Patient Preference and Adherence

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ORIGINAL RESEARCH

Association Between Adherence to Oral Antidiabetic Medications and Cost Sharing Among Patients with Type II Diabetes: A Cross-Sectional Study

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Background: One of the critical factors that affect medication adherence is cost-sharing (the percentage that a patient pays out-of-pocket to cover health expenses), which sometimes may become a barrier to initiate or refill prescription medications.
Aim: The primary aim of this study was to assess the association between adherence to oral antidiabetic medications (OADs) using the Adherence to Refills and Medicines Scale for Diabetes (ARMS-D) questionnaire and cost-sharing among patients with type 2 diabetes. The secondary aim was to evaluate the extent to which patients are adherent to their OADs, and which factors were significantly affecting patients' adherence to their OADs.
Methods: Four hundred adult patients that visited the Diabetes Clinic of the Jordan University Hospital who were on OADs were interviewed by the researcher and were asked to complete the study questionnaire. The questionnaire consists of two sections: patients' characteristics and ARMS-D. Simple and multivariable linear regression analyses were used to assess the determinants (demographic, clinical, and economic characteristics) associated with patient's adherence to their OADs.
Results: When measured by ARMS-D (sores range from 11 to 44), where higher scores indicate lower adherence, 71% of participants reported lower adherence (scores > 11) to their OADs, while 29% achieved full adherence (scores = 11). Our analysis identified that there was no significant association between adherence to OADs and cost-sharing ($P > 0.05$). However, multiple regression analysis revealed that demographic factors, such as age and education level, along with clinical factors, such as the number of pills per day, the number of anti-diabetic-medications side effects, and frequent episodes of hyperglycemia, were significantly affecting patients' adherence to OADs ($P < 0.05$).
Conclusion: The key findings of this study indicate that the effect of patients' characteristics on adherence is therefore caused primarily by demographic and clinical factors rather than economic factors.
Keywords: diabetes type II, adherence, cost-sharing, oral antidiabetic medications, Jordan

Introduction

Diabetes Mellitus (DM) is a common chronic metabolic disorder that correlates with high morbidity and mortality rates.[1,2] Diabetes is one of the leading ten causes of death around the world.[3] In 2021, it resulted in about 6.7 million deaths worldwide.[2] It is an age-related medical condition and an approximate of 450 million individuals worldwide suffer from this disease.[2] In 2022, as stated by the National Center for Diabetes, Endocrinology and Genetic Diseases, the diabetes and pre-diabetes prevalence in Jordan was approximately 45%.[4] Diabetes is a highly costing chronic condition that is associated with high range of expenses on individuals and societies.[5] Chronic high glucose blood levels contribute to several medical complications of DM, these complications impose a large impact on healthcare systems and increase total costs for diabetes management.[2]

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The treatment goal for DM revolves around controlling blood glucose levels and preventing disease-related complications.[6] Maintaining glycemic levels within the normal range by taking antidiabetic medications is proven to prevent and delay complications.[7] Oral Antidiabetic Drugs (OADs) attempt to control blood glucose levels to normal levels, which consequently reduce diabetic medical complications.[8] A significant aspect to successfully manage diabetes is adherence to antihyperglycemic medications.[9]

Medication adherence is a broadly used measure to assess the quality of a patient's medication use.[5] Adherence to medications is defined by the World Health Organization (WHO) as "the degree to which the person's behavior corresponds with the agreed recommendations from a health care provider."[10] Enhancing adherence to antihyperglycemic medications leads to improved glycemic control, can prevent more expensive complications, and reduces the number of hospitalizations and emergency unit visits. Consequently, improving adherence results in less expenses and reduced overall costs.[5]

Assessment of adherence is the first step to capturing non-adherence.[11] Medication Adherence Questionnaires (MAQs) with good validity and reliability are recommended for measuring adherence.[12] An example of a questionnaire specific for diabetes is Adherence to Refills and Medicines Scale for Diabetes (ARMS-D).[12]

Adherence to medications is impacted by patient-specific factors, disease-related factors, and socioeconomic factors.[13] One of the critical factors that affect medication adherence is cost-sharing (the percentage that a patient pays out-of-pocket to cover health expenses), which sometimes may become a barrier to initiate or refill prescription medications.[5,14] High cost-sharing levels may result in disturbance to therapy that imposes harmful effects on patients with chronic diseases, including diabetes.[15]

Many studies have examined the impact of cost-sharing or socio-demographic factors on patient adherence. However, there is limited literature that considers cost-sharing together with a broad range of demographic and clinical factors within the same analytical framework.

For example, Xie et al analyzed the association between socio-demographic characteristics and adherence to self-management behaviors, including taking medication, in patients with coexisting type 2 diabetes and hypertension.[16] Additionally, Eaddy et al intended to examine how increased cost sharing affects medication.[17] While these studies provided important insights, most have examined cost-sharing and demographic or clinical factors separately. Our study addresses this gap by evaluating the effect of cost-sharing, as well as demographic and clinical factors on medication adherence. This approach helps in understanding how these factors contribute to adherence behaviors in real-world settings.

To our knowledge, this is the first study conducted in Jordan to evaluate the association between adherence to oral antidiabetic medications and cost-sharing among patients with type 2 diabetes. The primary aim of this study was to assess the association between adherence to OADs using the Adherence to Refills and Medicines Scale for Diabetes (ARMS-D) questionnaire and cost-sharing among patients with type 2 diabetes. The secondary aim was to evaluate the extent to which patients are adherent to their OADs, and which factors are significantly affecting patients' adherence to their OADs.

