Patient Preference and Adherence

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ORIGINAL RESEARCH

Medication Adherence and Its Associated Determinants in Older Adults with Type 2 Diabetes and Cardiovascular Comorbidities

Ahmad Al-Azayzih[1], Roaa J Kanaan[1], Shoroq M Altawalbeh[1], Walid Al-Qerem[2], Saja Smadi[1]

[1]Department of Clinical Pharmacy, Faculty of Pharmacy, Jordan University of Science and Technology, Irbid, Jordan; [2]Department of Pharmacy, Faculty of Pharmacy, Al-Zaytoonah University of Jordan, Amman, Jordan

Correspondence: Ahmad Al-Azayzih, Clinical Pharmacy Department, Faculty of Pharmacy-Jordan University of Science and Technology, Irbid, 22110, Jordan, Email aaazayzih@just.edu.jo

Aims of the Study: To evaluate medication adherence level and identify predictors of poor medication adherence in elderly patients with Cardiovascular (CVS) diseases and type 2 diabetes in Jordan.

Methods: This cross-sectional study was conducted on elderly patients who attended King Abdullah University Hospital (KAUH) outpatient diabetes and cardiology clinics from March 6, 2023, to July 6, 2023. Data on age, sex, socio-demographics, biological variables, medication characteristics, and chronic comorbidities were obtained from electronic patients' medical records and a validated questionnaire. Medication adherence levels (low, moderate, and high) were assessed using the Arabic version of the 4-item Morisky, Green, and Levine Medication Adherence Scale-Medication Assessment Questionnaire.

Results: Data from 506 elderly patients were analyzed. The average age of the participants was 67.93 years (SD = 6.22). 7.9% of patients showed low adherence levels, 33.6% showed moderate adherence level, and 58.5% of patients showed a high level of adherence toward their prescribed medications. Multivariable ordinal logistic regression analysis revealed that single/currently unmarried patients and patients who were living with others were more likely to have a higher adherence level; Odd Ratios (ORs) were 4.75 and 4.10, respectively. Patients who took their medications ≥ 3 and 2 times a day showed higher adherence to their medications than those who only took them once a day.; ORs were 2.15 and 2.36, respectively.

Conclusion: This study indicated an inadequate level of adherence among patients with type 2 diabetes and cardiovascular comorbidities. This study revealed the necessity of implementing programs to help in raising the awareness among elderly patients with type 2 diabetes and CVDs of the importance of adherence to prescribed long-term medication regimens.

Keywords: diabetes, medication adherence, elderly, cardiovascular diseases, geriatrics, Jordan

Introduction

Chronic medical conditions, including type 2 diabetes and cardiovascular diseases (CVDs), are common among elderly patients worldwide. According to previous estimates, studies found that–50–99% of patients aged ≥ 60 years presented with at least two chronic medical conditions in which cardiovascular diseases topped the chronic morbidities in this population.[1] A large–scale survey conducted in the USA on elderly patients found that CVD commonly coincided with diabetes mellitus disease (37.1–47.1%).[2]

Elderly individuals with CVD and Diabetes usually have other aging-associated conditions, including geriatric syndromes (GSs), defined as impaired organ physiological functions due to the augmented cumulative effects of multiple diseases on organ functions.[3] Elderly patients could experience more than GSs during their lifetime leading to higher risk of frailty, falls, and cognitive functions impairments.[4–6] Reports have linked such manifestations to a decline in physiological organ functions and frequent use of medications for various types of GSs in the elderly patients.[7,8]

The treatment of CVD and diabetes in elderly patients usually involves various medications to control blood glucose levels as well as different symptoms related to CVD. Such intensive drug therapy in the elderly undoubtedly leads to

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polypharmacy. Polypharmacy refers to the simultaneous administration of multiple medications (≥ 5 medications concurrently).[9,10] While prescribing multiple medications is generally necessary for obtaining clinical benefits in these patients, polypharmacy can lead to a significant drug burden and rising concern for developing drug-related problems. Polypharmacy is a highly prevalent issue in elderly subjects and is generally linked to health-related negative consequences in older adults, including non-or poor medication adherence, drug interactions and adverse drug events, increased number of hospitalizations, and increased level of mortality.[11–13]

