3 months, at 0.4% (No=3). Notably, 57.8% (No=423) reported no diabetic complications, while retinopathy was the most prevalent complication at 31.3% (No=229), and stroke was the least at 1.8% (No=13).

Table 4 illustrates the health profile of Type 2 diabetic patients in Saudi Arabia. Considering other comorbidities, the most common condition among the participants was hypertension, affecting 357 individuals (49.0%). Other comorbidities included rheumatic diseases, osteoarthritis, and others (132, 18.1%) and diseases of the digestive system such as inflammatory bowel disease (96, 13.2%). Regarding medication use, most participants were on multiple medications. A significant portion (192, 26.2%) received three medications, while six or more medications were prescribed to 142 participants (19.4%). Regarding smoking habits, 105 participants (14.3%) reported that they smoke. Finally, exercise habits show that a few numbers of participants (201, 27.5%) do not engage in any physical activity. Among those who do exercise, 294 participants (40.2%) reported engaging in less than 60 minutes of physical activity weekly, while 147 participants (20.1%) met the recommended 60–150 minutes of exercise per week.

Table 5 clarifies data on healthcare access and medication support among 732 type 2 diabetic patients. A significant majority, 85.9% (No=629), reported receiving information about anti-diabetic medications from their physicians. Regarding the frequency of doctor visits, the highest percentage, 36.5% (No=267), reported visiting their doctor more than three times a year, and only 3.7% (No=27) reported visiting their doctor once a year. The vast majority of patients, 88.5% (No=648), confirmed they were continuing to receive healthcare from their doctors, with only 11.5% (No=84)

Table 4 Health Profile of Type 2 Diabetic Patients in Saudi Arabia: Comorbidities, Medication, and Lifestyle Behaviors (N=732)

Data	No	%
Other co-morbidities		
None	264	36.3%
Hypertension	357	49.0%
Rheumatic diseases, osteoarthritis, and others	132	18.1%
Diseases of the digestive system such as Inflammatory bowel disease and others	96	13.2%
Respiratory diseases such as asthma and others	48	6.6%
Psychological diseases such as obsessive-compulsive disorder and others	10	1.4%
Vascular and heart diseases	66	9.1%
Skin diseases such as psoriasis, vitiligo, and others	41	5.6%
Hyper/Hypothyroidism	31	4.3%
Cholesterol	32	4.4%
Others	11	1.5%
Number of received medications		
None	54	7.4%
1	58	7.9%
2	117	16.0%
3	192	26.2%
4	110	15.0%
5	59	8.1%
6 and more	142	19.4%
Smoking		
Yes	105	14.3%
No	627	85.7%
How much time do you spend exercising weekly		
I do not do any sports	201	27.5%
Less than 60 mins	294	40.2%
60–150 mins	147	20.1%
More than 150 mins	90	12.3%

Table 5 Healthcare Access and Medication Support in Type 2 Diabetic Patients (N=732)

Item	No	%
Did your physician give you information about anti-diabetic medications?		
Yes	629	85.9%
No / I do not know	103	14.1%
How many times do you visit the doctor during the year?		
Once a year	27	3.7%
Twice (every 6 months)	260	35.5%
Three times (every 4 months)	178	24.3%
More than three times a year	267	36.5%
Are you continuing to receive health care from your doctor?		
Yes	648	88.5%
No	84	11.5%
Do you have someone who helps you take medications?		
Yes	147	20.1%
No, I depend on myself	585	79.9%

reporting otherwise. In terms of medication assistance, a total of 79.9% (No=585) of patients reported managing their medications independently, while 20.1% (No=147) indicated they had someone who helped them.

Table 6 examines medication adherence and refill behaviors among 732 type 2 diabetic patients. A significant 33.9% of patients reported forgetting to take their medications at least sometimes. Similarly, 20.1% decided not to take their medications at least sometimes. Regarding medication refills, 13.4% forgot to refill their medications, and 14.2% ran out of medications at least sometimes. Furthermore, 16.7% skipped a dose without consulting their doctor, and 20.5% missed medications when feeling better. Notably, 6.6% missed medications when feeling sick, indicating a potential vulnerability during illness. Carelessness led to missed medications for 11.7%. A substantial 33.7% changed their medication dose to suit their needs, highlighting potential issues with medication management. Additionally, 20.1% forgot medications that they were supposed to take more than once a day. Finally, 4.1% put off their medications due to high costs. Conversely, a combined 58.6% reported refilling their medication before running out, indicating a reasonably high rate of proactive refill behavior.

