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Depression, and Drug Adherence in Type 2 Diabetes Mellitus in Primary Care in the Kingdom of Bahrain

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Abstract

Depression stands out as the predominant risk factor among Type 2 diabetes (T2DM) patients. Depression and its association with drug adherence in T2DM patients are lacking in Bahrain. The current study aimed to examine the association depression in relation to drug adherence in T2DM in primary care centers in the Kingdom of Bahrain. This was a cross-sectional study that enrolled 455 people with T2DM. Data on demographics, risk behavior, and diabetes details were noted. Measuring tools such as patient health questionnaire (PHQ-9) to measure depression severity, and General Medication Adherence Scale (GMAS) were used to assess medical adherence respectively. Categorical variables and continuous variables were presented in a frequency table and mean ± SD/ Median (Min, Max) respectively. The data was analyzed using SPSS 24.0 software. The statistical significance threshold was set at p=0.05. The study involved participants with an average age of 54.5 ± 11.5 (M±SD) years. The frequency of depression based on PHQ-9 and medical adherence as per GMAS among T2DM patients was 30.5% and 79.1% respectively. There was a significant association between the prevalence of depression and adherence (x^2=25.03; P=0.001). Age (r=-0.121; P= 0.010), education (r=-0.096; P=0.040), family income (r=-0.101; P=0.031), physical activity (r=-0.193; P=0.001), and self-rated diabetes control within the last visit (r=-0.200; P=0.001) were significantly negatively correlated with PHQ – 9 scale. Likewise, age (r=-0.231; p=0.001), education (r=-0.123; p=0.008), nationality (r=-0.185; p=0.001), physical activity (r=-0.108; p=0.021), and self-rated diabetes control within the last visit (r=-0.139; p=0.003) were significantly negatively correlated with the GMAS scale. Our findings suggest that medical adherence is linked to depression. Age, height, education, family income, physical activity, and self-rated diabetes control in the previous visit are all important factors that are correlated to depression and drug adherence.

Keywords: Bahrain, Depression, Drug adherence, Patient health questionnaire (PHQ-9), General Medication Adherence Scale (GMAS)

1. Introduction

Diabetes Mellitus is an epidemic-growing public health challenge worldwide (Mostafavi et al., 2021). It is rising rapidly in both emerging and established nations; nevertheless, it is more prevalent in Arab world states (Meo et al., 2017). The prevalence of diabetes in Bahrain is approximately 14-16% (Alawainati et al., 2020).

T2DM is a chronic disease associated with a high rate of depressive symptoms, diabetes-related distress, and clinical depression. The prevalence of depression is twice in T2D patients when compared to non-T2DM individuals (Indelicato et al., 2017). Treatment of diabetes includes diabetes self-management education, lifestyle interventions, glycemic management; and pharmacologic treatment of high blood pressure and cholesterol (Richardson et al., 2021). According to the earlier data, medication adherence for Type 2 Diabetes Mellitus ranges between 10% and 74% across various populations. (Mirahmadizadeh et al., 2020). Patients who only achieve poor

glycemic control and generally have low medication adherence, could potentially be related to the presence of nervous depression (Gonzalez et al., 2021).

The risk factors for general stress, diabetes related distress (DRD), and depression are not similar across different geographical regions (Chew et al., 2016). Previous data which was conducted in China reported that medication compliance could potentially interact with symptoms of depression. However, this study was restricted to only older T2DM patients (Yang et al., 2023). As depression is most common among diabetic patients in Bahrain (Nasser et al., 2009), this study was conducted to deeply uncover the association between depression symptoms and medical adherence. To our current understanding, to date, no study has been conducted to support the association of depression in association with drug adherence in T2DM in Bahrain. Therefore, the current study aimed to assess the association between psychological morbidities of the Depressive Disorders with Drug Adherence in T2D in Primary Care in the Kingdom of Bahrain.

2. Method

2.1 Study Design and Study Population

The current cross-sectional study was carried out from May to August 2023 and participants were recruited from eight different health centers in the Kingdom of Bahrain, two of which were randomly selected by the government. All participants who volunteered for the study were screened for inclusion criteria. The study included patients aged 21-75 years who had T2DM for > 1year with consistent follow-up of minimumthree appointments and with current laboratory results (three months) and who could read and speak English or Arabic fluently. Pregnant or recently postpartum patients, or who had psychiatric/psychological disorders (schizophrenia, bipolar disorder, and dementia) that could impair judgment and memory, or who were unable to read or understand Arabic or English, were excluded from the study.