Methods

Study Design

This is a cross-sectional, exploratory study that was conducted at the Diabetes and Endocrinology clinic of Jordan University Hospital (JUH). JUH is a large university affiliated teaching hospital located in Amman, Jordan. It provides specialized outpatient and inpatient services and serves a diverse patient population from both urban and rural areas. Data collection started on 27-May-2024 and continued until 5-September-2024.

Selection of Patients

Inclusion and Exclusion Criteria

Patients were included in the study if they met the following criteria: adult (18 years old); who visited the Diabetes and Endocrinology clinic of the Jordan University Hospital and were on oral antidiabetic medications.

Patients using insulin without oral antidiabetic medications were excluded, as were those who declined to participate.

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Sample Size Calculation

Sample size was calculated using the standard formula for calculating the sample size, which is used to calculate the sample size for proportion with a finite population correction

$$\text{Sample Size Formula} = \left[z^2 * p(1-p)\right]/e^2/1 + \left[z^2 * p(1-p)\right]/e^2 * N]$$

Where:

N is the population size

z is the z-score

e is the margin of error

p is the standard of deviation

The formula was obtained from the online website CUEMATH.[18]

Population was calculated in the periodic interval from June 2024 to August 2024 as patients come to the clinic every 3 months. To determine the number of patients who attended the diabetes and endocrinology clinic during the selected duration of time, we contacted the patient affairs officer. In June, 2,287 patients came to the clinic, while 3,058 came to the clinic in July, and 2,847 came to the clinic in August.

The total number of 8192 patients represent all patients who attended the diabetes and endocrinology clinic during the selected period of time. To determine the percentage of diabetic patients who were using OADs, we asked a specialist doctor working at the clinic who stated it to be an approximate of 60% of total patients attending the clinic. After ruling out the stated percentage, the total population of diabetic patients who were on OADs were approximately 4,915 patients. The calculated sample size was 357, with a confidence level of 95% (z=1.96), a margin of error of 5%, a standard deviation of 50%, and a total population of 4,915 (based on the data explained above).

Ethical Statement

This study was conducted after obtaining ethical approval by the Institutional Review Board at Jordan University Hospital (IRB-JUH) (Reference number: 10/2024/10675) on 16-April-2024. All patients provided informed consent, in accordance with the Declaration of Helsinki.

Data Collection and Study Instruments

The data was collected by the researcher, who is a licensed pharmacist, during routine visits to the outpatient diabetic clinic. Potential participants, all of whom were outpatients attending follow-up appointments, were approached in person and were initially asked a few questions to detect if they fit the study's inclusion criteria, then they were inquired if they were willing to participate in the study.

If the patient met the inclusion criteria and agreed to participate, the first part of the questionnaire was administered via face-to-face interview by the researcher. The second part, which includes the adherence measurement scale, was self-reported by the patient. The data collection process took approximately 7 to 10 minutes per participant. No incentives were provided for participants.

The questionnaire consists of two sections, the first section includes demographic characteristics (such as gender, age, education level, smoking status, place of residence, and monthly income), clinical characteristics (such as type of diabetes, duration of diabetes, HbA1c test results, number of other chronic conditions, number of pills taken per day, side effects of oral antidiabetic medications, diabetes-related complications, frequency of hypoglycemia and hyperglycemia, and oral antidiabetic drugs used), and economic characteristics (including patient's health insurance type, cost-sharing percentage, and monthly medication expenditures).

Hypoglycemia was defined as a blood glucose level < 70 mg/dL, and hyperglycemia as > 180 mg/dL, in accordance with the American Diabetes Association (ADA) guidelines. Frequent hypoglycemia or hyperglycemia was defined as experiencing such episodes more than twice per week. Data such as HbA1c levels were reported by patients based on information previously provided to them by their healthcare providers, while data on episodes of hypoglycemia and hyperglycemia were reported by patients based on their own experiences.

Participants were asked to report their average monthly out-of-pocket spending on all medications, as well as on diabetes medications specifically. Additionally, they were asked to report the percentage of their medication costs that they personally paid out of pocket which was recorded as the cost-sharing percentage. The self-reported values were used as continuous variables in the analysis.

The second section includes adherence measurement scale. The adherence scale used in this questionnaire was Adherence to Refills and Medicines Scale for Diabetes (ARMS-D). It consists of 11 self-reporting adherence measurement questions, which measure the adherence of diabetic patients to their oral antidiabetic medications. The Adherence to Refills and Medications Scale (ARMS) was originally developed by Dr Kripalani et al in 2009 to assess adherence to medication taking and refilling among patients with chronic diseases.[19,20] ARMS is easily administered, with a high internal consistency (Cronbach's alpha = 0.814), reliability, and validity.[19] It was tested on many chronic conditions including coronary heart disease, dyslipidemia, hypertension, and diabetes mellitus.[19] ARMS is a 12-item self-reporting adherence measure that evaluates the ability of an individual to take and refill their prescribed medications. It consists of 2 subscales; an 8-item subscale that assesses medication taking and a 4-item subscale that assesses medication refills.[11] Responses to questions are scored from 1 (none of the time) to 4 (all of the time), and the total score can range from 12 to 48. Lower scores indicate higher levels of medication adherence.[11] ARMS is a generic tool used to evaluate patient adherence to any type of prescribed medications. A modified version, more specific to diabetes, was developed and named ARMS-D.[11]