Figure 2 displays the adherence rate to refills and medications among 732 type 2 diabetic patients. A total of 52.5% (n=384) of patients were classified as adherent and 47.5% (n=348) were classified as non-adherent.

Figure 3 presents the reasons that reduce medication adherence among Type 2 diabetic patients. The majority of participants (62.4%) reported no reasons for reducing their commitment to taking medication. Among those who reported barriers to adherence, the most common reason was forgetting to take medication (22.1%). Other reasons included stopping medications due to side effects (8.1%) and stopping medication when feeling well (8.6%). A smaller proportion of patients stopped taking medications because of their multiplicity (5.6%) or taking medication only when the disease worsens (5.1%). Financial constraints were less common, with only 1.4% of patients reporting inability to afford medication as a reason for non-adherence. Psychological factors and concerns about kidney and liver failure were reported by just 0.13% of patients each.

Table 7 examines factors associated with refill and medication adherence among type 2 diabetic patients. A highly significant association ($p = 0.001$) was observed with region. Patients residing in the Southern region demonstrated the lowest adherence rate, with only 22.6% being adherent, compared to higher adherence rates in the Eastern (62.3%), Middle (60.3%), and Northern (56.9%) regions. Monthly income also significantly impacted adherence ($p = 0.001$). Patients with a monthly income of less than 5000 SR exhibited the highest adherence rate at 61.1%, while those in higher income brackets showed substantially lower adherence. Marital status significantly influenced adherence ($p = 0.002$). Single patients had the lowest adherence rate, with only 32.6% being adherent, compared to 55.0% for married patients. Occupation showed a significant association with adherence ($p = 0.008$). Patients not working or students had a higher adherence rate of 56.5%, while retired patients had a lower rate of 42.9%. Residence type also showed a significant association ($p=0.016$). Patients who live in rural areas had a higher adherence rate of 56.1% compared to those who live in immigration areas (15.4%) or downtown (52%).

Table 6 Adherence to Medication and Refill among Type 2 Diabetic patients (N=732)

Items	Never		Sometimes		Most Times		Always	
	No	%	No	%	No	%	No	%
forget to take your meds	484	66.1%	202	27.6%	32	4.4%	14	1.9%
decide not to take your meds	585	79.9%	83	11.3%	35	4.8%	29	4.0%
forget to refill your meds	634	86.6%	76	10.4%	18	2.5%	4	0.5%
run out of meds	628	85.8%	80	10.9%	20	2.7%	4	0.5%
skip a dose without dr consult	610	83.3%	92	12.6%	20	2.7%	10	1.4%
miss meds when feel better	582	79.5%	123	16.8%	20	2.7%	7	1.0%
miss meds when feel sick	684	93.4%	35	4.8%	7	1.0%	6	0.8%
miss meds due to careless	646	88.3%	68	9.3%	12	1.6%	6	0.8%
change meds dose to suit your needs	485	66.3%	176	24.0%	52	7.1%	19	2.6%
forget meds that you supposed to take more than 1 a day	585	79.9%	117	16.0%	26	3.6%	4	0.5%
put off your meds due to high cost	702	95.9%	26	3.6%	2	0.3%	2	0.3%
refill before meds run out	303	41.4%	61	8.3%	44	6.0%	324	44.3%