2.2 Ethical Considerations

This present study had been verified and approved by the ethical committee serial number 12 dated 10/10/2022 and written informed consent had been obtained from all the included patients. Prior to data collection, participants received comprehensive information regarding the questionnaire's aims, research objectives, and the utilization of their data. To protect participants' confidentiality, the study used anonymous data collection, storage, transmission, and disposal methods.

2.3 Sample Size Calculation

The convenient nonprobability sampling method was adopted.

The sampling size was determined using the following formula (Sankar et al., 2018):

$$n=Z21-\alpha 2pq/d2$$

where, Z = 1.96 and d = 0.05.

The sample size was estimated to be 379 participants considering the reported prevalence of depression in T2DM (55.7 %) and considering a confidence interval of 95 % (α = 5 %)

The sample size was rounded up to 400 for more accuracy.

2.4 Data Collection

The records of 455 screened patients were reviewed to collect the following data: demographic data (age gender, education, marital status, nationality, family income); risk behavior (current smoking status, alcohol status, physical activity, physical chronic comorbidity, mental health diagnosis); diabetes details (diabetes duration, diabetes complication, self-rated diabetes control within the last visit, diabetes treatment). An electronic scale was used to record body weight. The participant's height was measured without shoes using a standard height board. BMI was calculated by dividing weight in kilograms by height in meters squared (Indelicato et al., 2017). As per the World Health Organization (WHO) BMI was categorized as follows: underweight 18 kg/m^2, standard = 18.5-24.9 kg/m^2, overweight = 25-29.9 kg/m^2, obesity 30 kg/m^2, and morbid obesity 40 kg/m^2 and the threshold for an abnormal waist circumference was set at 102cm for men and 88cm for women (Uzogara et al., 2016; Kintzoglanakis et al., 2020).

Assessment of depression symptoms: Patient Health Questionnaire (PHQ-9) is employed for the evaluation of depression. Major depression is diagnosed when 5 or more of the 9 depressive symptom criteria are present for at least “more than half the days” in the past 2 weeks, with one of the symptoms being depressed mood or anhedonia. Other depression is diagnosed when two, three, or four depressive symptoms have been experienced for “more than half the days” in the previous two weeks, with one of the symptoms being depressed mood or anhedonia. The

PHQ-9 score is a measure of severity, which spans from 0 to 27, with each of the 9 items rated from 0 (never) to 3 (nearly every day). When compared against the mental health professional (MHP) reinterview, a PHQ-9 score of ≥10 demonstrated a sensitivity and specificity of 88% for major depression. PHQ-9 scores of 5, 10, 15, and 20 indicated mild, moderate, moderately severe, and severe depression, correspondingly. The PHQ-9 showed outstanding internal reliability, boasting a Cronbach's α coefficient of 0.89 (Kroenke et al., 2001; Ford et al., 2020).

Assessment of medical adherence: The General Medication Adherence Scale (GMAS) is a self-reporting adherence measure with 11 items. Each item has four outcomes and is assigned an adherence score. The maximum score that could be obtained is 33. The sum of all items results in a final score that can be interpreted as high (30-33), good (27-29), partial (17-26), low (11-16), or poor (10) adherence. The scale's reliability was evaluated through the assessment of Cronbach's alpha (α) value, with a threshold of $\alpha \geq 0.7$ indicating acceptable reliability. The scale was initially developed and validated in Urdu. The scale of English version was recently validated in English-speaking Saudi patients (Naqvi et al., 2020).

2.5 Statistical Analysis

SPSS software version 24.0 was used to analyze the data. Data analysis was carried out with version 24 of IBM SPSS Statistics (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp). Categorical variables and continuous variables were presented in a frequency table and mean ± SD/ Median (Min, Max) respectively. The Spearman rank correlation test was used to assess the correlation between assessments on different instruments used in patients withT2DM. To verify the relationship between the characteristics in the two groups Pearson's chi-square test was implemented. When this test did not meet its requirements ($n > 20$, all expected values in the table were greater than 1 and at least 80% of these were greater than or equal to 5) Fisher's exact test was carried out. The $p < 0.05$ was considered statistically significant.

3. Results

This study included 455 subjects with a mean age of 54.5 ± 11.5 years. The majority of the patients were male (62.2%) and obese (41.3%). Most of the participants had 'zero complications (72.3%)' and were under 'oral medication (62.4%)' (Table 1).

Table 1. Demographic characteristics of the study sample.

