The Egyptian Journal of Hospital Medicine (January 2024) Vol. 94, Page 1063-1072

Adherence of Diabetic Patients to Healthy Lifestyle and Medication and Its Impact on Glycemic Control, Complications of Diabetes and Quality of Life: A Hospital Based Cross-Section Study in Benha City, Egypt

Medhat A Khalil, Ayman M Elbadawy, Rasha O Abdelmoniem, Mohammed S Saleh, Fawzia F Asfour, Walaa M Ibrahim*

Internal Medicine Department, Faculty of Medicine, Benha University, Benha, Egypt

***Corresponding Author:** Walaa M Ibrahim, **Phone number:** (+20) 01112988046, **Email:** gendia.walaa@yahoo.com

ABSTRACT

Background: Diabetes, a growing concern globally, imposes significant health and economic burdens. Adherence to treatment is pivotal for managing diabetes and improving patient outcomes.

Objective: This study aimed to assess the adherence effect on glycaemic control, quality of life, diabetic complications and comorbidities of diabetes.

Methods: This cross-sectional study was conducted on 450 diabetic patients with type 1 and type 2 DM attending the Endocrine and Diabetes Unit at Benha University Hospitals at Benha City, Egypt. All studied patients were compared according to adherence to medications, adherence to healthy lifestyle and adherence to exercise and diet.

Results: Significant associations were observed between sociodemographic characteristics and adherence to diet, medication, and physical activity. Higher adherence levels were linked with factors like education, marital status, and smoking status. Adherence to a healthy diet was notably related to improved diabetic parameters, while poor adherence correlated with a higher prevalence of diabetic complications, elevated lipid profiles, and elevated HbA1c levels.

Conclusions: Diabetic patients' management interventions with comorbidity should focus on progressing of adherence to medication and adherence to dietary and physical lifestyle.

Keywords: Adherence, Diabetes, Quality of life.

INTRODUCTION

Diabetes is an increasing public health concern among non-communicable diseases (NCDs) in both developed and developing nations [1]. Eighty percent of the 425 million adults (20–79) with diabetes worldwide in 2017 resided in low-income and middle-income nations (LMICs). By 2045, the figure is anticipated to have risen to 629 million. In 2017, diabetes was responsible for four million deaths worldwide [2].

For improved outcomes with chronic diseases like diabetes, treatment adherence is vital. Adherence can be defined as the degree to which an individual's conduct aligns with the prescribed lifestyle modifications and medication regimens prescribed by a medical practitioner [3].

Non-compliance was associated with increased mortality and morbidity, the advancement of complications, unfavourable disease outcomes, and a diminished quality of life overall. In addition to repeated laboratory tests and physician visits, it increases the likelihood of hospitalisation, disability, and premature death, all of which have economic repercussions [4].

Diverse patient populations, disease conditions, and treatment regimens exhibit significant differences in adherence. A mean non-compliance rate with treatment for acute diseases stands at 25 %, whereas for chronic conditions like diabetes, that figure exceeds 50 %. Early diagnosis, access to and adherence to treatment, and compliance with healthy lifestyle modification recommendations—specifically, a healthy diet and regular physical activity—are crucial for delaying the progression of the disease [5].

Patient interviews and self-reports are the two most frequently employed methods for assessing compliance, although there are additional methods that can be utilised. A number of international studies have attempted to quantify the adherence of individuals with diabetes to their prescribed medicine [6].

We aimed to assess the adherence impact on glycemic control, diabetic complications, quality of life, and comorbidities of diabetes.

PATIENTS AND METHODS

Patients: This is a cross-sectional study, which was carried out on 450 type 1 and 2 diabetic patients attending the Endocrine and Diabetes Unit at Benha University Hospital in Benha City, Egypt during the period from June to December 2022.

Inclusion criteria: All individuals with diabetes who were present at the Unit on the interview day and provided informed consent to partake in the study.

Exclusion criteria: Age below 18 or above 75 years and pregnant and lactating women.

Methodology:

The following data were collected:

Socio-demographic characteristics, medical history, investigations in form of HbA1c measurements and other investigations (lipid profile measuring total cholesterol and triglyceride levels, renal function tests and albumin/creatinine ratio). Also, fundus examination to detect diabetic retinopathy and ECHO cardiography

Received: 13/07/2023
Accepted: 14/09/2023

to detect ejection fraction either preserved or reduced EF.

Assessment of Quality of life:

The health scores obtained from the EQ-5D-5L were standardised into a single index value ranging from 0 to 1. The resulting quality of life will be classified as follows: good quality of life (0.67-1), fair quality of life (0.34-0.66), or poor quality of life (< 0.33). Questions pertaining to self-care, physical activity, adherence to a dietary regimen as prescribed and adherence to on a timely basis, and compliance with medication regimens.