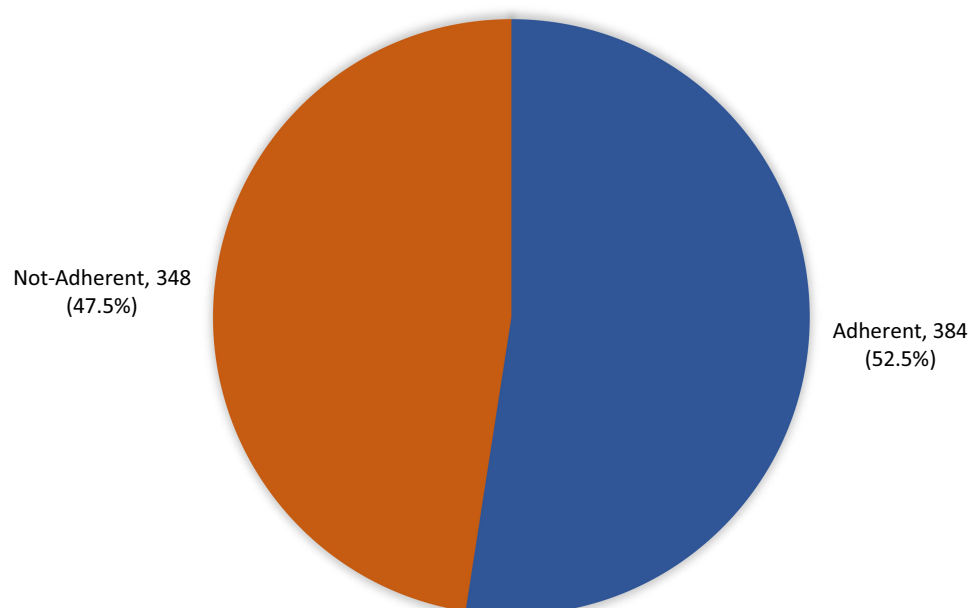


Figure 2 Type 2 Diabetic Patients' Adherence Rate to Re-fill and Medications (n=732).

Table 7 presents other factors associated with diabetic patients' medication refill and adherence. Significant factors influencing adherence include the age of onset of diabetes, with those diagnosed at age 50 or older showing the highest adherence (61.3%) compared to younger groups ($p=0.001$). Diabetic complications were also a key factor, with those without complications having better adherence (57.0%) than those with complications (46.3%, $p=0.004$). Diabetic control, as measured by HbA1c levels, showed that patients with well-controlled diabetes ($<7\%$) had better adherence (58.1%) compared to those with poorly controlled diabetes ($>8\%$, 45.9%, $p=0.025$). Monitoring blood glucose levels more frequently was positively associated with adherence. Co-morbidities also played a role; patients without other co-morbidities demonstrated better adherence (60.1%) compared to those with additional health conditions (48.2%, $p=0.002$). The number of medications prescribed influenced adherence as well. Patients on 3 medications showed the highest adherence (67.2%), while those on 6 or more medications had lower adherence (43.0%, $p=0.068$). Receiving information from a physician about anti-diabetic medications was another significant factor; those who received guidance had higher adherence (56.8%) compared to those who did not (26.2%, $p=0.001$). Doctor visits also correlated with adherence. Patients who visited their doctor more frequently (three or more times a year) had better adherence (66.3%) compared to those who only visited once a year (37.0%, $p=0.001$). Finally, the presence of a helper for medication was not significantly associated with adherence ($p=0.134$).

Table 8 presents the results of a multiple logistic regression analysis that identifies the predictors of medication non-adherence among type 2 diabetic patients. Patients from the Southern region were significantly more likely to be non-adherent compared to those from the Eastern region ($OR=6.59$, $p=0.001$). Additionally, higher monthly income was associated with better adherence ($OR=1.40$, $p=0.021$), indicating that patients with greater financial resources were more likely to follow their prescribed medication regimens. Regarding occupation, non-medical field occupations were linked to higher odds of non-adherence ($OR=1.13$, $p=0.049$). Patients living in downtown areas had a lower likelihood of non-adherence ($OR=0.71$, $p=0.038$). Furthermore, age at onset of diabetes was a significant factor, with older patients or those diagnosed later in life being less likely to be non-adherent ($OR=0.98$, $p=0.009$). The presence of diabetic complications was another significant predictor of non-adherence, as patients with complications were more likely to be non-adherent ($OR=1.44$, $p=0.047$). A key finding was the lack of physician-provided information about anti-diabetic medications, which significantly increased the odds of non-adherence ($OR=2.15$, $p=0.005$). More frequent doctor visits were associated with better adherence ($OR=1.53$, $p=0.001$). Finally, infrequent healthcare access was strongly associated with non-adherence ($OR=2.34$, $p=0.003$).