Variables	Sub-Category	Number of Subjects (%)
Demographic Data		
Age	Mean ± SD	54.5 ± 11.5 Years
	Median (minimum, maximum)	56.0 (21,80)
Weight	Mean ± SD	83.1 ± 16.2 Kg
	Median (minimum, maximum)	82.0 (46,149)
Height	Mean ± SD	1.7 ± 0.1 metre
	Median (minimum, maximum)	1.7 (1.4,1.9)
Gender	Male	283 (62.2%)
	Female	172 (37.8%)
Education	Less than secondary school graduation	60 (13.2%)
	Secondary school graduation	221 (48.6%)
	College or university	123 (27.0%)
	Higher education	51 (11.2%)
Marital status	Never married	28 (6.2%)
	Married	386 (84.8%)
	Divorced, separated, or widowed	41 (9.0%)

Nationality	Bahraini	373 (82.0%)
	Non-Bahraini	82 (18.0%)
Family income	Less than 1000 BD	356 (78.2%)
	1000-2000 BD	84 (18.5%)
	More than 2000 BD	15 (3.3%)
BMI	Underweight	2 (0.4%)
	Standard	76 (16.7%)
	Overweight	162 (35.6%)
	Obesity	188 (41.3%)
	Morbid obesity	27 (5.9%)
Waist circumference	Normal waist circumference	267 (58.7%)
	Abnormal waist circumference	188 (41.3%)
Risk Behaviour		
Current smoking status	Never smoked	324 (71.2%)
	Ex-smoker	61 (13.4%)
	Occasionally smoker	31 (6.8%)
	Daily smoker	39 (8.6%)
Alcohol Status	Never	422 (92.7%)
	Ex alcoholic	10 (2.2%)
	Monthly or less	14 (3.1%)
	2 -4 times per month or more	6 (1.3%)
	5 - 4 or more times per week	3 (0.7%)
Physical activity	No physical exercise	151 (33.2%)
	Mild physical exercise	166 (36.5%)
	Moderate physical exercise	122 (26.8%)
	Vigorous physical activity	16 (3.5%)
Physical chronic comorbidity	Zero conditions	180 (39.6%)
	1 -2 conditions	214 (47.0%)
	More than 3 conditions	61 (13.4%)
Mental health diagnosis	No psychiatric	414 (91.0%)
	Depression	14 (3.0%)
	Anxiety	24 (5.3%)
	Other psychiatric diagnoses	3 (0.7%)
Diabetes Mellitus		
Diabetes duration	Mean ± SD	11.1 ± 7.5 Years
	Median (minimum, maximum)	10.0 (1,40)
Diabetes complication	Zero complication	329 (72.3%)
	1 – 2 complications	119 (26.2%)
	More than 3 complications	7 (1.5%)
Self-rated diabetes control within the last visit	Poor control	47 (10.3%)
	Fair control	137 (30.1%)

	Good control	174 (38.2%)
	Very good control	52 (11.4%)
	Excellent	45 (9.9%)
Diabetes treatment	No treatment	6 (1.3%)
	Diet	7 (1.5%)
	Oral medication	284 (62.4%)
	Oral + Insulin treatment	158 (34.7%)

BD, Bahraini Dinar; BMI, Body mass index; SD, standard deviation.

The current study reported that the majority of the patients had no symptoms of depression (69.5%) as per the PHQ -9 Scale of Depression. However, most patients adhere to medication according to the GMAS Scale of adherence (79.1%) (Table 2).

Table 2. PHQ-9 and GMAS scales used in this study

PHQ – 9 scale		n (%)
Prevalence of Depression	No	316 (69.5%)
	Yes (Mild + moderate + severe)	139 (30.5%)
GMAS Scale		
Prevalence of adherence	No (partial + low + poor)	95 (20.9%)
	Yes (High + good)	360 (79.1%)

GMAS, General Medication Adherence Scale; PHQ-9, Patient Health Questionnaire.

The chi-square test indicated a significant correlation between “depression” and “drug adherence” (chi-square = 25.03, P-value = 0.001). Fisher’s exact test showed that ‘mental health problems’ were significantly correlated with the ‘depression level’ (P-value = 0.007) and ‘drug adherence’ (P-value = 0.011). As per the chi-square test, there was significant association between ‘nationality’ and ‘drug adherence’ (chi–chi-square =13.23, P-value = 0.007) (Table 3).

Table 3. Association between PHQ-9 and GMAS scales; PHQ-9 score and mental health diagnosis; GMAS scales and mental health diagnosis and GMAS scales and Nationality.