Adherence to Refills and Medicines Scale for Diabetes (ARMS-D) is an 11-item valid and reliable self-reporting adherence measure with high internal consistency, which was measured with item- rest correlations and Cronbach's alpha (item-rest correlations 0.41–0.66; Cronbach's alpha = 0.86).[11] ARMS-D is an 11-item scale because one of the ARMS items was removed due to its low relevancy to adherence to diabetes medications.[11] Responses with "none of the time" are scored 1, "some of the time" are scored 2, "most of the time" are scored 3 and "all of the time" are scored 4. Total scores can range from 11 to 44, where higher total adherence scores correspond to lower adherence. A score of 11 represents perfect adherence, while a score of 44 represents the poorest level of adherence.[11] ARMS-D is easy to administer, can be understood by patients with different literacy levels, and provides an estimation of glycemic control as well.[11]

Statistical Analysis

The analysis was conducted using Statistical Package for the Social Sciences (SPSS) software version 22. Descriptive analysis was used to describe patient's demographics, clinical and economic characteristics. Categorical data was expressed as frequencies and percentages, whereas continuous data was expressed as means ± standard deviations. Normality of adherence data was tested using the Kolmogorov–Smirnov test and Shapiro–Wilk test. The extent to which patients are adherent to their OADs in the study sample was evaluated using the 11-item ARMS-D. We classified adherence as a dichotomous variable(full adherence, lower adherence): full adherence for scores of 11 and lower adherence for scores higher than 11.[21] Cost-sharing that patients pay out of their own pockets for their OADs was determined based on cost information collected from participants. The Chi-square and Fisher's exact tests were used as appropriate to compare differences in categorical variables between full adherence and lower adherence groups, whereas Mann–Whitney *U*-test was used for continuous variables. Additionally, simple linear and multivariable linear regression analyses were used to assess the determinants (demographic, clinical, and economic characteristics) associated with patient's adherence to their OADs. In the regression analysis, the continuous adherence score was used as the outcome variable to retain the full variability of adherence behavior. *P* values less than 0.05 were considered as statistically significant.

Results

A total of 400 patients were included in this study, with 67% being female and 33% male. Most participants (53.5%) were aged 51–65 years, and 31.8% were over 65 . As for education, over half (51.7%) had completed high school or below, while the remaining held higher degrees. The majority (81.5%) were non-smokers and 69.8% resided in Amman. In terms of income, 52% had a monthly income that is less than 500 JOD followed by 36% that had a monthly income ranging between 500 and 999 JOD.

The mean adherence score of participants was 14.15 ± 3.699, ARMS-D scores ranged from 11 to 29 points. Full adherence score (score=11) was achieved by 116 (29%) participants, while 284 (71%) participants reported lower adherence to OADs. None of the participants obtained an absolute nonadherence score of ARMS-D.

Table 1 displays demographic characteristics of the study sample and the differences in frequencies and percentages of patients in each adherence group, full adherence and lower adherence groups, according to their demographic characteristics. Patients in the lower adherence group had significantly higher levels of education (P = 0.021), whereas the P values of other demographic variables; gender, age, smoking status, place of residence, and monthly income were not significantly significant (P > 0.05).

Table 2 shows the clinical characteristics of the study sample and differences in frequencies and percentages of patients in each adherence group, full adherence and lower adherence groups, according to their clinical characteristics. The P value of frequent hyperglycemia was statistically significant, equal to 0.001, patients in the lower adherence group

Table 1 Comparison of Medications Adherence According to Demographic Characteristics

Demographic Variable	**All Participants**		**Full Adherence**		**Lower Adherence**		***P* Value**
	F (N=400)	**%**	**F (N=116)**	**%**	**F (N=284)**	**%**	
Gender							
Male	132	33%	39	33.6%	93	32.7%	0.866[A]
Female	268	67%	77	66.4%	191	67.3%	
Age (years)							
21–35	4	1%	0	0	4	1.4%	0.208[B]
36–50	55	13.8%	11	9.5%	44	15.5%	
51–65	214	53.5%	64	55.2%	150	52.8%	
> 65	127	31.8%	41	35.3%	86	30.3%	
Education							
High school or below	207	51.7%	73	62.9%	134	47.2%	**0.021[A]**
Diploma	80	20%	18	15.5%	62	21.8%	
Bachelor's degree	84	21%	16	13.8%	68	23.9%	
Postgraduate studies	29	7.2%	9	7.8%	20	7%	
Smoking status							
Yes	74	18.5%	16	13.8%	58	20.4%	0.121[A]
No	326	81.5%	100	86.2%	226	79.6%	
Place of residence							
Amman	279	69.8%	81	69.8%	198	69.7%	0.983[A]
Outside Amman	121	30.3%	35	30.2%	86	30.3%	

(*Continued*)

Table 1 (Continued).

Demographic Variable	All Participants		Full Adherence		Lower Adherence		*P* Value
	F (N=400)	%	F (N=116)	%	F (N=284)	%	
Monthly income (JD)							
< 500	208	52%	69	59.5%	139	48.9%	0.246[B]
500–999	144	36%	38	32.8%	106	37.3%	
1000–1499	33	8.3%	5	4.3%	28	9.9%	
1500–1999	3	0.8%	1	0.9%	2	0.7%	
> 2000	12	3%	3	2.6%	9	3.2%	

Notes: Chi – square[A] and Fischer Exact[B] tests were used (as appropriate) to estimate p values. Full adherence for scores of 11, lower adherence for scores higher than 11. Bold values indicate statistically significant differences (p < 0.05).
Abbreviations: F, Frequencies; %, Percentages; JD, Jordanian dinar.