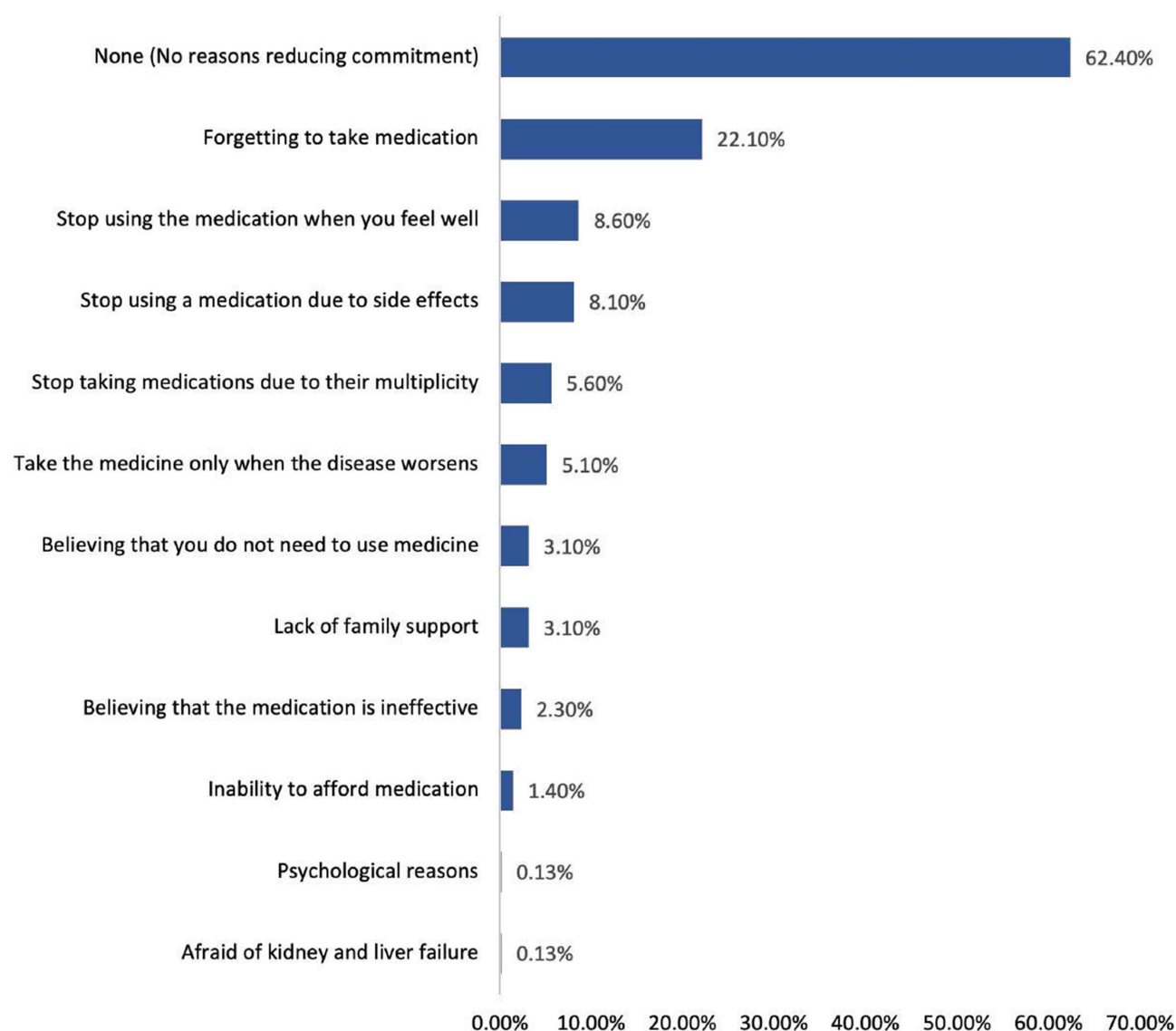


Figure 3 Reasons That Reduce Commitment to Taking Medication among Type 2 Diabetic Patients.

Discussion

Medication adherence is defined by the Food and Drug Administration (FDA) as the extent to which patients take their medications as prescribed, in agreement with their healthcare provider. Optimal adherence to diabetes medication and lifestyle modifications has been shown to reduce emergency room visits, hospitalizations,¹⁹ and diabetes-related complications.²⁰ There are several factors that contribute to medication adherence in patients with DM, including family support, routine, side effects, complexity of the medication regimen, blood sugar levels, and forgetfulness. Additionally, one of the major factors influencing adherence is the relationship between healthcare professionals and their patients.⁹

Our study found that adherence to medication and refills was 52.5%, as measured by ARMS. In comparison, a previous study conducted in the Al Hasa region of Saudi Arabia in 2012 reported a non-compliance rate of 67.9%,⁹ which is significantly higher than our findings. The difference in adherence rates may be influenced by the passage of time and the impact of the COVID-19 pandemic on people's behavior regarding medication adherence and refills. Nonetheless, the medication adherence rate observed in our study was satisfactory and higher than those reported in studies conducted in the Eastern Province of Saudi Arabia, Egypt, Switzerland, and Ethiopia, where adherence rates were 34.7%, 38.9%, 40%, and 51.3%, respectively.^{21–24} However, it was lower than the rates observed in Tabuk²⁵ (76.4%).