	Prevalence of Depression	**Prevalence of adherence**		**Result**
		No (partial + low + poor)	Yes (High + good)	
PHQ-9 and GMAS	No	46 (14.6%)	270 (85.4%)	Chi-square value = 25.03, DF = 1, P-value = 0.001*#
	Yes (Mild + moderate + severe)	49 (35.3%)	90 (64.7%)	
	Mental health diagnosis	**Prevalence of Depression**		
		No	Yes (Mild + moderate + severe)	
PHQ-9 score and mental health diagnosis	No psychiatric disease	301 (72.7%)	113 (27.3%)	P-value = 0.001**#
	Depression	5 (35.7%)	9 (64.3%)	
	Anxiety	9 (37.5%)	15 (62.5%)	

	Other psychiatric diagnoses	1 (33.3%)	2 (66.7%)	
GMAS scales and mental health diagnosis	**Mental health diagnosis**	**Prevalence of adherence**		P-value = **0.011****#
		No (partial + low + poor)	Yes (High + good)	
	No psychiatric disease	79 (19.1%)	335 (80.9%)	
	Depression	6 (42.9%)	8 (57.1%)	
	Anxiety	8 (33.3%)	16 (66.7%)	
	Other psychiatric diagnoses	2 (66.7%)	1 (33.3%)	
GMAS scales and Nationality	**Nationality**	**Prevalence of adherence**		Chi-square value = 13.23, DF = 1, P-value = **0.001***#
		No (partial + low + poor)	Yes (High + good)	
	Bahraini	90 (24.1%)	283 (75.9%)	
	Non-Bahraini	5 (6.1%)	77 (93.9%)	

GMAS, General Medication Adherence Scale; PHQ-9, Patient Health Questionnaire.

A significant negative correlation was noted between demographic outcomes such as age (r = -0.121; P = 0.010), education (r = -0.096; P = 0.040), family income (r = -0.101; P = 0.031), physical activity (r = -0.193; P = 0.001), and self-rated diabetes control within the last visit (r = -0.200; P = 0.001) with PHQ – 9 score. The demographic outcomes such as age (r = -0.231; p = 0.001), education (r = -0.123; p = 0.008), nationality (r = -0.185; p = 0.001), physical activity (r = -0.108; p = 0.021), and self-rated diabetes control within the last visit (r=-0.139; p = 0.003) showed a negative correlation with GMAS scale (Table 4).

Table 4. Correlation of demographic outcomes with PHQ -9 and GMAS Scale

Factors	**PHQ – 9 score**		**GMAS scale**	
Demographic Data	r value	P value	r value	P value
Age	-0.121	**0.010***	-0.231	**0.001***
Gender	0.181	**0.001***	0.003	0.945
Weight	0.097	**0.038***	0.085	0.069
Height	-0.048	0.310	0.141	**0.002***
Education	-0.096	**0.040***	-0.123	**0.008***
Marital status	0.013	0.783	-0.038	0.417
Nationality	-0.010	0.827	-0.185	**0.001***
Family income	-0.101	**0.031***	-0.005	0.921
BMI	0.082	0.082	0.017	0.711
Waist circumference	0.072	0.124	-0.026	0.582
Risk Behaviour				
Current smoking status	0.044	0.353	0.043	0.363
Alcohol Status	-0.040	0.395	-0.070	0.133
Physical activity	-0.193	**0.001***	-0.108	**0.021***
Chronic physical comorbidity	0.085	0.070	0.145	**0.002***
Mental health diagnosis	0.233	**0.001***	0.119	**0.011***

Diabetes Mellitus				
Diabetes duration	0.058	0.214	-0.020	0.665
Diabetes complication	0.197	**0.001***	0.102	**0.030***
Self-rated diabetes control within the last visit	-0.200	**0.001***	-0.139	**0.003***
Diabetes treatment	0.125	**0.008***	-0.015	0.755

*Indicates statistically significant; GMAS, General Medication Adherence Scale; PHQ-9, Patient Health Questionnaire.

Severe depression was associated with demographic data such as family income less than 1000 bd (100%), overweight (80%), never smoked (80%) or consumed alcohol (100%), physical chronic comorbidity - 1 -2 conditions (80%), zero diabetes complication (100%), diabetes treatment with oral medication (80%) (Table 5).