Medication-dependent approaches are considered the mainstay of treatment for CVD and diabetes. CVD and antidiabetic medications are frequently prescribed to individuals worldwide, especially geriatric populations. Adherence to medication regimens to control chronic disease-related negative manifestations is becoming increasingly complicated for elderly individuals with multiple morbidities. Many factors have been identified to be associated with lack of proper medications adherence in patients. These factors are classified into healthcare system-related factors (eg, lack of accessibility to healthcare facilities), patient-specific personal factors (intentional and non-intentional), socio-economic-related factors, psychosocial factors and medication-related factors (eg, cost and adverse drug reactions).[14–16]

Identifying and addressing these barriers are crucial for improving adherence and patient outcomes. Ensuring consistent medication adherence among older patients with chronic diseases remains a major challenge. Non-adherence can lead to negative outcomes such as therapeutic failure and futile disease control, higher rates of hospital readmissions due to medication-related issues, need for additional medical or surgical procedures, and increased healthcare expenses.[17–19]

This study aimed to examine and identify the prevalence of medications non-adherence, evaluate the degree of non-adherence, and identify the factors that influence medication non-adherence in elderly patients with coexisted type 2 diabetes mellitus and other CVDs, including hypertension, ischemic heart disease, heart failure, and cardiac arrhythmia. It is noteworthy that limited studies in Jordan have investigated non-adherence issues in the geriatric population in general and have not evaluated the prevalence and associated factors leading to poor adherence among elderly patients with CVD and diabetes.

Methods

Study Design and Population

A cross-sectional study was conducted on 506 patients who attended King Abdullah University Hospital (KAUH) outpatient diabetes and cardiology clinics from March 6, 2023, to July 6, 2023. Patients' data collection was accomplished by using a structured questionnaire and electronic medical records. During the data collection phase, the study included patients aged 60 years and older who had a confirmed diagnosis of type 2 diabetes mellitus (DM) and diagnosed with at least one cardiovascular disease (CVD). CVDs included in this study were hypertension, acute coronary syndrome (ACS), atrial fibrillation, venous thromboembolism, heart failure and cardiomyopathy, and rheumatic valvular heart disease. Participation in the study was voluntary, and the patients provided their consent by signing a consent form. However, patients without any diagnosed cardiovascular disease or those not taking any medication specifically intended for their type 2 diabetes and cardiovascular conditions were excluded from the study.

Measurements

Sociodemographic data, including marital status, and living conditions, were collected through a survey. Medical records were used to collect age, gender, biomedical data, including measurements of serum creatinine, creatinine clearance, fasting blood sugar (FBS), random blood sugar (RBS), glycosylated hemoglobin (HbA1C), low-density lipoprotein (LDL), high-density lipoprotein (HDL), total cholesterol, triglycerides, hemoglobin, systolic blood pressure (SBP), and diastolic blood pressure (DBP). Additionally, patients' medications details and medical characteristics were obtained from their hospital electronic medical records.

Adherence Instrument

The Arabic version of the 4-item Morisky, Green, and Levine Medication Adherence Scale-Medication Assessment Questionnaire (MGL-MAG) was used to previously validated,[20,21] was used. It consists of four questions that help determine the level of medication adherence. Patients were categorized into three levels based on their responses to these questions.

If the patient answered "NO" to all four questions, they were considered to have high adherence, indicating that the patient reported not forgetting their medication, did not alter the dose, and did not stop the medication without consulting a health care provider. Conversely, if the patient answered "YES" to one or two questions, they were categorized as having moderate adherence. This suggests that patients may occasionally forget their medication or make slight alterations to the dosing regimen but not to a significant extent. If the patients answered "YES" to three or more questions, they were classified as having low adherence. This implies that patients frequently forget to take their medication, intentionally skip doses, or make significant changes to their dosing regimens without medical advice.

Sample Size Calculation

To ensure the reliability and accuracy of our study outcomes, we calculated the sample size using the Krejcie and Morgan formula. This calculation aimed to achieve statistically meaningful results with a consistent level of confidence and a small margin of error. The formula considers target confidence level of 95% and margin of error of 5%. Based on this calculation, we determined that a minimum of 385 subjects was required for our study.[22]

Statistical Analysis

Data analysis was performed using the SPSS Software version 23. Descriptive statistics were used to present frequencies and percentages for categorical variables. Continuous variables are represented as the mean (SD) or median (IQR), depending on their normality. To evaluate variations in patient characteristics across different levels of adherence, one-way ANOVA, Kruskal–Wallis test, and chi-square test were conducted as appropriate. Multivariable ordinal logistic regression was used to assess the factors associated with medication adherence. The variables were selected using a backward stepwise process ($P<0.2$ to stay). Statistical significance was set at a 2-sided P value of less than 0.05.