Table 2 Comparison of Medications Adherence According to Clinical Characteristics

Clinical Variables	All Participants		Full Adherence		Lower Adherence		*P* Value
	F (N=400)	%	F (N=116)	%	F (N=284)	%	
Duration of diabetes							
< 1 year	43	10.8	16	13.8	27	9.5	0.504[A]
1–10 years	190	47.5	55	47.4	135	47.5	
11–20 years	107	26.8	31	26.7	76	26.8	
> 20 years	60	15	14	12.1	46	16.2	
HbA1c							
< 7	164	41	52	44.8	112	39.4	0.529[A]
7–7.9	97	24.3	30	25.9	67	23.6	
8–8.9	60	15	14	12.1	46	16.2	
≥ 9	79	19.8	20	17.2	59	20.8	
Number of comorbidities							
0	89	22.3	27	23.3	62	21.8	0.189[A]
1 or 2	257	64.3	79	68.1	178	62.7	
≥ 3	54	13.5	10	8.6	44	15.5	
Number of anti-diabetic medications							
1	199	49.8	56	48.3	143	50.4	0.338[A]
2	119	29.8	30	25.9	89	31.3	
3	70	17.5	25	21.6	45	15.8	
≥ 4	12	3	5	4.3	7	2.5	

(*Continued*)

Table 2 (Continued).

Clinical Variables	All Participants		Full Adherence		Lower Adherence		*P* Value
	F (N=400)	%	F (N=116)	%	F (N=284)	%	
Number of pills per day							
< 3	26	6.5	9	7.8	17	6	0.791[A]
3–5	116	29	30	25.9	86	30.3	
6–8	97	24.3	29	25	68	23.9	
> 8	161	40.3	48	41.4	113	39.8	
Number of anti-diabetic-medications side effects							
None	326	81.5	94	81	232	81.7	0.507[B]
1	44	11	16	13.8	28	9.9	
2	16	4	4	3.4	12	4.2	
3	10	2.5	2	1.7	8	2.8	
≥ 4	4	1	0	0	4	1.4	
Number of diabetes-related complications							
None	327	81.8	94	81	233	82	0.684[B]
1	53	13.3	18	15.5	35	12.3	
2	16	4	3	2.6	13	4.6	
≥ 3	4	1	1	0.9	3	1.1	
Frequent hypoglycemia							
Yes	66	16.5	17	14.7	49	17.3	0.525[A]
No	334	83.5	99	85.3	235	82.7	
Frequent hyperglycemia							
Yes	126	31.5	23	19.8	103	36.3	**0.001[A]**
No	274	68.5	93	80.2	181	63.7	

Notes: Chi – square[A] and Fischer Exact[B] tests were used (as appropriate) to estimate p values. Full adherence for scores of 11, lower adherence for scores higher than 11. Bold values indicate statistically significant differences ($p < 0.05$).
Abbreviations: HbA1c, glycated hemoglobin; F, Frequencies; P, Percentages.

were significantly experiencing frequent episodes of hyperglycemia, whereas the *P* values of other clinical variables; duration of diabetes, HbA1c, number of comorbidities, number of pills per day, number of anti-diabetic-medications side effects, number of diabetes-related complications, frequent hypoglycemia, and number of anti-diabetic medications were not statistically significant ($P > 0.05$).

Of the total number of patients (n = 400) who were taking OADs, metformin was the most frequently used medication. The majority of the participants (89.5%, n = 358) were using metformin, whereas 166 (41.5%) were taking Dipeptidyl-peptidase4-inhibitors (DPP-4i), 108 (27%) Sulfonylureas (SU), and 40 (10%) Sodium–glucose cotransporter 2 inhibitors (SGLT2i).

The most common side effect among participants was nausea, which was reported by 5.8% (n = 23) of total participants followed by dizziness, which was reported by 5% (n = 20) of participants. The most reported diabetes-related complication was eye problems (retinopathy), which presented in 10.5% (n = 42) of patients. The second most reported complications were foot problems and neuropathy, which presented in 3.8% (n = 15) and 3.5% (n = 14) of patients, respectively.

Table 3 shows the differences in means ± standard deviations and medians of patients in each adherence group, full adherence and lower adherence groups, according to their cost-sharing expenses. There was no significant differences between adherence groups(full adherence vs. lower adherence groups) in regard to average cost-sharing percentages, mean total medications' cost per month, and the mean diabetes medications' costs per month when analyzed by Mann–Whitney *U*-test.

Table 4 demonstrates simple linear regression analysis results for demographic and clinical factors concerning patients' adherence to OADs. Higher ARMS-D scores indicate lower patient adherence. The regression model in this table examines the relationship between various independent variables and ARMS-D scores. Therefore an inverse correlation between an independent variable and ARMS-D scores corresponds to a direct correlation with patient

Table 3 Comparison of Medications Adherence According to Cost-Sharing Expenses

Economic Variables	All Participants		Full Adherence		Lower Adherence		*P* Value
	Mean ± SD	Median	Mean ± SD	Median	Mean ± SD	Median	
Cost-sharing percentage	14.38 ± 8.71	15	14.59 ± 11.43	15.00	14.30 ± 7.33	15.00	0.879
Medication costs per month (JD)	22.62 ± 40.96	10	22.92 ± 40.76	10.00	22.497 ± 41.11	10.00	0.306
Diabetes medication costs per month (JD)	11.12 ± 22.64	5	11.01 ± 22.06	4.10	11.16 ± 22.9149	5.00	0.252

Notes: The Mann–Whitney *U*-test was used to estimate p-values. Full adherence for scores of 11, lower adherence for scores higher than 11.
Abbreviations: SD, Standard deviation; JD, Jordanian dinar.