Table 7 Factors Associated with Diabetic Patient's Re-fill and Medication Adherence

Factors		Re-Fill and Medication Adherence				p-value
		Adherent		Not-Adherent		
		No	%	No	%	
Region	Eastern	127	62.3%	77	37.7%	0.001*
	Middle	117	60.3%	77	39.7%	
	Northern	107	56.9%	81	43.1%	
	Southern	33	22.6%	113	77.4%	
Gender	Male	180	50.8%	174	49.2%	0.398
	Female	204	54.0%	174	46.0%	
Age in years	< 40	41	46.6%	47	53.4%	0.367
	40-49	76	50.3%	75	49.7%	
	50-59	116	52.0%	107	48.0%	
	60-69	113	58.2%	81	41.8%	
	70+	38	50.0%	38	50.0%	
Body mass index	Normal weight	54	49.1%	56	50.9%	0.432
	Overweight	115	56.7%	88	43.3%	
	Obesity class I	111	49.3%	114	50.7%	
	Obesity class II	53	50.5%	52	49.5%	
	Obesity class III	51	57.3%	38	42.7%	
Monthly income	< 5000 SR	299	61.1%	190	38.9%	0.001*^
	5000-10000 SR	57	36.3%	100	63.7%	
	10000-20000 SR	27	33.3%	54	66.7%	
	> 20000 SR	1	20.0%	4	80.0%	
Marital status	Single	15	32.6%	31	67.4%	0.002*
	Married	344	55.0%	281	45.0%	
	Divorced / widow	25	41.0%	36	59.0%	
Educational level	Illiterate	74	57.4%	55	42.6%	0.357
	Basic education	156	54.2%	132	45.8%	
	Secondary / diploma	68	48.2%	73	51.8%	
	University / above	86	49.4%	88	50.6%	
Occupation	Not working / student	196	56.5%	151	43.5%	0.008*^
	Non-medical field	114	52.3%	104	47.7%	
	Medical field	4	100.0%	0	0.0%	
	Retired	70	42.9%	93	57.1%	
Residence	Rural area	110	56.1%	86	43.9%	0.016*
	Immigration area	2	15.4%	11	84.6%	
	Downtown	272	52.0%	251	48.0%	
Family history of Diabetes mellitus	Yes	338	53.3%	296	46.7%	0.240
	No	46	46.9%	52	53.1%	
Age of onset of diabetes	< 30 years	54	38.3%	87	61.7%	0.001*
	30-39 years	77	55.8%	61	44.2%	
	40-49 years	112	50.2%	111	49.8%	
	50 / more years	141	61.3%	89	38.7%	
Have diabetic complications	No	239	57.0%	180	43.0%	0.004*
	Yes	145	46.3%	168	53.7%	

(Continued)

Table 7 (Continued).