Ethical Approval

The study protocol was approved by the Institutional Review Board of Jordan University of Science and Technology. (Ref. # KA53/151/2022). Informed consent was obtained (written) from all the included study participants. This study complies with the Declaration of Helsinki.

Results

A total of 506 patients aged ≥ 60 years with diabetes and at least one cardiovascular disease were included in this study. The average age was 67.93 (SD = 6.22) years. The gender distribution was almost balanced with females, accounting for 51.20% of the participants; 83.20% were married, the majority (93.28%) of participants were not living alone, and 57.31% resided in the city. A large proportion (92.89%) were retired or unemployed, with only 22.33% engaged in physical activities, and 57.50% had a family history of diabetes.

Regarding the distribution of patients according to their medication adherence, 55.10% of married patients exhibited high adherence compared to 74.10% of unmarried individuals. Furthermore, among individuals with college/university education, 63.10% exhibited high adherence compared to 55.8% in participants with less than a college education, and 4.28% demonstrated low adherence compared to 10% in participants with less than a college education (P=0.029) (Table 1).

Among the comorbid cardiovascular conditions observed in the study participants, hypertension was the most prevalent, affecting 94.1% of individuals. 44.9% had acute coronary syndrome (ACS), including angina or myocardial infarction (MI). Other cardiovascular diseases were present in smaller proportions, with atrial fibrillation noted in 9.3% of cases and cerebrovascular accidents (CVAs) in 5.1% of cases (Table 2).

Table 1 Socio-Demographic Characteristics of the Study Participants

Variable	Total Population (n=506)		The 4-item Morisky, Green, and Levine Medication Assessment Questionnaire (MGL-MAG)			P-value*
			High Adherence (n= 296)	Moderate Adherence (n= 170)	Low Adherence (n= 40)	
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Age		67.93 (6.22)	68.14 (6.09)	67.86 (6.38)	66.67 (6.39)	0.161
	Category	N (%)	N (%)	N (%)	N (%)	
Gender	Male	247 (48.80)	141 (57.1)	84 (34.00)	22 (8.90)	0.670
	Female	259 (51.20)	155 (59.80)	86 (33.20)	18 (6.91)	
Body mass index (kg/m2)	Normal (≤24.9)	58 (11.46)	32 (55.17)	16 (27.59)	10 (17.24)	0.654
	Overweight (25–29.9)	184 (36.36)	104 (56.50)	66 (35.90)	14 (7.60)	
	Obese (≥30)	264 (52.18)	159 (60.20)	87 (33.00)	18 (6.80)	
Marital status	Married	421 (83.20)	232 (55.10)	152 (36.10)	37 (8.80)	0.003
	Single/other	85 (16.80)	63 (74.10)	18 (21.20)	4 (4.70)	
Living conditions	Not living alone	472 (93.28)	278 (58.90)	157 (33.30)	37 (7.80)	0.614
	Living alone	34 (6.72)	16 (47.06)	13 (38.23)	5 (14.71)	
Residency	City	290 (57.31)	78 (36.60)	91 (31.40)	23 (6.90)	0.253
	Countryside	216 (42.69)	117 (54.17)	79 (36.57)	20 (9.26)	
Educational level	College/university	187 (36.96)	118 (63.10)	61 (32.62)	8 (4.28)	0.029
	Less than college	319 (63.04)	178 (55.80)	109 (34.20)	32 (10.00)	
Job Status	Retired/Unemployed	470 (92.89)	279 (59.40)	153 (32.60)	38 (8.10)	0.118
	Employed	36 (7.11)	17 (47.22)	17 (47.22)	2 (5.56)	
Monthly income	More than 1000 JD*	37 (7.31)	21 (56.76)	12 (32.43)	4 (10.81)	0.176
	500–1000 JD*	139 (27.47)	87 (62.60)	47 (33.80)	5 (3.60)	
	Less than 500 JD*	330 (65.22)	188 (57.00)	110 (33.30)	32 (9.70)	
Smoking status	Yes	102 (20.20)	51 (50.00)	42 (41.20)	9 (8.80)	0.143
	No	404 (79.80)	245 (60.60)	128 (31.70)	31 (7.70)	
Physical activities	Yes	113 (22.33)	72 (63.70)	36 (31.90)	5 (4.40)	0.220
	No	393 (77.67)	224 (57.00)	134 (34.10)	35 (8.90)	
Family history of Diabetes Miletus	Yes	291 (57.50)	162 (55.70)	106 (36.40)	23 (7.90)	0.278
	No	215 (42.50)	134 (62.30)	64 (29.80)	17 (7.90)	