Table 4 Simple Linear Regression Model Between Demographic and Clinical Factors Associated with Patients' Adherence to Oral Antidiabetic Drugs

Variables	Simple Linear Model	
	Beta- coefficient	*P* value
Gender		
Male	Reference	
Female	− 0.077	0.126
Age (years)		
> 65	Reference	
51–65	0.129	**0.019**
36–50	0.241	**0.000**
21–35	0.047	0.347
Education		
High school or below	Reference	
Diploma	0.142	**0.006**
Bachelor's degree	0.266	**0.000**
Postgraduate studies	0.028	0.568

(*Continued*)

Table 4 (Continued).

Variables	Simple Linear Model	
	Beta- coefficient	*P* value
Smoking status		
Yes	Reference	
No	− 0.078	0.118
Place of residence		
Amman	Reference	
Outside Amman	− 0.006	0.903
Monthly income (JD)		
< 500	Reference	
500–999	0.113	**0.029**
1000–1499	0.181	**0.000**
1500–1999	0.025	0.618
> 2000	0.037	0.455
Duration of diabetes		
< 1 year	Reference	
1–10 years	− 0.043	0.612
11–20 years	− 0.104	0.193
> 20 years	− 0.061	0.396
HbA1c		
< 7	Reference	
7–7.9	0.001	0.984
8–8.9	− 0.036	0.508
≥ 9	0.054	0.321
Number of comorbidities		
0	Reference	
1 or 2	− 0.033	0.573
≥ 3	− 0.054	0.366
Number of pills per day		
< 3	Reference	
3–5	− 0.039	0.685
6–8	− 0.164	**0.078**
> 8	− 0.276	**0.007**

(*Continued*)

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Table 4 (Continued).

Variables	Simple Linear Model	
	Beta- coefficient	***P* value**
Number of anti-diabetic-medications side effects		
None	Reference	
1	0.046	0.352
2	0.073	0.141
≥ 3	0.149	**0.003**
Number of diabetes-related complications		
None	Reference	
1	− 0.061	0.277
2	0.028	0.583
≥ 3	− 0.033	0.510
Frequent hypoglycemia		
Yes	Reference	
No	− 0.031	0.534
Frequent hyperglycemia		
Yes	Reference	
No	− 0.093	0.062
Number of anti-diabetic medications		
1	Reference	
2	− 0.046	0.389
3	− 0.065	0.222
≥ 4	− 0.026	0.615

Notes: Bold values indicate statistically significant differences ($p < 0.05$).
Abbreviations: JD, Jordanian dinar; HbA1c, glycated hemoglobin.

adherence, and vice versa. One of the demographic factors that significantly affects patients' adherence is patients' age. Patients aged 51 to 65 years (Beta = 0.129, P = 0.019) and patients aged 36 to 50 (Beta = 0.241, *P* = 0.000) showed lower adherence compared to patients aged more than 65 years old. Another significant factor is the education level. Patients that hold a diploma degree (Beta = 0.142, *P* = 0.006) and patients that hold bachelor's degree (Beta = 0.266, *P* = 0.000) were less likely to adhere to their oral antidiabetic drugs compared to participants that had completed high school or below. Also, another significant factor is monthly income. Participants that had a monthly income ranging between 500 and 999 JOD (Beta = 0.113, *P* = 0.029) and a monthly income ranging between 1000 and 1499 JOD (Beta = 0.181, *P* = 0.000) tend to adhere less compared to those with a monthly income that is less than 500 JOD. Whereas gender, smoking status, and place of residence do not significantly affect adherence ($P > 0.05$).

One of the significant factors among clinical variables that is associated with patients' adherence to OADs is the number of pills per day. Patients who took more than eight pills per day (Beta = - 0.276, *P* = 0.007) tend to adhere more to their medications compared to those who took less than 3 pills per day. Another significant factor is the number of antidiabetic-medications side effects. Patients experiencing 3 or more side effects (Beta = 0.149, P = 0.003) showed lower adherence to their OADs compared to those who did not experience any side effects.

Table 5 displays the results of a simple linear regression analysis examining cost-related factors assocaited with patients' adherence to thier OADs. Cost-sharing percentage, total monthly medication costs and diabetes medication costs per month were not significant factors influencing adherence ($P > 0.05$).

Table 6 illustrates results from multiple linear regression analysis of the factors concerning patients' adherence to OADs. A backward stepwise approach was adopted to generate the final model with an R square value of 0.128 . The results of this model indicated that age, education level, number of pills per day, number of anti-diabetic-medications side effects and frequent hyperglycemia were significant determinants of adherence to OADs among diabetic patients.