Patient adherence to medications was evaluated by utilizing Morisky Medication Adherence Scale 8 (MMAS 8):

The MMAS-8 is a self-reported, general assessment instrument that evaluates medication adherence. It comprises eight items designed to assess instances of non-compliance with medication regimens. The developer/owner of the scale can provide the scoring criteria, which are based on the summated scores from the MMAS-8 and range from 0 to 8. Morisky has predetermined the cut-points; adherence levels may be classified as high (equivalent to 8 points), medium (6 or 7 points), or low (less than 6 points).

Adherence to dietary plan:

A written dietary plan was provided to each participant prior to the interview as standard care at the centre. The diet comprises inquiries regarding the consumption frequency of fruits, red meat, vegetables, butter, bread, desserts, dates, sugar, and rice, as well as the fat content and number of meals per day of the milk consumed. On a scale from zero to forty-eight, the dietary habit variables were assessed; a high score indicates that the respondent maintains healthy eating habits.

Physical activity was classified as the following:

Those who engaged in rigorous daily exercise were classified as active, those who exercised 15–30 minutes per day as moderate, those who exercised < 15 minutes per day as mild, and those who did not exercise at all as sedentary. Adherence to physical activity was assessed by Global Physical Activity Questionnaire (GPAQ).

Statistical analysis

Categorical variables are presented as frequencies and percentages. Numerical variables are reported as the mean ± standard deviation. The χ^2 test was used for the correlation between variables except for tables with small frequencies, where the Fisher Exact test was used. $P \leq 0.05$ was considered significant. Data analysis was performed by means of SPSS for Windows (Statistical Package for Social Sciences) v28.

Ethical consideration: Written informed consent was obtained from every patient. The study was done after approval from The Endocrine and Diabetes Unit Ethical committee, Faculty of Medicine, Benha University (Approval code: Ms 5-6-2022).

RESULTS

Table (1) showed a significant association between sociodemographic characteristics and adherence to medication with both sex and education. In terms of sex, there was a statistically significant higher frequency of poor adherence in females (p=0.04*). Regarding education, the education level had a significant impact on adherence to medication. Patients who received university education were more adherent to medications. BMI was significantly high in poor adherence group compared to medium and high adherence groups (p<0.001). Individuals with a longer duration of diabetes demonstrated higher levels of poor adherence (p<0.001*). Poor adherence was more significantly associated with type 1 DM (p<0.001).

Table (1): Effect of different sociodemographic characteristics and duration of DM on adherence to medication

Characteristics		Poor (n=33)		Medium (n=193)		High (n=224)		Test of sig.	p-value
Age (mean ± SD)		47.76	12.11	51.79	13.52	49.99	13.41	1.8	0.2
Gender No. (%)	**Male**	8	24.2%	90	46.6%	105	46.9%	6.3	0.04*
	Female	25	75.8%	103	53.4%	119	53.1%		
Marital status No. (%)	**Not married**	4	12.1%	30	15.5%	43	19.2%	1.6	0.4
	Married	29	87.9%	163	84.5%	181	80.8%		
Residence No. (%)	**Urban**	12	36.4%	65	33.7%	99	44.2%	4.9	**0.1**
	Rural	21	63.6%	128	66.3%	125	55.8%		
Education No. (%)	**illiterate**	12	36.4%	57	29.5%	40	17.9%	30.5	**<0.001***
	Primary school	9	27.3%	22	11.4%	23	10.3%		
	Inter-mediate school	1	3.0%	1	0.5%	0	0.0%		
	High school	9	27.3%	67	34.7%	92	41.1%		
	university education	2	6.1%	46	23.8%	69	30.8%		
Occupation No. (%)	**Not working**	21	63.6%	96	49.7%	103	46.0%	5.7	**0.2**
	Mental work	2	6.1%	33	17.1%	47	21.0%		
	Manual work	10	30.3%	64	33.2%	74	33.0%		
Smoking No. (%)	**nonsmoker**	29	87.9%	149	77.2%	186	83.0%	3.4	**0.2**
	smoker	4	12.1%	44	22.8%	38	17.0%		
Weight in kg (mean ± SD)		162.2	4.67	165.1	6.2	166.1	6.12	11.2	**<0.001***
Height in cm (mean ± SD)		95.39	19.02	84.11	16.85	81.64	13.95	6.1	**0.02***
BMI (mean ± SD)		36.52	8.43	31.14	6.46	29.50	4.98	20.9	**<0.001***
DM duration (mean ± SD)		14.64	16.57	9.10	7.24	7.88	8.39	8.6	<0.001*
DM type No. (%)	**T1D**	25	75.8%	57	29.5%	79	35.3%	26.3	<0.001*
	T2D	8	24.2%	136	70.5%	145	64.7%		

Data are presented as number (%). *: significant P value

Table (2) showed that sociodemographic characteristics where there were significant associations between adherence to diet and marital status, education, occupation and smoking. There was a statistically significant impact on adherence to diet. Patients who were married, non-smokers, and received university education were more adherent to diet. A significant higher BMI in unhealthy group compared to less healthy and healthy groups ($p<0.001$). Patients with type 2 DM, oral antidiabetic regimen, and longer duration of diabetes were less adherent to healthy diet.