Note: *Statistically significance was set at P <0.05.
Abbreviations: SD, Standard Deviation; JD, Jordanian Dinar.

The results showed that in addition to CVS comorbidities existed in study participants, the three most common diseases were dyslipidemia (65%), rheumatoid arthritis (12.3%), and gout (10.5%). Furthermore, a significant difference in adherence levels was found among patients with dyslipidemia. 62.6% of patients with dyslipidemia had high adherence compared to 50.8% of those without dyslipidemia (P<0.001).

Table 2 Cardiovascular (CVS) Disease Characteristics of the Study Participants

Cardiovascular Disease	Category		Morisky, Green, and Levine Medication Assessment Questionnaire (MGL-MAG)			P value*
			High Adherence (n= 296)	Moderate Adherence (n= 170)	Low Adherence (n= 40)	
		N (%)	N (%)	N (%)	N (%)	
Hypertension	YES	476 (94.1)	280 (58.8)	159 (33.4)	37 (7.8)	0.814
	NO	30 (5.9)	16 (53.3)	11 (36.7)	3 (10)	
Acute coronary syndrome (ACS)	YES	227 (44.9)	124 (54.6)	81 (35.7)	22 (9.7)	0.197
	NO	279 (55.1)	172 (61.6)	89 (31.9)	18 (6.5)	
Heart Failure (HF)	YES	48 (9.5)	23 (47.9)	21 (43.8)	4 (8.3)	0.266
	NO	458 (90.5)	273 (59.6)	149 (32.5)	36 (7.9)	
Atrial Fibrillation (AFib)	YES	47 (9.3)	26 (55.3)	17 (36.2)	4 (8.5)	0.898
	NO	459 (90.7)	270 (58.8)	153 (33.3)	36 (7.8)	
Cerebrovascular Accidents (CVAs)	YES	26 (5.1)	14 (53.8)	8 (30.8)	4 (15.4)	0.350
	NO	480 (94.9)	282 (58.8)	162 (33.8)	36 (7.5)	
Venous Thromboembolism (VTE)	YES	9 (1.8)	4 (44.4)	4 (44.4)	1 (11.1)	0.688
	NO	497 (98.2)	292 (58.8)	166 (33.4)	39 (7.8)	
Cardiomyopathy	YES	8 (1.6)	3 (37.5)	3 (37.5)	2 (25)	0.161
	NO	498 (98.4)	293 (58.8)	167 (33.5)	38 (7.6)	
Rheumatic valvular heart disease	YES	1 (0.2)	0 (0)	0 (0)	1 (100)	0.003
	NO	505 (99.8)	296 (58.6)	170 (33.7)	39 (7.7)	

Note: *Statistically significance was set at P <0.05.

Among patients with Liver Disease, 50.0% exhibited high adherence, 20.0% displayed moderate adherence, and 30.0% demonstrated low adherence, compared to 58.7%, 33.9%, and 7.5%, respectively, in patients without liver disease (Table 3).

Biomedical characteristics were evaluated within the study participants, the mean systolic blood pressure was 136.17 mmHg (SD = 21.2), and for Creatinine Clearance (CrcL), it was 52.34 mL/min (SD = 19.75). Additionally, the mean values (with their respective SDs) for HbA1c and fasting blood sugar (FBS) were reported as 7.73 (1.66) and 9.06 (3.74), respectively.

Individuals with high adherence had an average FBS of 8.72 mmol/L. In contrast, participants with moderate adherence had an average FBS of 9.24 mmol/L. Among those with low adherence, the average FBS rose from 10.71 mmol/L. Among the participants who showed high adherence, the average triglyceride level was 2.11 mmol/L. Meanwhile, individuals with moderate adherence had an average triglyceride level of 1.95 mmol/L. For those with low adherence, the average triglyceride level increased to 2.28 mmol/L, with reported p <0.05) (Table 4).