Factors		Re-Fill and Medication Adherence				p-value
		Adherent		Not-Adherent		
		No	%	No	%	
Diabetic control based on last HbA1c	Well-Controlled (<7%)	154	58.1%	111	41.9%	0.025*
	Fairly Controlled (7-8%)	124	52.5%	112	47.5%	
	Poor-Controlled (> 8%)	106	45.9%	125	54.1%	
Duration of diabetes in years	< 5 years	124	53.9%	106	46.1%	0.110
	5-9 years	88	56.8%	67	43.2%	
	10-15 years	93	54.7%	77	45.3%	
	> 15 years	79	44.6%	98	55.4%	
How frequently do you monitor your blood glucose levels	More than once daily	72	34.3%	138	65.7%	0.001*
	Once daily	45	40.9%	65	59.1%	
	More than once weekly	33	67.3%	16	32.7%	
	Once weekly	114	80.3%	28	19.7%	
	Monthly	4	66.7%	2	33.3%	
	Every 3 months	1	33.3%	2	66.7%	
	Others	24	82.8%	5	17.2%	
	Unknown / Don't remember	91	49.7%	92	50.3%	
Smoking	Yes	46	43.8%	59	56.2%	0.055
	No	338	53.9%	289	46.1%	
Other co-morbidities	No	158	60.1%	105	39.9%	0.002*
	Yes	226	48.2%	243	51.8%	
Number of received medications		14	25.9%	40	74.1%	0.068
	1	30	51.7%	28	48.3%	
	2	62	53.0%	55	47.0%	
	3	129	67.2%	63	32.8%	
	4	56	50.9%	54	49.1%	
	5	32	54.2%	27	45.8%	
	6 and more	61	43.0%	81	57.0%	
Did your physician give your information about anti-diabetic medications?	Yes	357	56.8%	272	43.2%	0.001*
	No / don't know	27	26.2%	76	73.8%	
How many times do you visit the doctor during the year?	Once a year	10	37.0%	17	63.0%	0.001*
	Twice (every 6 months)	156	60.0%	104	40.0%	
	Three times (every 4 months)	118	66.3%	60	33.7%	
	More than three times a year	100	37.5%	167	62.5%	
Are you continuing to receive health care from your doctor	Yes	358	55.2%	290	44.8%	0.001*
	No	26	31.0%	58	69.0%	
Do you have someone who helps you take medications	Yes	69	46.9%	78	53.1%	0.134
	No, I depend upon myself	315	53.8%	270	46.2%	

Notes: P: Pearson χ^2 test, ^: Exact probability test, * P < 0.05 (significant).

These variations in adherence levels could be attributed to several factors, including the availability of free medical services, varying levels of awareness regarding the importance of medication adherence, regional strategies to promote adherence, and differences in the measurement tools used across studies.²⁵

In this study, significant factors influencing medication adherence and refills included income level, marital status, occupation, and residency area. Similarly, a prior study conducted in Ethiopia identified financial difficulties as the

Table 8 Multiple Logistic Regression Model for Predictors of Type 2 Diabetic Patients Medications Non-adherence

Predictors	p-value	OR _A	95% CI	
			Lower	Upper
Region				
Middle vs. Eastern	0.304	1.49	0.70	3.16
Northern vs. Eastern	0.063	1.98	0.96	4.08
Southern vs. Eastern	0.001*	6.59	3.32	13.11
Higher monthly income	0.021*	1.40	1.05	1.86
unmarried vs. married	0.780	1.07	0.68	1.67
Non-medical filed occupation	0.049*	1.13	1.02	1.31
Downtown residence	0.038*	0.71	0.52	0.98
Age at onset of DM	0.009*	0.98	0.97	1.00
Have diabetic complications	0.047*	1.44	1.04	2.12
Poor controlled DM	0.537	1.07	0.87	1.31
Higher frequency of monitoring blood glucose levels	0.354	0.97	0.91	1.03
Have other co-morbidities	0.111	1.37	0.93	2.01
Physicians don't give you information about anti-diabetic medications.	0.005*	2.15	1.27	3.66
Frequency of visits to the doctor during the year	0.001*	1.53	1.24	1.88
Infrequent receive health care from doctor	0.003*	2.34	1.32	4.13

Note: * P < 0.05 (significant).

Abbreviations: OR_A, Adjusted odds ratio; CI, Confidence interval.

primary external barrier to medication adherence.²⁴ Despite the availability of free healthcare in Saudi Arabia, issues such as transportation challenges⁹ and difficulties in scheduling clinic visits still impact adherence. Marital status also emerged as a significant factor, with a study by Alfulayw et al identifying a significant association between marital status and medication adherence.²¹ However, a study conducted in Al-Ahsa, Saudi Arabia, found no statistically significant relationship between marital status and adherence.⁹ Regarding residency, several studies have reported significant differences between rural and urban populations, with rural residents exhibiting higher adherence and refill rates.^{9,26} However, a study by Alfulayw et al did not observe a significant association between place of residence and medication adherence.²¹ Consistent with our findings, occupation was also identified as a significant factor influencing adherence in the Saudi population, as reported by Alfulayw et al.²¹