Table 5 Simple Linear Regression Model Between Cost-Related Factors and Patients' Adherence to Oral Antidiabetic Drugs

Economic Variables	Simple Linear Model	
	B- coefficient	***P* Value**
Cost-sharing percentage	− 0.010	0.845
Medication costs per month (JD)	− 0.044	0.380
Diabetes medication costs per month (JD)	− 0.022	0.662

Table 6 Multiple Regression Model Between Independent Factors and Patients' Adherence to Oral Antidiabetic Drugs

Variables	Multivariable Model	
	Beta- coefficient	***P* Value**
Age (years)		
> 65	Reference	
51–65	-	-
36–50	0.113	0.020
21–35	-	-
Education		
High school or below	Reference	
Diploma	0.130	0.008
Bachelor's degree	0.220	0.000
Postgraduate studies	-	-
Number of pills per day		
< 3	Reference	
3–5	-	-
6–8	− 0.124	0.021
> 8	− 0.202	0.000

(*Continued*)

Table 6 (Continued).

Variables	Multivariable Model	
	Beta- coefficient	*P* Value
Number of anti-diabetic-medications side effects		
None	Reference	
1	-	-
2	-	-
≥ 3	0.095	0.047
Frequent hyperglycemia		
Yes	Reference	
No	− 0.121	0.011

Notes: A dash (-) indicates that the category was excluded during backward stepwise regression (removal criterion: p > 0.05). Beta-coefficients and P-values are reported only for categories retained in the final model.

Discussion

The current study found that 71% of participants reported lower adherence to their OADs, while 29% achieved full adherence, when measured by ARMS-D. The results of this study did not show any significant association between adherence to OADs and cost-sharing. However, demographic factors, such as age and education, were significantly affecting patients' adherence to OADs. Moreover, clinical factors, such as the number of pills that patients take per day, number of anti-diabetic-medications side effects, and frequent episodes of hyperglycemia, were significantly affecting adherence to OADs.

In contrast to our findings, many studies have found that an increase in patients' cost-sharing negatively impacts patients' adherence to their medications.[15,22,23] However, according to our present study, we found no significant association between adherence to oral antidiabetic medications and cost-sharing among patients with type 2 diabetes. This may be related to cultural and social factors among Jordanian participants, as most patients believe that drugs expenditures have a priority over other expenditures. According to Basheti et al,[24] total health care expenditure in Jordan was estimated to be about 8% as a percentage of gross domestic product (GDP) in 2017. Further, Nazer and Tuffaha[25] reported that almost one-fourth of the total health care expenditure is spent on medications, which is considered high for a middle- income country. Additionally, the relatively low cost-sharing percentage reported by patients in our study setting may explain the absence of a significant association between cost-sharing and medication adherence.

Among demographic factors in this study, age, education level, and monthly income were significantly affecting patients' adherence to OADs when analyzed by simple linear regression. However, when analyzed by multiple linear regression, only age and educational level were significantly affecting patients' adherence to OADs. Our study results showed that older adults were more likely to show better adherence to their OADs. This result may be associated with the exclusive care and support that elderly patients receive, which concludes in better levels of adherence. This finding is consistent with previous studies.[1,26,27] For example, Arvanidakshan et al[1] reported an improvement in diabetic patients' adherence to OADs with increasing age. Similarly, Aloudah et al[27] determined that older patients were significantly more adherent to OADs. Also, Huber & Reich[26] suggested a significant impact of age on the adherence to OADs, they stated that patients in the age group (75–84 years) were two times more likely to be adherent compared with patients aged 18–44 years. In contrast, Asheq et al[28] reported that the degree of adherence to antidiabetic medications decline with increasing age. Regarding the educational level, our study revealed that lower literacy patients reported higher levels of adherence to their OADs. It seems possible that these results may be related to the fact that participants with higher educational levels had a greater capability to clarify the actual case and true reality as they were more self-aware when describing their behavior toward medication taking in regard to what was prescribed. These findings were opposing Kassahun et al[29] outcomes, which stated that lower educated patients were less adherent to antidiabetic medications.

Among clinical factors studied in this study, the number of pills that patients take per day and the number of anti-diabetic-medications side effects were significantly associated with adherence to OADs when analyzed by simple linear regression. However, when analyzed by multiple linear regression, the number of pills that patients take per day, the number of anti-diabetic-medications side effects together with frequent episodes of hyperglycemia were significantly associated with patients' adherence to OADs. According to our results, a positive relationship between the number of pills that patients take per day and their adherence to OADs was reported. This may be a result of patients' excessive care and the tools they use, such as pill organizers or pill reminder apps, when they are prescribed a higher number of pills. This finding is contrary to that of Bhusal et al,[30] who found that lower number of pills increased patients' adherence to their medications. Additionally, our results demonstrated that patients who experience higher number of anti-diabetic-medications side effects were more likely to be less adherent to their medications. An explanation to this factor may be attributed to the practice of avoiding, as people tend to avoid negative experiences. These findings are similar to those obtained by Kassahun et al,[29] who found that diabetic patients experiencing side effects with their antidiabetic drugs show lower levels of adherence to their medications. Furthermore, the present study revealed that patients with frequent episodes of hyperglycemia were less adherent to their OADs. One possible explanation for this finding is that uncontrolled blood sugar levels could be a result of patients' nonadherence to their prescribed medications.

This study provides new insights into medication adherence among patients with type 2 diabetes in Jordan, contributing valuable evidence to the growing body of research in the region. Unlike many previous studies that emphasized economic factors such as cost-sharing as primary barriers to adherence, our findings reveal that demographic and clinical factors play a more significant role in adherence behavior. The lack of a significant association between cost-sharing and adherence contrasts with some global studies, suggesting that financial barriers may be less critical in this context.

Implications for Practice

The study findings contribute to our understanding of the factors that influence patients' adherence to their medications; by determining these factors we can enhance the overall level of adherence to medications, resulting in better clinical outcomes and lower costs. The findings of this study have significant suggestions for healthcare professionals aiming to improve patients' adherence to their prescribed medications.