Table (2): Effect of different sociodemographic characteristics and duration of DM on adherence to healthy diet

Characteristics		Unhealthy (n=79)		Less healthy (n=175)		Healthy (n=196)	Test of sig.	p-value	
Age (mean ± SD)		51.43	12.80	50.84	13.27	50.05	13.77	0.3	0.7
Gender No. (%)	Male	27	34.2%	83	47.4%	93	47.4%	4.6	0.09
	Female	52	65.8%	92	52.6%	103	52.6%		
Marital status No. (%)	Not married	12	15.2%	21	12.0%	44	22.4%	7.4	0.03*
	Married	67	84.8%	154	88.0%	152	77.6%		
Residence No. (%)	Urban	32	40.5%	70	40.0%	74	37.8%	0.3	**0.9**
	Rural	47	59.5%	105	60.0%	122	62.2%		
Education No. (%)	Illiterate	28	35.4%	44	25.1%	37	18.9%	27.9	**<0.001 ***
	Primary school	8	10.1%	27	15.4%	19	9.7%		
	Inter-mediate school	1	1.3%	0	0.0%	1	0.5%		
	High school	34	43.0%	65	37.1%	69	35.2%		
	university education	8	10.1%	39	22.3%	70	35.7%		
Occupation No. (%)	Not working	47	59.5%	95	54.3%	78	39.8%	13.1	**0.01***
	Mental work	13	16.5%	25	14.3%	44	22.4%		
	Manual work	19	24.1%	55	31.4%	74	37.8%		
Smoking No. (%)	Nonsmoker	60	75.9%	131	74.9%	173	88.3%	12.3	**0.002***
	Smoker	19	24.1%	44	25.1%	23	11.7%		
Weight in kg (mean ± SD)		93.11	19.76	84.99	16.32	78.78	11.58	26.2	**<0.001 ***
Height in cm (mean ± SD)		163.6	5.51	164.8	6.25	166.6	6.08	8.2	**<0.001 ***
BMI (mean ± SD)		34.96	8.24	31.58	6.26	28.24	3.53	42.4	**<0.001 ***
DM duration		11.62	12.01	9.33	9.58	7.42	6.25	6.7	0.001*
DM type No. (%)	**T1D**	35	44.3%	69	39.4%	57	29.1%	7.3	0.03*
	T2D	44	55.7%	106	60.6%	139	70.9%		
DM treatment No. (%)	**Insulin**	18	22.8%	39	22.3%	30	15.3%	46.1	<0.001 *
	Oral	33	41.8%	114	65.1%	152	77.6%		
	Combined	28	35.4%	22	12.6%	14	7.1%		

Data are presented as number (%). *: significant P value.

There was a significant difference across the groups, with the active group having the lowest mean age ($p < 0.001$). Sex exhibited a significant difference, with the active group having the highest males percentage and the sedentary group having the highest females percentage ($p = 0.03$). Marital status also demonstrated a significant association, as the active group had the lowest percentage of unmarried individuals ($p= 0.009$). Residence displayed a significant difference, with the active group having the highest percentage of urban residents and the sedentary group having the highest percentage of rural residents ($p = 0.01$).

Education level showed a significant association, with the active group having the highest university education participants' percentage and the sedentary group having the highest illiterate participants' percentage ($p < 0.001$). Occupation exhibited a significant difference, as the sedentary group had the highest percentage of individuals not working, while the active group had the highest percentage engaged in manual work ($p < 0.001$). Smoking status showed a significant association, with the active group having the lowest percentage of smokers ($p = 0.006$). However, there were no significant differences observed for weight, height, and BMI among the groups. A significant higher BMI in sedentary group ($p < 0.001$). No significant difference was observed between studied cases according to type of daily activity in DM duration and types and treatment regimen (Table 3).

Table (3): Effect of different socio demographic characteristics and duration of DM on adherence to daily physical activity