Table 5. Demographic factors associated with PHQ – 9

Factors		**PHQ – 9 score**				
Demographic Data		**No depression (n =316) (%)**	**Mild depression (n = 92)(%)**	**Moderate depression (n = 33)(%)**	**Moderate Severe depression (n = 9)(%)**	**Severe depression (n = 5)(%)**
Gender	Male	214 (67.7%)	49 (53.3%)	16 (48.5%)	2 (22.2%)	2 (40.0%)
	Female	102 (32.3%)	43 (46.7%)	17 (51.5%)	7 (77.8%)	3 (60.0%)
Education	Less than secondary school graduation	34 (10.8%)	21 (22.8%)	4 (12.1%)	1 (11.1%)	-
	Secondary school graduation	152 (48.1%)	45 (48.9%)	15 (45.5%)	6 (66.7%)	3 (60.0%)
	College or university	93 (29.4%)	16 (17.4%)	11 (33.3%)	2 (22.2%)	1 (20.0%)
	Higher education	37 (11.7%)	10 (10.9%)	3 (9.1%)	-	1 (20.0%)
Marital status	Never married	14 (4.4%)	8 (8.7%)	5 (15.2%)	-	1 (20.0%)
	Married	280 (88.6%)	71 (77.2%)	27 (81.8%)	5 (55.6%)	3 (60.0%)
	Divorced, separated, or widowed	22 (7.0%)	13 (14.1%)	1 (3.0%)	4 (44.4%)	1 (20.0%)
Nationality	Bahraini	258 (81.6%)	77 (83.7%)	26 (78.8%)	8 (88.9%)	4 (80.0%)
	Non-Bahraini	58 (18.4%)	15 (16.3%)	7 (21.2%)	1 (11.1%)	1 (20.0%)
Family income	Less than 1000 BD	239 (75.6%)	77 (83.7%)	28 (84.8%)	7 (77.8%)	5 (100.0%)
	1000-2000 BD	63 (19.9%)	14 (15.2%)	5 (15.2%)	2 (22.2%)	-
	More than 2000 BD	14 (4.4%)	1 (1.1%)	-	-	-
BMI	Underweight	2 (0.6%)	-	-	-	-
	Standard	63 (19.9%)	11 (12.0%)	2 (6.1%)	-	-
	Overweight	103 (32.6%)	38 (41.3%)	11 (33.3%)	6 (66.7%)	4 (80.0%)
	Obesity	133 (42.1%)	38 (41.3%)	14 (42.4%)	3 (33.3%)	-
	Morbid obesity	15 (4.7%)	5 (5.4%)	6 (18.2%)	-	1 (20.0%)
Waist circumference	Normal waist circumference	193 (61.1%)	50 (54.3%)	14 (42.4%)	6 (66.7%)	4 (80.0%)
	Abnormal waist circumference	123 (38.9%)	42 (45.7%)	19 (57.6%)	3(33.3%)	1 (20.0%)

Risk Behaviour						
Current smoking status	Never smoked	229 (72.5%)	63 (68.5%)	24 (72.7%)	4 (44.4%)	4 (80.0%)
	Ex-smoker	41 (13.0%)	11 (12.0%)	5 (15.2%)	4 (44.4%)	-
	Occasionally smoker	22 (7.0%)	6 (6.5%)	1 (3.0%)	1 (11.1%)	1 (20.0%)
	Daily smoker	24 (7.6%)	12 (13.0%)	3 (9.1%)	-	-
Alcohol Status	Never	291 (92.1%)	87 (94.6%)	30 (90.9%)	9 (100.0%)	5 (100.0%)
	X alcoholic	5 (1.6%)	4 (4.3%)	1 (3.0%)	-	-
	Monthly or less	13 (4.1%)	-	1 (3.0%)	-	-
	2 -4 times per month or more	5 (1.6%)	-	1 (3.0%)	-	-
	5 – 4 or more times per week	2 (0.6%)	1 (1.1%)	-	-	-
Physical activity	No physical exercise	91 (28.8%)	37 (40.2%)	13 (39.4%)	6 (66.7%)	4 (80.0%)
	Mild physical exercise	112 (35.4%)	36 (39.1%)	15 (45.5%)	2 (22.2%)	1 (20.0%)
	Moderate physical exercise	100 (31.6%)	17 (18.5%)	4 (12.1%)	1 (11.1%)	-
	Vigorous physical activity	13 (4.1%)	2 (2.2%)	1 (3.0%)	-	-
Physical chronic comorbidity	Zero conditions	136 (43.0%)	28 (30.4%)	15 (45.5%)	1 (11.1%)	-
	1 -2 conditions	137 (43.4%)	54 (58.7%)	12 (36.4%)	7 (77.8%)	4 (80.0%)
	More than 3 conditions	43 (13.6%)	10 (10.9%)	6 (18.2%)	1 (11.1%)	1 (20.0%)
Mental health diagnosis	No psychiatric	301 (95.3%)	77(83.7%)	26 (78.8%)	6 (66.7%)	4 (80.0%)
	Depression	5 (1.6%)	3 (3.3%)	5 (15.2%)	1 (11.1%)	-
	Anxiety	9 (2.8%)	12 (13.0%)	2 (6.1%)	1 (11.1%)	-
	Other psychiatric diagnoses	1 (0.3%)	-	-	1 (11.1%)	1 (20.0%)
Diabetes Mellitus						
Diabetes complication	Zero complication	247 (78.2%)	54 (58.7%)	18 (54.5%)	6 (66.7%)	4 (80.0%)
	1 – 2 complications	68 (21.5%)	32 (34.8%)	15 (45.5%)	3 (33.3%)	1 (20.0%)
	More than 3 complications	1 (0.3%)	6 (6.5%)	-	-	-
Self-rated diabetes control within the last visit	Poor control	21 (6.6%)	17 (18.5%)	7 (21.2%)	-	2 (40.0%)
	Fair control	91 (28.8%)	28 (30.4%)	12 (36.4%)	4 (44.4%)	2 (40.0%)
	Good control	125 (39.6%)	33 (35.9%)	10 (30.3%)	5 (55.6%)	1 (20.0%)
	Very good control	42 (13.3%)	9 (9.8%)	1 (3.0%)	-	-
	Excellent	37 (11.7%)	5 (5.4%)	3 (9.1%)	-	-
Diabetes treatment	No treatment	4 (1.3%)	2 (2.2%)	-	-	-
	Diet	3 (0.9%)	2 (2.2%)	2 (6.1%)	-	-
	Oral medication	215 (68.0%)	42 (45.7%)	19 (57.6%)	4 (44.4%)	4 (80.0%)
	Oral + Insulin treatment	94 (29.7%)	46 (50.0%)	12 (36.4%)	5 (55.6%)	1 (20.0%)