These findings have a number of significant implications for future practice. The outcomes highlight the importance of taking into consideration factors that lead to lower adherence when prescribing medications. Hence, healthcare providers should focus on younger patients who show lower levels of adherence. Also, attention should be allocated to raising awareness about medications side effects; patients should be informed about the side effects that could occur after taking their medications, and they must be aware of the importance of adherence to their prescribed regimen.

Implications for Research

Given the lack of a significant association between cost-sharing and adherence in our study, further research is needed to explore the contexts in which financial barriers most impact medication taking behavior. This study provides a valuable starting point for future research to contribute to a better understanding of adherence behavior by exploring additional influences such as psychological, behavioral, and system-level factors.

Implications for Policy

While reducing financial barriers remains important, policymakers should also invest in support services that help patients manage their treatment more effectively. Such comprehensive approaches can help improve adherence and overall health outcomes among patients with type 2 diabetes in Jordan.

Limitations of the Study

A limitation of this study is that the generalizability of the results is restricted to diabetic patients attending Jordan University Hospital (JUH). We suggest that further research with multiple sites should be carried out to confirm the generalization of our findings. In addition, the measurement tool for adherence (ARMS-D) was self-reported by patients so information could be biased by social desirability or recall biases, where participants tend to show themselves in a better manner or they cannot fully remember information. We recommend in future investigations using more than one tool to measure adherence rather than using self-reporting measures only to avoid any bias. Furthermore, we suggest that future studies should explore other potential factors that may influence medication adherence.

Despite these limitations, the study provides valuable insight into the real-world patterns of medication adherence in a public healthcare setting. The use of a validated adherence scale (ARMS-D) and inclusion of relevant clinical and demographic variables enhance the credibility of the findings. These results may guide the development of tailored strategies to improve adherence among patients with type 2 diabetes in comparable healthcare environments.

Conclusion

The results of this study indicated that adherence to OAD is primarily related to patients' characteristics rather than economic factors. Specifically, older patients, lower educated patients, those who take more medications, and those who experience fewer side effects were more likely to adhere to their medications. No significant association was found between cost-sharing and the level of adherence. These findings highlight the need for targeted interventions that address clinical complexity and individual patient characteristics rather than focusing solely on financial barriers. Tailoring support based on age, education, and clinical burden may improve adherence and, ultimately, health outcomes in patients with type 2 diabetes. These results are encouraging in that the economic factor may not be a significant barrier to adherence to OAD in Jordan. However, the findings should be interpreted cautiously, given the study's limitations.

Data Sharing Statement

The data that supports the findings of this study are available from the corresponding author upon reasonable request.

Disclosure

The authors report no conflicts of interest in this work.

References

1. Aravindakshan R, Abraham SB, Aiyappan R. Medication adherence to oral hypoglycemic drugs among individuals with type 2 diabetes mellitus–a community study. *Indian J Community Med*. 2021;46(3):503–507. doi:10.4103/ijcm.IJCM_985_20
2. Piragine E, Petri D, Martelli A, Calderone V, Lucenteforte E. Adherence to oral antidiabetic drugs in patients with type 2 diabetes: systematic review and meta-analysis. *J Clin Med*. 2023;12(5):1981. doi:10.3390/jcm12051981
3. Almomani MH, Al-Tawalbeh S. Glycemic control and its relationship with diabetes self-care behaviors among patients with type 2 diabetes in Northern Jordan: a cross-sectional study. *Patient Prefer Adherence*. 2022;16:449–465. doi:10.2147/ppa.S343214
4. National Center for Diabetes,Endocrinology and Genetics; 2025. Available from: https://ncd.org.jo/. Accessed March 22, 2025.
5. Kim NH, Look KA. the effect of reduced drug copayments on adherence to oral diabetes medications among childless adults in Wisconsin Medicaid. *J Manag Care Spec Pharm*. 2019;25(12):1432–1441. doi:10.18553/jmcp.2019.25.12.1432
6. Xie X, Wu C, Hao Y, et al. Benefits and risks of drug combination therapy for diabetes mellitus and its complications: a comprehensive review. *Front Endocrinol*. 2023;14:1301093. doi:10.3389/fendo.2023.1301093
7. Ebid A-HI, Mobarez MA, Ramadan RA, Mahmoud MA. Impact of a clinical pharmacist intervention program on the follow-up of type-2 diabetic patients. *Hospital Pharmacy*. 2020;57(1):76–82. doi:10.1177/0018578720973881
8. Saundankar V, Peng X, Fu H, et al. Predictors of change in adherence status from 1 year to the next among patients with type 2 diabetes mellitus on oral antidiabetes drugs. *J Manag Care Spec Pharm*. 2016;22(5):467–482. doi:10.18553/jmcp.2016.22.5.467
9. Bibeau WS, Fu H, Taylor AD, Kwan AY. Impact of out-of-pocket pharmacy costs on branded medication adherence among patients with type 2 diabetes. *J Manag Care Spec Pharm*. 2016;22(11):1338–1347. doi:10.18553/jmcp.2016.22.11.1338
10. Farhat R, Assaf J, Jabbour H, et al. Adherence to oral glucose lowering drugs, quality of life, treatment satisfaction and illness perception: a cross-sectional study in patients with type 2 diabetes. *Saudi Pharm J*. 2019;27(1):126–132. doi:10.1016/j.jsps.2018.09.005
11. Mayberry LS, Gonzalez JS, Wallston KA, Kripalani S, Osborn CY. The ARMS-D out performs the SDSCA, but both are reliable, valid, and predict glycemic control. *Diabet Res Clin Pract*. 2013;102(2):96–104. doi:10.1016/j.diabres.2013.09.010
12. Basu S, Garg S, Sharma N, Singh MM. Improving the assessment of medication adherence: challenges and considerations with a focus on low-resource settings. *Ci Ji Yi Xue Za Zhi*. 2019;31(2):73–80. doi:10.4103/tcmj.tcmj_177_18
13. Peh KQE, Kwan YH, Goh H, et al. An adaptable framework for factors contributing to medication adherence: results from a systematic review of 102 conceptual frameworks. *J Gen Intern Med*. 2021;36(9):2784–2795. doi:10.1007/s11606-021-06648-1
14. Al-Obaidi S, Hijazeen R, Arabyat RM, Alabbadi I. Adherence to oral anticoagulants in patients with non-valvular atrial fibrillation: the role of patients' characteristics and out-of-pocket payments. *Expert Rev Pharmacoecon Outcomes Res*. 2024;24(7):845–852. doi:10.1080/14737167.2024.2377663