Characteristics		Sedentary (n=128)		Mild (n=160)		Moderate (n=109)		Active (n=53)		Test of sig.	p-value
Age (mean ± SD)		54.9	10.8	50.8	13.7	48.6	12.2	43.6	16.8	10.6	<0.001 *
Gender No. (%)	**Male**	46	35.9%	78	48.8%	45	41.3%	34	64.2%	13.6	0.003*
	Female	82	64.1%	82	51.2%	64	58.7%	19	35.8%		
Marital status No. (%)	**Not married**	27	21.1%	20	12.5%	14	12.8%	16	30.2%	11.6	0.009*
	Married	101	78.9%	140	87.5%	95	87.2%	37	69.8%		
Residence No. (%)	**Urban**	36	28.1%	68	42.5%	45	41.3%	27	50.9%	10.6	0.01*
	Rural	92	71.9%	92	57.5%	64	58.7%	26	49.1%		
Education No. (%)	**Illiterate**	50	39.1%	37	23.1%	18	16.5%	4	7.5%	80.1	<0.001 *
	Primary school	8	6.3%	27	16.9%	19	17.4%	0	0.0%		
	Inter-mediate school	0	0.0%	2	1.3%	0	0.0%	0	0.0%		
	High school	33	25.8%	66	41.3%	52	47.7%	17	32.1%		
	university education	37	28.9%	28	17.5%	20	18.3%	32	60.4%		
Occupation No. (%)	**Not working**	70	54.7%	96	60.0%	40	36.7%	14	26.4%	33.4	<0.001 *
	Mental work	27	21.1%	22	13.8%	24	22.0%	9	17.0%		
	Manual work	31	24.2%	42	26.3%	45	41.3%	30	56.6%		
Smoking No. (%)	**non-smoker**	100	78.1%	121	75.6%	92	84.4%	51	96.2%	12.4	0.006*
	Smoker	28	21.9%	39	24.4%	17	15.6%	2	3.8%		
Weight in kg (mean ± SD)		86.9	18.6	82.5	14.5	82.8	16.4	81.5	11.5	2.5	0.07
Height in cm (mean ± SD)		164.0	6.3	164.9	6.2	165.6	6.0	169.7	3.7	11.9	<0.001 *
BMI (mean ± SD)		32.5	6.9	30.5	5.7	30.0	6.5	28.3	3.9	6.9	<0.001 *
DM duration		9.1	10.0	8.0	7.6	9.8	10.5	9.3	6.2	0.8	0.5
DM type No. (%)	**T1D**	42	32.8%	58	36.3%	38	34.9%	23	43.4%	1.9	0.6
	T2D	86	67.2%	102	63.7%	71	65.1%	30	56.6%		
DM treatment No. (%)	**Insulin**	26	20.3%	29	18.1%	16	14.7%	16	30.2%	8.6	0.2
	Oral	82	64.1%	111	69.4%	73	67.0%	33	62.3%		
	Combined	20	15.6%	20	12.5%	20	18.3%	4	7.5%		

Data are presented as number (%). *: significant P value

Table (4) showed impact of adherence to medication of diabetic patients on diabetic retinopathy and different lab parameters. Poor adherence was associated with a higher prevalence of retinopathy and elevated triglyceride, total cholesterol levels, and HbA1c levels (p<0.001). Different complications of DM were significantly higher in patients with poor adherence to medications compared to patients with medium and high adherence. There was a significant high prevalence of dementia in medium adherence patients (p=0.03).

Table (4): Impact of adherence to medication in diabetic patients on different lab parameters, DM complications and other comorbidities

Characteristics		Poor (n=33)		Medium (n=193)		High (n=224)		X^2	p-value
Lipid profile	Triglyceride (>150mg dl)	27	81.8%	125	64.8%	102	45.5%	24.9	<0.001*
	Total Cholesterol (>200mg dl)	27	81.8%	125	64.8%	102	45.5%	24.9	<0.001*
Complications									
Fundus abnormalities (retinopathy)		12	36.4%	44	22.8%	12	5.4%	37.1	<0.001*
Peripheral neuropathy		31	93.9%	126	65.3%	51	22.8%	108.1	<0.001*
Stroke (ischemic – hage)		10	30.3%	30	15.5%	24	10.7%	9.5	0.009*
Fungul Skin infection		6	18.2%	40	20.7%	8	3.6%	30.2	<0.001*
Diabetic foot		8	24.2%	32	16.6%	2	0.9%	39.5	<0.001*
UTI		29	87.9%	121	62.7%	89	39.7%	39.2	<0.001*
CKD (Alb./ Creat. Ratio)	CKD	14	42.4%	76	39.3%	41	18.4%	28.7	<0.001*
	Non-CKD	19	57.6%	117	60.6%	183	81.7%		
Heart failure (EF)	Reduced EF	17	51.5%	66	34.2%	35	15.6%	30.3	<0.001*
	Preserved EF	16	48.5%	127	65.8%	89	84.4%		
Comorbidities									
Liver diseases		**2**	6.1%	14	7.3%	16	7.1%	0.1	0.9
Bone fracture		**4**	12.1%	28	14.5%	19	8.5%	3.8	0.2
Dementia		**0**	0.0%	12	6.2%	4	1.8%	7.3	0.03*
HbA1C		**9.36**	1.77	7.65	1.45	6.66	1.07	75.1	<0.001*

Data are presented as number (%). *: significant P value.

This table showed the impact of adherence to diet of diabetic patients on investigations. Unhealthy diet was associated with a higher prevalence of diabetic retinopathy and elevated triglyceride and total cholesterol levels, and HbA1c levels. Different complications of DM were significantly higher in patients with poor adherence to healthy diet compared to patients with medium and high adherence. There was high prevalence of liver diseases (0.009), bone fracture (<0.001) and dementia (p=0.08) that were associated with unhealthy diet (Table 5).