BMI, Body mass index; PHQ-9, Patient Health Questionnaire.

Demographics data that poorly correlated with GMAS score were secondary school graduation (55.6%), nationality – Bahraini (100.0%), obesity (55.6%), mild physical exercise (44.4%) and physical chronic comorbidity-1 -2 conditions (66.7%) (Table 6).

Table 6. Demographic factors associated with the GMAS Scale

Factors		**GMAS Score**				
Demographic Data		**High (n = 292) (%)**	**Good (n = 68)(%)**	**Partial (n = 79)(%)**	**Low (n = 7)(%)**	**Poor (n = 9)(%)**
Gender	Male	182 (62.3%)	44 (64.7%)	44 (55.7%)	6 (85.7%)	7 (77.8%)
	Female	110 (37.7%)	24 (35.3%)	35 (44.3%)	1 (14.3%)	2 (22.2%)
Education	Less than secondary school graduation	30 (10.3%)	5 (7.4%)	18 (22.8%)	4 (57.1%)	3 (33.3%)
	Secondary school graduation	148 (50.7%)	31 (45.6%)	34 (43.0%)	3 (42.9%)	5 (55.6%)
	College or university	73 (25.0%)	27 (39.7%)	22 (27.8%)	-	1 (11.1%)
	Higher education	41 (14.0%)	5 (7.4%)	5 (6.3%)	-	-
Marital status	Never married	10 (3.4%)	4 (5.9%)	10 (12.7%)	2 (28.6%)	2 (22.2%)
	Married	262 (89.7%)	55 (80.9%)	58 (73.4%)	4 (57.1%)	7 (77.8%)
	Divorced, separated, or widowed	20 (6.8%)	9 (13.2%)	11 (13.9%)	1 (14.3%)	-
Nationality	Bahraini	225 (77.1%)	58 (85.3%)	74 (93.7%)	7 (100.0%)	9 (100.0%)
	Non-Bahraini	67 (22.9%)	10 (14.7%)	5 (6.3%)	-	-
Family income	Less than 1000 BD	229 (78.4%)	54 (79.4%)	60 (75.9%)	6 (85.7%)	7 (77.8%)
	1000-2000 BD	48 (16.4%)	14 (20.6%)	19 (24.1%)	1 (14.3%)	2 (22.2%)
	More than 2000 BD	15 (5.1%)	-	-	-	-
BMI	Underweight	-	2 (2.9%)	-	-	-
	Standard	53 (18.2%)	9 (13.2%)	11 (13.9%)	2 (28.6%)	1 (11.1%)
	Overweight	100 (34.2%)	26 (38.2%)	32 (40.5%)	3 (42.9%)	1 (11.1%)
	Obesity	124 (42.5%)	24 (35.3%)	34 (43.0%)	1 (14.3%)	5 (55.6%)
	Morbid obesity	15 (5.1%)	7 (10.3%)	2 (2.5%)	1 (14.3%)	2 (22.2%)
Waist circumference	Normal waist circumference	167 (57.2%)	45 (66.2%)	47 (59.5%)	5 (71.4%)	3 (33.3%)
	Abnormal waist circumference	125 (42.8%)	23 (33.8%)	32 (40.5%)	2 (28.6%)	6 (66.7%)
Risk Behaviour						
Current smoking status	Never smoked	212 (72.6%)	49 (72.1%)	53 (67.1%)	5 (71.4%)	5 (55.6%)
	X smoker	36 (12.3%)	10 (14.7%)	12 (15.2%)	1 (14.3%)	2 (22.2%)
	Occasionally smoker	17 (5.8%)	6 (8.8%)	7 (8.9%)	-	1 (11.1%)
	Daily smoker	27 (9.2%)	3 (4.4%)	7 (8.9%)	1 (14.3%)	1 (11.1%)
Alcohol Status	Never	266 (91.1%)	66 (97.1%)	77 (97.5%)	6 (85.7%)	7 (77.8%)
	X alcoholic	7 (2.4%)	1 (1.5%)	-	-	2 (22.2%)
	Monthly or less	12 (4.1%)	1 (1.5%)	-	1 (14.3%)	-
	2 -4 times per month or	4 (1.4%)	-	2 (2.5%)	-	-