This study found that age was not a significant factor in medication adherence and refills. However, earlier studies have suggested that adherence tends to increase with age.^{21,23} On the other hand, Shams et al reported lower adherence among elderly patients, with good adherence rates of 28.1% in the elderly, 36.2% in middle-aged adults, and 51.8% in younger individuals.²² Gender was not significantly associated with medication adherence in our study, a finding consistent with several previous reports.^{21,22,26} However, some studies have suggested that women are more likely to adhere to treatment regimens,^{9,27} while others have reported higher adherence among men.^{23,28} Additionally, our study found no significant association between educational level and adherence, which aligns with the findings of multiple prior studies.^{21,26}

Our study found a non-statistically significant association between smoking status and adherence to medications and refills. This result contrasts with findings from a study conducted in Shiraz, Iran, which reported a significant relationship between smoking and medication adherence.²⁹ Similarly, no significant association was observed between physical activity and medication adherence in our study. However, a study from Eastern Nepal demonstrated that daily jogging was significantly associated with improved adherence,³⁰ supporting the hypothesis that regular physical activity may enhance mood and motivation, thereby promoting better adherence—particularly among individuals following a structured exercise regimen.²¹ In terms of diabetes information, factors such as the age of onset, having diabetic complications, lower HbA1c levels, daily blood glucose level (BGL) checks, other comorbidities, receiving sufficient information from physicians about antidiabetic medications, the frequency of annual doctor visits, and the continuity of healthcare have a statistically significant relationship with adherence to medications and refills. For instance, a study conducted in Johor, Malaysia, found that medication adherence was significantly associated with good glycemic

control.³¹ Similarly, a study in Shiraz, Iran, reported the same findings.²⁹ Additionally, a study in the Kurdistan Region of Iraq indicated that non-adherent participants were more likely to have higher HbA1c levels, reflecting poorer glycemic control.³² Nonadherence to medications and refills has been attributed to factors such as polypharmacy, financial constraints, or concerns about side effects.³³ Participants who were prescribed a glucometer for self-monitoring of BGLs experienced positive outcomes, such as lower BGLs.³⁴ Furthermore, a good relationship with the physician helped reduce concerns and issues related to medications, leading to more frequent visits to the same physician for regular check-ups, thereby ensuring continuity of care.^{35–37}

Our study found a significant association between the presence of chronic diseases and medication adherence and refill rates, whereas the number of medications was not statistically associated with adherence. In contrast, a study conducted at a tertiary hospital in Saudi Arabia involving 8932 adults with DM found that approximately 78% experienced polypharmacy, with a higher prevalence observed among women and patients with multiple comorbid conditions, including cardiovascular disease, chronic kidney disease, musculoskeletal disorders, respiratory issues, and mental health conditions.³⁸ Due to the numerous complications associated with DM, patients often require more medications, and factors such as the cost of polypharmacy, pill burden, and drug side effects contribute to polypharmacy, ultimately worsening the patient's condition.³⁹

Limitations

Our study has several limitations, including recall bias, as participants may not accurately remember past treatments, and non-response bias, which may affect data accuracy. Additionally, selection bias is a concern since all participants were recruited from governmental PHCs offering free healthcare, excluding the private sector, which may impact the external validity and generalizability of the findings. The cross-sectional design prevents establishing causal relationships, requiring longitudinal studies for better insight into temporal associations. Furthermore, as the study was questionnaire-based, it is subject to self-reporting bias, which may lead to overestimation or underestimation of adherence behaviors.

Conclusion

This study highlights that nearly half of patients with T2DM in Al-Ahsa were non-adherent to their prescribed medications and refills, as measured by the ARMS, despite the availability of free healthcare services. The findings emphasize the multifactorial nature of medication adherence, with significant associations observed across sociodemographic, clinical, and healthcare-related variables. Key factors influencing adherence included income level, marital status, occupation, residency area, diabetic complications, glycemic control, frequency of blood glucose monitoring, and continuity of physician care. Importantly, multivariable analysis identified residence in the Southern region, presence of complications, lack of physician counseling, and limited access to healthcare as strong predictors of non-adherence.

The study underscores the need for targeted, patient-centered interventions aimed at improving medication adherence, especially among high-risk groups. Educational initiatives, enhanced communication between patients and healthcare providers, and better continuity of care are essential to address barriers to adherence. Future research should further explore behavioral and psychosocial determinants of adherence and assess the effectiveness of tailored interventions in improving long-term treatment outcomes for diabetic patients in different regions of Saudi Arabia.

Data Sharing Statement

All relevant data supporting the findings of this study are included within the manuscript.

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Disclosure

The authors declare no conflicts of interest in this work.

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