Table (5): Impact of adherence to diet in diabetic patients on different lab parameters, DM complications and other comorbidities

Characteristics		Unhealthy (n=79)		Less healthy (n=175)		Healthy (n=196)		X^2	p-value
		No.	%	No.	%	No.	%		
Lipid profile	Triglyceride (>150mg dl)	71	89.9%	109	62.3%	74	37.8%	66.2	<0.001*
	Total Cholesterol (>200mg dl)	71	89.9%	109	62.3%	74	37.8%	66.2	<0.001*
Complications									
Diabetic retinopathy		30	38.0%	26	14.9%	12	6.1%	44.5	<0.001*
Peripheral neuropathy		77	97.5%	114	65.1%	17	8.7%	219.8	<0.001*
Stroke(ischemic-hage)		21	26.6%	41	23.4%	2	1.0%	50.1	<0.001*
Fungul Skin infection		22	27.8%	18	10.3%	14	7.1%	23.7	<0.001*
Diabetic foot		28	35.4%	10	5.7%	4	2.0%	78.7	<0.001*
Recurrent UTI		60	75.9%	107	61.1%	72	36.7%	42.2	<0.001*
Heart failure (EF)	Reduced EF	30	38.0%	62	35.4%	26	13.3%	30.3	<0.001*
	Preserved EF	49	62.0%	113	64.6%	170	86.7%		
CKD (Alb./ Creat. Ratio)	CKD	48	60.7%	55	31.4%	28	14.3%	62.6	<0.001*
	Non-CKD	31	39.2%	120	68.6%	168	85.7%		
Comorbidities									
Liver diseases		12	15.2%	10	5.7%	10	5.1%	9.5	0.009*
Bone fracture		14	17.7%	31	17.7%	6	3.1%	23.6	<0.001*
Dementia		6	7.6%	6	3.4%	4	2.0%	5.1	0.08*
HbA1C		9.53	1.90	7.22	.88	6.44	.55	25.4	<0.001*

Data are presented as number (%). *: significant P value

Table (6) showed that sedentary life was significantly associated with diabetic retinopathy (p=0.08), high lipid profile (p<0.001) and HBA1c level. Different complications of DM were significantly low in patients with active exercise compared to patients with less physical activity. There was a significant high prevalence of dementia (p=0.01) and bone fractures (p<0.001) in sedentary group.

Table (6): Impact of adherence to daily physical activity in diabetic patients on different lab parameters, DM complications and other comorbidities

Characteristics		Sedentary (n=128)		Mild (n=160)		Moderate (n=109)		Active (n=53)		X^2	p-value
Lipid profile	Triglyceride (>150)	93	72.7%	92	57.5%	51	46.8%	18	34.0%	28.8	<0.001*
	Total Cholesterol (>200)	93	72.7%	92	57.5%	51	46.8%	18	34.0%	28.8	<0.001*
Complications											
Diabetic retinopathy		26	20.3%	26	16.3%	12	11.0%	4	7.5%	6.7	0.08*
Peripheral neuropathy		91	71.1%	74	46.3%	39	35.8%	4	7.5%	86.5	<0.001*
Stroke(ischemic-hage)		33	25.8%	17	10.6%	10	9.2%	4	7.5%	19.9	<0.001*
Fungul Skin infection		24	18.8%	16	10.0%	6	5.5%	8	15.1%	10.9	0.01*
Diabetic foot		18	14.1%	14	8.8%	10	9.2%	0	0.0%	8.9	0.03*
Recurrent UTI		78	60.9%	87	54.4%	53	48.6%	21	39.6%	8.1	0.04*
CKD (Alb. / Creat. Ratio)	CKD	58	45.3%	49	30.6%	20	18.3%	4	7.5%	51.1	<0.001*
	Non CKD	70	54.7%	111	69.4%	89	81.7%	49	92.5%		
Heart failure (EF)	less than 50%	44	34.4%	48	30.0%	22	20.2%	4	7.5%	17.2	<0.001*
	more than 50%	84	65.6%	112	70.0%	87	79.8%	49	92.5%		
Comorbidities											
Liver diseases		12	9.4%	14	8.8%	6	5.5%	0	0.0%	6.1	0.1
Bone fracture		34	26.6%	5	3.1%	8	7.3%	4	7.5%	42.8	<0.001*
Dementia		10	7.8%	4	2.5%	2	1.8%	0	0.0%	10.2	0.01*
HbA1C		7.5	1.4	7.3	1.6	7.2	1.7	6.9	0.7	2.4	0.07*

Data are presented as number (%). *: significant P value.

DISCUSSION

In relation to medication adherence, various sociodemographic factors were identified in a study [7] as being associated with medication adherence in diabetic patients. These factors included monthly income, self-monitoring of blood glucose (SMBG) practice, the number of medications being taken, and sources of medication cost coverage. Notably, the level of medication adherence was found to be significantly associated with medical conditions. Higher durations of DM (> 5 years) were significantly associated with poor self-care behaviour, which was in turn associated with poor medication adherence, according to a previous study [8]. A study found that there was no significant association between the duration of diabetes and medication adherence [9].