The mean number of medications per patient was 7.8 (SD = 2.7). Statins were the most frequently used medication, accounting for 13.26% of all medications, followed by aspirin (12.15%). Taking medications twice daily was the most common dosing frequency reported by study participants. Regarding diabetes medications, the use of only one medication per patient was the most common practice, constituting 40.1% of the total number of diabetes medications per patient. Insulin therapy was the most frequently used medication for diabetes, accounting for 7.58% of all the medications. According to the

Table 3 Other Comorbidities Characteristics of the Study Participants

Variable	Category		The 4-Item Morisky, Green, and Levine -Medication Assessment Questionnaire (MGL-MAG)			P value*
			High Adherence (n= 296)	Moderate Adherence (n= 170)	Low Adherence (n= 40)	
		N (%)	N (%)	N (%)	N (%)	
Dyslipidemia	YES	329 (65.0)	206 (62.6)	108 (32.8)	15 (4.6)	<0.001
	NO	177 (35.0)	90 (50.8)	62 (35.0)	25 (14.1)	
Rheumatoid Arthritis	YES	62 (12.3)	37 (59.7)	21 (33.9)	4 (6.5)	0.902
	NO	444 (87.7)	259 (58.3)	149 (33.6)	36 (8.1)	
Gout	YES	53 (10.5)	37 (69.8)	15 (28.3)	1 (1.9)	0.106
	NO	453 (89.5)	259 (57.2)	155 (34.2)	39 (8.6)	
Thyroid Dysfunction	YES	51 (10.1)	28 (54.9)	19 (37.3)	4 (7.8)	0.893
	NO	454 (89.7)	267 (58.8)	151 (33.3)	36 (7.9)	
Benign Prosthetic Hyperplasia (BPH)	YES	46 (9.1)	26 (56.5)	18 (39.1)	2 (4.3)	0.521
	NO	460 (90.9)	270 (58.7)	152 (33.0)	38 (8.3)	
Chronic Kidney Disease (CKD)	YES	39 (7.7)	21 (53.8)	13 (33.3)	5 (12.8)	0.485
	NO	467 (92.3)	275 (58.9)	157 (33.6)	35 (7.5)	
Asthma	YES	36 (7.1)	25 (69.4)	8 (22.2)	3 (8.3)	0.318
	NO	470 (92.9)	271 (57.7)	162 (34.5)	37 (7.9)	
Cancer	YES	22 (4.3)	18 (81.8)	4 (18.2)	0 (0.0)	0.062
	NO	484 (95.7)	278 (57.4)	166 (34.3)	40 (8.3)	
Chronic Obstructive Pulmonary Disorder (COPD)	YES	13 (2.6)	10 (76.9)	1 (7.7)	2 (15.4)	0.112
	NO	493 (97.4)	286 (58.0)	169 (34.3)	38 (7.7)	
Liver disease	YES	10 (2.0)	5 (50.0)	2 (20.0)	3 (30.0)	0.031
	NO	496 (98.0)	291 (58.7)	168 (33.9)	37 (7.5)	
Irritable Bowel Disease	YES	9 (1.8)	9 (100.0)	0 (0.0)	0 (0.0)	0.039
	NO	497 (98.2)	287 (57.7)	170 (34.2)	40 (8.0)	
Peptic Ulcer Disease (PUD)	YES	8 (1.6)	6 (75.0)	1 (12.5)	1 (12.5)	0.434
	NO	498 (98.4)	290 (58.2)	169 (33.9)	39 (7.8)	
CNS disorders**	YES	8 (1.6)	5 (62.5)	2 (25.0)	1 (12.5)	0.812
	NO	498 (98.4)	291 (58.4)	168 (33.7)	39 (7.8)	
Neuropathy	YES	7 (1.4)	5 (71.4)	2 (28.6)	0 (0.0)	0.665
	NO	499 (98.6)	291 (58.3)	168 (33.7)	40 (8.0)	

(*Continued*)

Table 3 (Continued).