	more					
	5 – 4 or more times per week	3 (1.0%)	-	-	-	-
Physical activity	No physical exercise	90 (30.8%)	24 (35.3%)	31 (39.2%)	3 (42.9%)	3 (33.3%)
	Mild physical exercise	101 (34.6%)	27 (39.7%)	33 (41.8%)	1 (14.3%)	4 (44.4%)
	Moderate physical exercise	90 (30.8%)	16 (23.5%)	12 (15.2%)	2 (28.6%)	2 (22.2%)
	Vigorous physical activity	11 (3.8%)	1 (1.5%)	3 (3.8%)	1 (14.3%)	-
Physical chronic comorbidity	Zero conditions	129 (44.2%)	23 (33.8%)	26 (32.9%)	1 (14.3%)	1 (11.1%)
	1 -2 conditions	130 (44.5%)	36 (52.9%)	38 (48.1%)	4 (57.1%)	6 (66.7%)
	More than 3 conditions	33 (11.3%)	9 (13.2%)	15 (19.0%)	2 (28.6%)	2 (22.2%)
Mental health diagnosis	No psychiatric	272 (93.2%)	63 (92.6%)	65 (82.3%)	6 (85.7%)	8 (88.9%)
	Depression	8 (2.7%)	-	5 (6.3%)	-	1 (11.1%)
	Anxiety	12 (4.1%)	4 (5.9%)	7 (8.9%)	1 (14.3%)	-
	Other psychiatric diagnoses	-	1 (1.5%)	2 (2.5%)	-	-
Diabetes Mellitus						
Diabetes complication	Zero complication	220 (75.3%)	48 (70.6%)	50 (63.3%)	5(71.1%)	6 (66.7%)
	1 – 2 complications	70 (24.0%)	19 (27.9%)	25 (31.6%)	2 (28.6%)	3 (33.3%)
	More than 3 complications	2 (0.7%)	1 (1.5%)	4 (5.1%)	-	-
Self-rated diabetes control within the last visit	Poor control	24 (8.2%)	6 (8.8%)	13 (16.5%)	3 (42.9%)	1 (11.1%)
	Fair control	84 (28.8%)	22 (32.4%)	25 (31.6%)	4 (57.1%)	2 (22.2%)
	Good control	115 (39.4%)	22 (32.4%)	33 (41.8%)	-	4 (44.4%)
	Very good control	33 (11.3%)	12 (17.6%)	6 (7.6%)	-	1 (11.1%)
	Excellent	36 (12.3%)	6 (8.8%)	2 (2.5%)	-	1 (11.1%)
Diabetes treatment	No treatment	1 (0.3%)	1 (1.5%)	2 (2.5%)	1 (14.3%)	1 (11.1%)
	Diet	2 (0.7%)	-	3 (3.8%)	1 (14.3%)	1 (11.1%)
	Oral medication	192 (65.8%)	38 (55.9%)	47 (59.5%)	3 (42.9%)	4 (44.4%)
	Oral + Insulin treatment	97 (33.2%)	29 (42.6%)	27 (34.2%)	2 (28.6%)	3 (33.3%)

BMI, Body mass index; GMAS, General Medication Adherence Scale.

4. Discussion

Depression and diabetes distress are widely used as indicators of psychologic state in type 2 diabetic patients (Zhang et al., 2013). Only one study had demonstrated the association of depression in association with T2DM in Bahrain (Almawi et al., 2008), but no study has been undertaken in Bahrain to find the association of depression and drug adherence in T2DM patients. The result of this study contributes to the important literature in investigating the pathways linking depression to T2DM and medical adherence.