In line with our results, a study [7] discovered a significant association between the degree of medication adherence and the level of glycemic control among patients with comorbid T2DM. It was discovered that patients who adhered to their medication more consistently had a lower likelihood of experiencing inadequate glycemic control in comparison with those who refrained from self-monitoring their blood glucose, were obese, or had low medication adherence. Furthermore, it was found in a study that improved glycemic control was associated with increased medication adherence [8].

Concurrently, a study was undertaken to examine the correlation between medication adherence and health-related quality of life among 518 diabetic patients. The study utilised the knowledge 20 questionnaire as the adherence subscale. An increased risk of pain/discomfort complications and issues was identified in patients with poorer medication adherence [10]. According to a research conducted in Iran [11], medication adherence decreased the risk of diabetic foot ulcers, retinopathy, nephropathy, neuropathy, cardiovascular disease, and hypertension. A prior investigation [10] demonstrated a robust positive association between non-adherence to medication and health-related quality of life for each of the medication non-adherence scale items.

In a descriptive cross-sectional study conducted by **Saleh** [12], a total of 288 individuals with diabetes participated in the research and completed a questionnaire with regards to dietary adherence. The survey gathered data on the participants' sociodemographic status, medical history, self-monitoring frequency, medication usage, the influence

of environmental factors and others concerns, dietary habits, and lifestyle choices. They demonstrated that 78.8 % adhered to the diet prescribed by their physicians. Consistent with our results, a study [13] revealed that adherence to a restricted diet amounted to a mere 15.7%. An analogous result was observed in Kathmandu, where the rate of adherence was 12.9%, and Dhaka, Bangladesh, where it stood at 14.29% [14]. This similarity in results may be attributed to a comparable sociocultural environment. In contrast, the rate of compliance with dietary recommendations in Delhi was 84.6% [15]. The presence of conflicting results may be attributed to the utilisation of diverse instruments for assessing adherence.

A research study conducted by **Baral *et al.*** [13] identified a significant association between family structure and dietary adherence. Specifically, the study found that individuals residing in single-parent households were 2.7 times more likely to adhere to their diets compared to those in joint-family households. An analogous result was observed in the research conducted in Nepalgunj [16].

Potential explanations for the similarity in results include comparable sample sizes, sampling methodologies, and sociocultural contexts. A similar result was observed in bivariate analysis, which found that illiteracy was associated with greater noncompliance than literacy [17]. Research conducted in Bangladesh [14], Saudi Arabia [18], and Ethiopia [19] provided additional support for this result. This relationship appears to be credible given that individuals pursuing formal education independently seek out comprehensive information concerning the disease and the diet importance. An alternative result revealed that 84.6% of the participants whose disease had been present for a certain period of time (11-15 years) adhered to the diet that was recommended [12].

A study reported that there was no relation between the type of treatment and adherence to diet [13]. However, according to a study conducted in Saudi Arabia, those who took oral medications adhere to their diets better than those who take both insulin and oral medications [18]. The low proportion of participants in their study who were concurrently using oral hypoglycemic drugs and insulin may account for this discrepancy (only 10.8%2). The magnitude of the proportion may have been insufficient to demonstrate a significant outcome.

Consistent with our findings, a study [12] demonstrated that physical activity and lifestyle modifications are essential for glycemic control and the reduction of morbidities and fatalities associated with diabetes.

Further significant reductions in the incidence of complications associated with diabetes were documented in the research article by **Schlesinger *et al.*** [20]. In this study, 56.4% of participants adhered to the lifestyle and exercise recommendations, which is greater than the percentage observed in another study by **Mukherjee *et al.*** [21].

According to **Baral *et al.*** [13] no association was found between comorbidity and dietary adherence. In contrast, patients who did not have comorbidities were more likely to adhere to their diets, according to an Ethiopian study [16].

Concerning complications associated with DM, an interview-based study was conducted with a systematically selected sample of type 2 diabetic patients. In order to evaluate dietary adherence, the Perceived Dietary Adherence Questionnaire was administered. They demonstrated that one-seventh of the participants adhered to their diets well. Anthropometric measurements, disease-related factors, dietary factors, adherence to medication, sociodemographic factors, and medication adherence were all examined in relation to dietary adherence. The results indicated that adherence to medication is more strongly related with the following variables: self-control over food, affordability of diet, physical activity, and medication. A relationship exists between dietary adherence and the type of family (social factor), with single-parent households being more likely to adhere to a diet [13].

In relation to diet adherence, a research study revealed that individuals who were able to afford the suggested diet were nearly three times more likely to adhere to it compared to those who were unable to afford it [13]. Furthermore, a prior investigation carried out in Ethiopia identified inadequate adherence as the cause of the exorbitant cost of food. The relationship appears logical, given that individuals with financial means have access to a variety of food options [19]. Likewise, **Baral *et al.*** [13] discovered that participants with food self-control were four times more likely to adhere to their diets than those without self-control. The aforementioned discovery is corroborated in the article [22]. This may be the result of the utilisation of self-reported data rather than instruments to assess self-control habits across all of these studies.