Variable	Category		The 4-Item Morisky, Green, and Levine -Medication Assessment Questionnaire (MGL-MAG)			P value*
			High Adherence (n= 296)	Moderate Adherence (n= 170)	Low Adherence (n= 40)	
		N (%)	N (%)	N (%)	N (%)	
Glaucoma	YES	3 (0.6)	2 (66.7)	1 (33.3)	0 (0.0)	0.873
	NO	503 (99.4)	294 (58.4)	169 (33.6)	40 (8.0)	
Lymphoma	YES	2 (0.4)	2 (100.0)	0 (0.0)	0 (0.0)	0.491
	NO	504 (99.6)	294 (58.3)	170 (33.7)	40 (7.9)	
Leukemia	YES	1 (0.2)	1 (100.00)	0 (0.0)	0 (0.0)	0.701
	NO	505 (99.8)	295 (58.4)	170 (33.7)	40 (7.9)	
OTHERS***	YES	4 (0.8)	2 (50.0)	0 (0.0)	0 (0.0)	0.708
	NO	502 (99.2)	294 (58.6)	168 (33.5)	40 (8.0)	
CCI	Mean (SD) Median (IQR)	3.91 (1.00) 4 (3–4)	3.95 (0.98) 4 (3–4)	3.89 (1.07) 4 (3–4)	3.77 (0.89) 4 (3–4)	0.410

Notes: *Statistically significance was set at P <0.05. **CNS disorders: Parkinson disease, Alzheimer disease, Epilepsy, Depression. ***Other diseases: Urinary incontinence, Erectile dysfunction, Sleep apnea.
Abbreviation: CCI, Charlson Comorbidity Index.

Table 4 Biomedical Variables of the Study Participants

Variable		The 4-Item Morisky, Green, and Levine -Medication Assessment Questionnaire (MGL-MAG)			P-value
		High Adherence (n= 296)	Moderate Adherence (n=170)	Low Adherence (n=40)	
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Serum Creatinine (micmole/L)	94.55 (57.9)	99.65 (69.4)	86.04 (36.6)	93.75 (34.3)	0.267
Creatinine clearance (mL/min)	52.34 (19.75)	51.14 (20.52)	53.42 (17.57)	53.81 (22.53)	0.521
Fast Blood Sugar	9.06 (3.74)	8.72 (3.71)	9.24 (3.71)	10.71 (3.77)	0.005
HbA1c (%)	7.73 (1.66)	7.64 (1.67)	7.79 (1.58)	8.11 (1.86)	0.098
Total cholesterol (mmol/L)	6.13 (25.63)	4.32 (1.14)	4.33 (1.44)	4.65 (1.22)	0.260
Low-density lipoprotein (mmol/L)	2.45 (0.995)	2.41 (0.95)	2.43 (1.012)	2.76 (1.19)	0.164
High-density lipoprotein (mmol/L)	1.12 (0.418)	1.12 (0.37)	1.12 (0.423)	1.16 (0.64)	0.736
Triglycerides (mmol/L)	2.07 (1.093)	2.11 (1.091)	1.95 (1.121)	2.28 (0.956)	0.038
Systolic blood pressure (mmHg)	136.17 (21.2)	136.4 (21.36)	134.4 (18.8)	141.87 (27.87)	0.451
Diastolic blood pressure (mmHg)	78.83 (10.50)	78.6 (10.80)	78.8 (9.83)	79.8 (11.34)	0.655

distribution of medication frequency, 6.5% of patients took medications once daily, 58.5% twice daily, and 35% three or more times daily. High adherence level was prevalent in 33.3% of patients with once-daily frequency, compared to 59.5% and 61.6% with two and three or more medication frequency, respectively (P =0.019) (Table 5).

The responses to the questions of the MGL Questionnaire showed that the majority of participants responded that they were often inaccurate with their medications administration time schedule (n=356, 70.36%). Approximately one-third of the participants indicated that they sometimes forgot to take their medications (n=153, 30.24%). Participants reported that they sometimes stopped taking DM or CVS medications when they felt better (n=51, 10.08%) or worse (n=20, 3.95%) (Table 6).