Out of 455 patients with T2DM, the mean age of the participants was 54.5 ± 11.5 Years. This contributes to the strong association between the increasing age and T2DM. Majority of the participants were male (62.2%) and these findings aligned with Indelicato L, et al., (2007) (M: F = 104/68). In contrast, Almawi et al., (2008) reported that the ratio of females was high (M: F = 69:74). The sex distribution varies from region to region due to socioeconomic status, diversities in biology, environment, lifestyle that impacts the development and clinical presentation in both genders. most of the patients graduated from secondary school, were married, had income less

than 1000 BD, and were obese (Bellary et al., 2021; Kautzky-Willer et al., 2016). This could be justified as these modifiable factors majorly contribute to unhealthy lifestyle behavior and social disparities and thus are related to a increased risk of obesity and T2DM (Bellary et al., 2021; Kautzky-Willer et al., 2016).

In this study, we found that a total of 30.5% of the participants had depression as per PHQ-9 and most of the participants had high adherence to medication (79.1%). The study by Thour et al., (2015) reported a high incidence of depression (41%) and the study by Tran et al., (2021) reported a lower depression prevalence as compared to our study. The difference in the prevalence rate of depression could be due to the different assessment tools used to determine depression and even with the same instrument but different cutoff scores for depression (Tran et al., 2021).

Additionally, we discovered a significant association between the level of depression and medication adherence. (P-value = 0.001). These findings were in parallel with Gonzalez Heredi, et al., (2021) (P = 0.01). Sweileh et al., (2014) also reported that diabetic patients with major medication adherence scores were less likely to have depression than those with low medication adherence scores. Our study also demonstrated that mental health problems were significantly associated with depression (P-value = 0.001). This was consistent with Ciechanowski PS, et al., (2000) who reported that depressive symptoms had a significant on mental health ($P < 0.01$). This is due to depression which can easily make individuals feel unable to meet disease-control requirements, resulting in more diabetes symptoms, a higher prevalence of complications, and poor medication adherence.

In this study age, height, education, family income, physical activity, and self-rated diabetes control within the last visit were significantly negatively correlated with PHQ – 9 scale. Conversely, age, education, nationality, physical activity, and self-rated diabetes control within the last visit were significantly negatively correlated with the GMAS scale. In contrast, Mukeshimana and Chironda (2019) found that age and gender significantly correlated with PHQ-9. Study conducted by Wen et al., (2023) showed that only education level and diabetes complications were significantly correlated with anxiety score and depression score. The variation of association differs due to the criteria used to determine depression in these studies (Tran et al., 2021).

This study reported that severe depression was high in the variables such as family income less than 1000 bd, overweight, never smoked, or consumed alcohol, physical chronic comorbidity - 1 -2 conditions, zero diabetes complication, and diabetes treatment with oral medication. These findings aligned with Polak et al., (2022) who reported that these personal and socioeconomic factors are associated with differences in the incidence of depressive disorders, according to the findings of epidemiological studies.

GMAS score was poor among the patients who graduated from secondary school, nationality – Bahraini, obesity, mild physical exercise, and physical chronic comorbidity-1 -2 conditions. This is justified by the fact that patients with low education may struggle to understand the instructions provided by the healthcare team and may even fail to identify medications (de Oliveira et al., 2021). Patients with obesity, mild physical exercise, and physical chronic comorbidity tend to neglect to purchase antidiabetic medicines (Hanko et al., 2007).

There are a few limitations to our study. Firstly, factors, such as medication cost, treatment regimen, perception of benefits, and self-confidence were not examined. Secondly, this is a cross-sectional study due to which we cannot ascertain the observed correlation between depression and diabetes. Despite these limitations, this study has several advantages, including a large sample size, assessing depression in relationship to diabetes mellitus medication adherence rate (PHQ-9&GMAS inventory instruments scale).

Further research should be considered to demonstrate the association between adherence to drug regimens and medical expenses. These results help to identify the factors linked to stress, anxiety, and depressive disorders in T2DM.To improve medical adherence clinicians can opt for mobile-based interventions to send the reminder text regarding low adherence. Our results benefit the clinicians in understanding the factors associated with depression and medical adherence which may eventually reduce the diabetes distress. Our findings could help in the collaborative care models that address the various mood disorders, depressive symptoms, stress, and anxieties that influence medical adherence in T2D patients. Our study also suggests that clinicians should consider the mental disorders in T2DM patients and provide necessary interventions based on the patient's requirements.

5. Conclusion

Our research concludes that depression is related to medical adherence. Age, height, education, family income, physical activity, and self-rated diabetes control in the previous visit all play a significant role in depression and medical adherence. As a result, these factors should be considered for setting up policies and new interventions to reduce the prevalence of depression and poor medical adherence.

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The data that support the findings of this study are available on request.

Competing Interests Statement

The authors declare that there are no competing or potential conflicts of interest.

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