With regard to the daily operations of DM, according to the findings of **Baral *et al.*** [13], participants demonstrated a greater adherence to moderate and vigorous physical activity (20.6 %) in comparison with following dietary recommendations (15.7 %). Consistent with the results regarding dietary adherence (17.4%), Iran also reported physical activity adherence (10.4%) [11]. On the contrary, a greater proportion of individuals in Saudi Arabia followed a healthy diet (64.66 %) and engaged in regular exercise (45.33 %) [18]. This could be attributed to the utilisation of distinct threshold values for dietary adherence and physical activity adherence.

According to **Baral *et al.*** [13], individuals who participated in physical activities demonstrated a 3.3-fold increase in adherence to a diet compared to those who did not engage in such activities. A similar result was discovered in a Saudi Arabian study [18]. A

significant positive correlation was observed between adherence to physical exercise and adherence to a diet prescribed for individuals with diabetes. A study by **Klinovszky *et al.*** [23] showed that adherence to diet showed a significant positive correlation with adherence to physical activity. This finding suggests that participants who made an effort to incorporate the prescribed diet were more likely to adhere to the physical exercise regimen.

Among the participants, 60.8% were overweight or obese, whereas 39.2% had a normal body mass index, according to a study by **Baral *et al.*** [13]. While, in Iran, it was 75.9% [11]. A study in Addis Ababa revealed that 46.4% of the participants were overweight or obese [24] . In the same way, adherence to a diet was not found to be related with waist circumference, according to **Baral *et al.*** [13]. On the contrary, **Raj *et al.*** [25] demonstrated an inverse correlation between waist circumference and dietary adherence in their research.

With respect to physical activity, in line with our findings, a study by **Saleh** [12] revealed that 56.4% of the participants were engaged in physical activity.

Consistent with our findings, A study by [26] corroborated our findings that active lifestyles are regarded as crucial for managing obesity (BMI) and achieving a low glycemic index in diabetic patients, as more than 70% of the study participants were physically active. In comparison with T2DM patients with moderate-to-high activity levels, those with low activity levels had a life expectancy that was approximately 0.1–0.5 years shorter, according to a previous study. It is crucial to educate patients in the early stages of diabetes mellitus and those at risk of developing the disease about the benefits of adopting a healthier lifestyle and increasing physical activity [27].

Uncontrolled diabetes mellitus has been identified as a cause of both microvascular and macrovascular complications. Moreover, these complications resulting from inadequately managed diabetes constitute significant contributors to impairment, untimely demise, and diminished quality of life [28].

CONCLUSION

Priority should be given for enhancing medication adherence, dietary habits, and physical activity in management interventions for diabetic patients with comorbidities.

- **Funding:** Nil.
- **Conflict of interest:** Nil.