For single/currently unmarried patients, the odds of a high adherence level versus the combined moderate and low adherence levels were 4.75 times higher than those for married patients. Likewise, the odds of the combined categories of high and moderate adherence versus low adherence level were 4.75 times higher than those for married patients after adjusting for potential confounders in the model. Similarly, patients who were living with others had higher odds of being at a higher adherence category by 4.1 times compared to those living alone. Patients with three or more drug frequencies during the day and those with twice the drug frequency per day had higher odds of being in a higher adherence level than those with once the drug frequency; ORs were 2.15 and 2.36, respectively. Being physically active was also associated (marginally significant; P =0.077) with higher odds of being at a higher adherence level by 1.53 times compared to patients not physically active. On the other hand, having less than a university education was associated (marginally significant; P =0.08) with lower odds of having a higher adherence level by 0.67 times compared to patients with university/college education (Table 7).

Table 5 Medications Related Variables Among Study Participants

Variable			**The 4-Item Morisky, Green, and Levine -Medication Assessment Questionnaire (MGL-MAG)**			**P-value***
			High Adherence (n= 296)	**Moderate Adherence (n= 170)**	**Low Adherence (n= 40)**	
		Mean (SD)	**Mean (SD)**	**Mean (SD)**	**Mean (SD)**	
Total number of medications**		7.8 (2.7)	7.7 (2.6)	7.9 (2.8)	8.4 (2.7)	0.311
	Category	N (%)	N (%)	N (%)	N (%)	
Medications frequency**	Once	33 (6.5)	11 (33.3)	19 (57.6)	3 (9.1)	0.019
	Twice	296 (58.5)	176 (59.5)	102 (34.5)	18 (6.0)	
	Three and more	177 (35)	109 (61.6)	49 (27.7)	19 (10.7)	
Number of DM medications	One	203 (40.1)	119 (58.6)	65 (32.0)	19 (9.4)	0.591
	Two	199 (39.3)	121 (60.8)	66 (33.2)	12 (6.0)	
	Three	87 (17.2)	44 (50.6)	34 (39.1)	9 (10.3)	
	Four	16 (3.2)	11 (68.8)	5 (31.2)	0 (0.0)	

Notes: *Statistically significance was set at P <0.05. **The most frequently administered medications by the patients were statins (13.26%), followed by Aspirin (12.15%) and PPIs (10.54%). Insulin (7.58%) was also commonly used, with Biphasic insulin being the most frequent type (40.56%), followed by insulin glargine (40.1%) among the total insulin administered.

Abbreviation: SD, Standard Deviation.

Table 6 Participants Responses to Morisky, Green, and Levine -Medication Assessment Questionnaire (MGL-MAG)

	Yes (N)	**%**
Do you ever forget to take your diabetes or cardiovascular condition medications?	153	30.24
Are you careless at times about taking your diabetes or cardiovascular medications?	356	70.36
When you feel better, do you sometimes stop taking your diabetes or cardiovascular medications?	51	10.08
Sometimes if you feel worse when you take your diabetes or cardiovascular medications, do you stop taking it?	20	3.95

Table 7 Factors Associated with Adherence Level

Adherence level	OR	P value	95% CI	
Marital status	4.75	<0.001	2.28	9.89
Living condition	4.10	0.003	1.64	10.25
Residency	0.74	0.130	0.50	1.09
Educational level	0.67	0.080	0.43	1.05
Income per month*				
<500				
500–1000	1.36	0.198	0.85	2.16
>1000	1.04	0.917	0.46	2.35
Smoking	0.74	0.218	0.47	1.19
Physical Activities	1.53	0.077	0.94	2.50
Family history of DM	0.75	0.146	0.51	1.11
Frequency of drugs				
Once				
Twice	2.36	0.022	1.13	4.90
≥3	2.15	0.046	1.01	4.58
HBA1C	0.91	0.132	0.81	1.03
CCI	1.05	0.682	0.82	1.35
Age	1.02	0.352	0.98	1.06

Note: *Jordanian Dinar.
Abbreviations: CI, Confidence Interval; CCI, Charleson Comorbidity Index.

Discussion

Assessing medication adherence in elderly patients with comorbidities, such as diabetes and cardiovascular diseases, is a crucial step towards assessing the clinical benefits of prescribed treatments for patients and their health outcomes. In addition, it will help minimize drug-related side effects resulting from overprescription due to the belief that the current medication regimen administered is not clinically effective, while the main reason is poor adherence issues.