15. Thornton Snider J, Seabury S, Lopez J, McKenzie S, Goldman DP. Impact of type 2 diabetes medication cost sharing on patient outcomes and health plan costs. *Am J Manag Care*. 2016;22(6):433–440.
16. Xie Z, Liu K, Or C, Chen J, Yan M, Wang H. An examination of the socio-demographic correlates of patient adherence to self-management behaviors and the mediating roles of health attitudes and self-efficacy among patients with coexisting type 2 diabetes and hypertension. *BMC Public Health*. 2020;20(1):1227. doi:10.1186/s12889-020-09274-4
17. Eaddy MT, Cook CL, O'Day K, Burch SP, Cantrell CR. How patient cost-sharing trends affect adherence and outcomes: a literature review. *P t*. 2012;37(1):45–55.
18. Khurma M. CUEMATH. Available from: https://www.cuemath.com/sample-size-formula/. Accessed 4, October 2024.
19. Kripalani S, Risser J, Gatti ME, Jacobson TA. Development and evaluation of the Adherence to Refills and Medications Scale (ARMS) among low-literacy patients with chronic disease. *Value Health*. 2009;12(1):118–123. doi:10.1111/j.1524-4733.2008.00400.x
20. Algarni MA, Althobiti MS, Alghamdi SA, et al. Medication Non-Adherence among Patients with Chronic Diseases in Makkah Region. *Pharmaceutics*. 2022;14(10):2010. doi:10.3390/pharmaceutics14102010
21. Khan M, Michelson S, Newman-Casey PA, Woodward MA. Medication adherence among patients with corneal diseases. *Cornea*. 2021;40 (12):1554–1560. doi:10.1097/ico.0000000000002680
22. Nelson DR, Heaton P, Hincapie A, Ghodke S, Chen J. Differential cost-sharing undermines treatment adherence to combination therapy: evidence from diabetes treatment. *Diabetes Ther*. 2021;12(8):2149–2164. doi:10.1007/s13300-021-01098-8
23. Tunceli K, Zhao C, Davies MJ, et al. Factors associated with adherence to oral antihyperglycemic monotherapy in patients with type 2 diabetes. *Patient Prefer Adherence*. 2015;9:191–197. doi:10.2147/ppa.S71346
24. Basheti IA, Mhaidat NM, Alqudah R, Nassar R, Othman B, Mukattash TL. Primary health care policy and vision for community pharmacy and pharmacists in Jordan. *Pharm Pract*. 2020;18(4):2184. doi:10.18549/PharmPract.2020.4.2184
25. Nazer LH, Tuffaha H. Health care and pharmacy practice in Jordan. *Can J Hosp Pharm*. 2017;70(2):150–155. doi:10.4212/cjhp.v70i2.1649
26. Huber CA, Reich O. Medication adherence in patients with diabetes mellitus: does physician drug dispensing enhance quality of care? Evidence from a large health claims database in Switzerland. *Patient Prefer Adherence*. 2016;10:1803–1809. doi:10.2147/ppa.S115425
27. Aloudah NM, Scott NW, Aljadhey HS, Araujo-Soares V, Alrubeaan KA, Watson MC. Medication adherence among patients with Type 2 diabetes: a mixed methods study. *PLoS One*. 2018;13(12):e0207583. doi:10.1371/journal.pone.0207583
28. Asheq A, Ashames A, Al-Tabakha M, Hassan N, Jairoun A. Medication adherence in type 2 diabetes mellitus patients during Covid-19 pandemic: a cross-sectional study from the United Arab Emirates. *F1000Res*. 2021;10:435. doi:10.12688/f1000research.51729.2
29. Kassahun A, Gashe F, Mulisa E, Rike WA. Nonadherence and factors affecting adherence of diabetic patients to anti-diabetic medication in Assela General Hospital, Oromia Region, Ethiopia. *J Pharm Bioallied Sci*. 2016;8(2):124–129. doi:10.4103/0975-7406.171696
30. Bhusal L, Deep Pathak B, Dhakal B, et al. Determination of level of self-reported adherence of antihypertensive drug(s) and its associated factors among patient with hypertension at a tertiary care center. *J Clin Hypertens*. 2022;24(11):1444–1450. doi:10.1111/jch.14592