REFERENCES

1. **Islam S, Purnat T, Phuong N *et al.* (2014):** Non-communicable diseases (NCDs) in developing countries: a symposium report. Global Health, 5 (1): 81-8.
2. **Yasmin F, Nahar N, Banu B *et al.* (2020):** The influence of mobile phone-based health reminders on patient adherence to medications and healthy lifestyle recommendations for effective management of diabetes type 2: a randomized control trial in Dhaka, Bangladesh. BMC Health Serv Res., 20 (1): 520.
3. **Horne R, Weinman J, Barber N *et al.* (2005):** Concordance, adherence and compliance in medicine taking. London: NCCSDO, 40: 6.
4. **Yasmin F, Nahar N, Banu B *et al.* (2020):** The influence of mobile phone-based health reminders on patient adherence to medications and healthy lifestyle recommendations for effective management of diabetes type 2: a randomized control trial in Dhaka, Bangladesh. BMC Health Services Research, 20 (1): 1-12.
5. **Jimmy B, Jose J (2011):** Patient medication adherence: measures in daily practice. Oman Med J, 26 (3): 155-9.
6. **Anghel L, Farcas A, Oprean R (2019):** An overview of the common methods used to measure treatment adherence. Med Pharm Rep, 92 (2): 117-22.
7. **Sendekie A, Netere A, Kasahun A, Belachew E (2022):** Medication adherence and its impact on glycemic control in type 2 diabetes mellitus patients with comorbidity: A multicenter cross-sectional study in Northwest Ethiopia. PLoS One, 17 (9): e0274971.
8. **Kassahun T, Gesesew H, Mwanri L, Eshetie T (2016):** Diabetes related knowledge, self-care behaviours and adherence to medications among diabetic patients in Southwest Ethiopia: a cross-sectional survey. BMC Endocrine Disorders, 16 (1): 28.
9. **Mannan A, Hasan M, Akter F *et al.* (2021):** Factors associated with low adherence to medication among patients with type 2 diabetes at different healthcare facilities in southern Bangladesh. Glob Health Action, 14 (1): 1872895.
10. **Chantzaras A, Yfantopoulos J (2022):** Association between medication adherence and health-related quality of life of patients with diabetes. Hormones, 21 (4): 691-705.
11. **Mirahmadizadeh A, Khorshidsavar H, Seif M, Sharifi M (2020):** Adherence to Medication, Diet and Physical Activity and the Associated Factors Amongst Patients with Type 2 Diabetes. Diabetes Ther., 11 (2): 479-94.
12. **Saleh A (2022):** People with diabetes adherence to drug, dietary, and lifestyle changes in Erbil city, Iraq. BMC Endocrine Disorders, 22 (1): 305.
13. **Baral J, Karki K, Thapa P *et al.* (2022):** Adherence to Dietary Recommendation and Its Associated Factors among People with Type 2 Diabetes: A Cross-Sectional Study in Nepal. J Diabetes Res, 6(1) 605-9.
14. **Mumu S, Saleh F, Ara F, Afnan F, Ali L (2016):** Non-adherence to life-style modification and its factors among type 2 diabetic patients. Indian J Public Health, 58 (1): 40-4.
15. **Basu S, Garg S, Sharma N, Singh M, Garg S (2018):** Adherence to self-care practices, glycemic status and influencing factors in diabetes patients in a tertiary care hospital in Delhi. World J Diabetes, 9 (5): 72-9.
16. **Parajuli J, Saleh F, Thapa N, Ali L (2014):** Factors associated with nonadherence to diet and physical activity among Nepalese type 2 diabetes patients; a cross sectional study. BMC Res Notes, 7(2): 5-8.
17. **Kafle N, Poudel R, Shrestha S (2018):** Noncompliance to diet and medication among patients with type 2 diabetes mellitus in selected hospitals of Kathmandu, Nepal. Journal of Social Health and Diabetes, 6 (02): 90-5.
18. **Khan A, Al-Abdul Lateef Z, Al Aithan M *et al.* (2016):** Factors contributing to non-compliance among diabetics

attending primary health centers in the Al Hasa district of Saudi Arabia. J Family Community Med., 19 (1): 26-32.

19. **Ayele A, Emiru Y, Tiruneh S *et al.* (2018):** Level of adherence to dietary recommendations and barriers among type 2 diabetic patients: a cross-sectional study in an Ethiopian hospital. Clin Diabetes Endocrinol, 8(6): 4-21.
20. **Schlesinger S, Neuenschwander M, Ballon A, Nöthlings U, Barbaresko J (2020):** Adherence to healthy lifestyles and incidence of diabetes and mortality among individuals with diabetes: a systematic review and meta-analysis of prospective studies. J Epidemiol Community Health, 74 (5): 481-7.
21. **Mukherjee S, Sharmasarkar B, Das K, Bhattacharyya A, Deb A (2016):** Compliance to anti-diabetic drugs: observations from the diabetic clinic of a medical college in kolkata, India. J Clin Diagn Res., 7 (4): 661-5.
22. **Ganiyu A, Mabuza L, Malete H, Govender I, Ogunbanjo G (2016):** Non-adherence to diet and exercise recommendations amongst patients with type 2 diabetes mellitus attending Extension II Clinic in Botswana. African Journal of Primary Health Care and Family Medicine, 5 (1): 1-6.
23. **Klinovszky A, Kiss I, Papp-Zipernovszky O, Lengyel C, Buzás N (2019):** Associations of different adherences in patients with type 2 diabetes mellitus. Patient Prefer Adherence, 13: 395-407.
24. **Worku A, Mekonnen Abebe S, Wassie M (2015):** Dietary practice and associated factors among type 2 diabetic patients: a cross sectional hospital based study, Addis Ababa, Ethiopia. Springerplus, DOI: 10.1186/s40064-015-0785-1
25. **Raj G, Hashemi Z, Soria Contreras D *et al.* (2018):** Adherence to Diabetes Dietary Guidelines Assessed Using a Validated Questionnaire Predicts Glucose Control in Adults With Type 2 Diabetes. Can J Diabetes, 42 (1): 78-87.
26. **Al-Sinani M, Min Y, Ghebremeskel K, Qazaq H (2015):** Effectiveness of and Adherence to Dietary and Lifestyle Counselling: Effect on metabolic control in type 2 diabetic Omani patients. Sultan Qaboos Univ Med J., 10 (3): 341-9.
27. **Çolak T, Acar G, Dereli E *et al.* (2016):** Association between the physical activity level and the quality of life of patients with type 2 diabetes mellitus. J Phys Ther Sci., 28 (1): 142-7.
28. **Dimore A, Edosa Z, Mitiku A (2023):** Glycemic control and diabetes complications among adult type 2 diabetic patients at public hospitals in Hadiya zone, Southern Ethiopia. PLoS One, 18 (3): e0282962.