In the present study, 210 (41.5%) elderly patients showed low to moderate adherence levels compared with 296 (58.5%) patients who showed a high level of adherence according to the MGL adherence scale. A similar report on diabetic patients from Saudi Arabia that utilized the same adherence scale showed a lower adherence rate (35.7%) compared to this study.[23] Relatively Higher levels of adherence were identified in this study in comparison to reports from India, showing that 44.4% of the study elderly patients who had both diabetes and hypertension were non-adherent to their prescribed medications.[15]

According to different adherence evaluating studies, many agree that threshold of adherence should be 80% or above to counted as satisfactory adherence level among patients.[23,24] According to this threshold value, our study participants did not meet the expected adherence satisfaction limit. Previous studies from different regions reported suboptimal adherence levels among patients with type 2 diabetes mellitus.[23,25,26]

The study results indicate that married patients who live with their families are more likely to develop low adherence status levels than single/unmarried patients. These results contrasted with other systematic review studies that indicated a lack of influence of marital status on adherence among different patient populations.[27] Another study showed an association between marital status and non-adherence, in which unmarried patients were more likely than married patients to be non-adherent by two or more folds.[28]

Patients with dyslipidemia, particularly hypertriglyceridemia, showed significant differences between those with high and low adherence levels. A previous study showed that statins used in patients with heart failure conditions increased the odds for high adherence level by an odds ratio equal to 16.59 and (P value=0.01).[29]

In this study, having less than a university education was associated (marginally significant; P =0.08) with lower odds (OR=0.67) of having a higher adherence level compared to patients with a higher university education. These results were in concordance with previous reports showing that higher education levels were negatively correlated with

medication adherence in patients suffering from inflammatory bowel disease.[30,31] Other studies from Jordan showed opposite outcomes and concluded that the higher the educational levels the higher adherence level found in patients with heart failure and other chronic condition.[29,32] In addition, another study from the USA, indicated that lower educational accomplishment was associated with higher adherence levels in men, but lower adherence levels among women diagnosed with hypertension.[33]

Furthermore, our results revealed a strong association between the frequency of medication administration and the level of medication adherence among elderly patients complaining of both diabetes and CVS conditions, indicating that a higher frequency of medications was positively correlated with a higher adherence level. Polypharmacy and higher medication frequency levels were previously reported to be associated with higher levels of poor to non-adherence.[12,34] A study has shown that strict adherence of the prescribers to clinical guidelines during the management of diabetes and cardiovascular conditions from one angle, as well as high compliance of patients themselves to physicians' instructions and prescription, can lead to more prevalent polypharmacy occurrence; thus, polypharmacy and medication adherence could lead to each other.[3]

The Charlson Comorbidity Index (CCI) analysis showed no significant association between higher levels of CCI and elevated cases of non-adherent states. Our results were not in concordance with those of a previous study on diabetic patients, which showed that higher CCI values were more likely to be nonadherent to oral hypoglycemic agents, angiotensin-converting enzyme inhibitors/angiotensin II receptor blockers, and statins.[35]

Studies have extensively investigated the potential factors leading to poor or non-medication adherence in elderly patients as well as in the general population with chronic medical conditions, such as diabetes and cardiovascular disease. This study tapered the potential predictors that might lead to low medication adherence in elderly people with the most prevalent chronic diseases in Jordan. The study findings could help minimize the risk of non-adherence in this vulnerable elderly patient group, considering that such factors could be modified if not avoided in patients.

Study Limitations and Strengths

Due to the cross-sectional and recall-based nature of the study, it could be affected by recall bias, as patients reported their adherence to their medication administration depending on their recall capability, which might underestimate the adherence level; thus, determining an accurate adherence level was not optimal. In addition, the selection of patients from only one tertiary hospital in Jordan may affect the generalizability of our results. However, the study site was one of the leading hospitals in Jordan, serving more than 25% of the total Jordanian population. This study was conducted by expert clinical pharmacists, who carefully collected patient data and responded to the highest scientific and ethical standards.

Conclusion

This study demonstrated marginally poor adherence level among elderly patients with type 2 diabetes mellitus and cardiovascular diseases. Differences were detected between different adherence levels (high, intermediate, and low) and marital status, education level, and number of comorbidities such as dyslipidemia and liver diseases. There is an obvious need to carefully assess medication adherence among elderly patients with various disease conditions, aiming to enhance the level of adherence, improving their health outcomes, and minimizing the medication burden risk, which might be developed from poor medication adherence in these patients.

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Disclosure

The authors declare no conflicts of interest in this work.

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