Original Article

Adherence to Recommended Regimen and Associated Factors among Type 2 Diabetes Mellitus Patients in Rwinkwavu District Hospital, Rwanda

Emmanuel Ufitamahoro, Erigene Rutayisire, Michael Habtu*

Department of Public Health, School of Health Sciences, Mount Kenya University, Kigali, Rwanda

***Corresponding author:** Michael Habtu. Department of Public Health, School of Health Sciences , Mount Kenya University, Kigali Campus, Rwanda. Email: mikel.habtu@gmail.com

Abstract

Background

The main risk factor for developing various complications and hospital admissions among type 2 diabetes is poor adherence to all recommended regimens.

Objective

To determine adherence to recommended regimen and associated factors among type 2 diabetes at Rwinkwavu District Hospital and its catchment area.

Methods

A descriptive cross-sectional study was employed. A total of 307 type 2 diabetes were selected using systematic random sampling. Data were collected using a questionnaire. Descriptive analysis (frequency and percentages) to describe the participants' characteristics, and Chi-square test to establish associated factors with adherence to recommended regimen were performed. Then multivariable logistic regression was used to determine factors independently associated with adherence to recommended regimen.

Results

The result shows that 85.7%, 27.0% and 38.8% of the respondents had good adherence to medication, diet and exercise respectively. Multivariable analysis revealed that not taking alcohol [aOR= 2.21; 95%CI= 1.11-4.42], accessibility of healthcare services [aOR= 2.59; 95%CI= 1.21-5.53] and no experience of drug side effects [aOR= 5.27; 95%CI= 2.46-11.32] were associated with high medication adherence. Factors associated with high adherence level to recommended diet were accessibility to healthcare services [aOR= 2.93; 95%CI= 1.20-7.17], receiving lifestyle modification sessions [aOR= 3.56; 95%CI= 1.02-12.46] and presence of chronic comorbidities [aOR= 2.36; 95%CI= 1.37-4.08]. In addition, higher level of education [aOR= 2.64; 95%CI= 1.05-6.67], accessibility to healthcare services [aOR= 2.83; 95%CI= 1.31-6.09] and shorter time since diagnosis of type 2 diabetes [aOR= 2.09; 95%CI= 1.08-4.51] were more likely to have high adherence to recommended exercise.

Conclusion

Different individual and clinical factors were identified as determinants of adherence to recommended regimen among type 2 diabetes patients. Therefore, the policy makers concerned with health promotion will need to consider ways of improving access to compressive lifestyle education and healthcare services as well as availing drugs with less side effects.

Rwanda J Med Health Sci 2022;5(3):276-290

Keywords: Adherence, Diet, Exercise, Medication, Recommended Regimen, Type 2 Diabetes

Introduction

Type 2 diabetes mellitus caused by ineffective use of insulin by the body is considered to be one of the most common public health issues especially in developing nations.[1] In recent years there has been increased concern that more than one-third of the type 2 diabetes related mortality is occurring below the age of 6o years.[2] In 2017, 425 million diabetes mellitus patients were living worldwide and it was projected to be 629 million by 2045.[3] In sub-Saharan Africa (SSA) the magnitude of type 2 diabetes ranges from 2.1% to 6.0% and within the coming 25 years the number will be doubled.[3] In Rwanda the occurrence of diabetes among adults aged 20 to 70 years has increased from 1.6% in 2010 to 5.2% in 2019.[4]

Various studies from developing countries of Africa and Asia have demonstrated that various levels of adherence to medication, diet and exercises among type 2 diabetes patients. For example studies in these developing countries have showed the level of adherence to the recommended diet between 25% and 65% while it was ranging from 15% to 40% for exercise.[5–9] In the same setting the level of adherence to medication ranges from 40% to 75%.[10–14] Poor adherence and rising occurrence of type 2 diabetes mellitus risk factors (alcohol consumption, smoking, overweight/ obesity, physical inactivity) are believed to be the key deterrents in preventing the burden of diabetes.[15] This is evidenced by a number of type 2 diabetes patients with several consequences including severe complications, high admission in the hospital, long duration of hospital stay, economic burden, low productivity and health facilities burden.[16–18]

The factors that affect adherence to the guideline among the type 2 diabetes mellitus are individual factors, socio-economy factors or clinical factors.[18] These include family dysfunction, poverty/low income, high cholesterol level, high glucose level, low level of education, unemployment, high medication and transport cost, unsteady living conditions, long distance from the health facilities, lack of social support, altering environment, attitude or culture about the diseases and treatment.[6,18–21]

A study done in 2015 among diabetes patients in Kigali indicated that 54.9% were not aware of the frequency of blood glucose testing, 58.0% were aware about the recommended meal plan and only 2.5% were engaging in physical exercises 3 times a week.[22] Another research carried out in Kigali also found that about 39% of the diabetes patients were not engaged in physical activities.[23] Another study done in Kigali city recently also indicated that 53.5% of type 2 diabetes had poor adherence to medication.[24] Worth noting is the fact that studies done in Rwanda were focusing on urban settings mainly in the capital city, Kigali. However, there is still limited data on adherence to medication, dietary habits and exercise as well as associated factors among type 2 diabetes patients from the rural areas of Rwanda. Thus, the present study was conducted to determine the level of adherence to recommended regimen and associated factors among type 2 diabetes in rural setting of Rwanda.

Materials and Methods

Study design and setting

The study used a quantitative cross-sectional design. It was conducted at Rwinkwavu District Hospital and its catchment area of eight health centers in Kayonza District. These health centers include Ndego, Cyarubare, Karama, Rwinkwavu, Kabarondo, Nyamirama, Ruramira and Rutare. The population covered by the District hospital is approximately 180,000 of which 90% is rural, according to the 2012 census.[25]

Population, sample size and sampling

The study targeted all adult type 2 diabetes patients (males and females) with 6 months duration since being diagnosed with the disease.

A single-population proportion formula by Cochran (1963) as cited in [26] for cross-sectional study was used to calculate the sample size.

$$n_0 = \frac{Z^2 pq}{e^2}$$

Where:
n_0 is desired samples size
'e' is the preferred margin of error at 5%,
'p' is the prevalence of adherence to exercise according to a recent study conducted in Ethiopia among type 2 diabetes was 26.4%. [27]
'Z' stands for the standard normal deviate, which matches to the 95 percent confidence level (1.96)
Non-response rate = 10%.
After considering all these assumptions, the sample size was estimated to be 329 type 2 diabetes patients.
To select respondents, first the total number of type 2 diabetes patients was obtained from the District hospital and eight health centres. This was estimated using the records of type 2 diabetes patients in the follow-up (about 800), and they were assigned proportionately to each health facility. Respondents were selected using systematic sampling method with an interval of two based on the total target population and calculated sample size. The first respondent was blindly selected from the first and the second. Respondents were selected according the order they followed in coming to the health facilities during the follow-up visit.

Data collection tool

A pretested questionnaire designed after extensive literature review was used. [5,9,28–30] The aim of this pre-testing the questionnaire was to check the extent to which it would be understood by the respondents, to identify areas for modifications and to familiarize research assistants with data collection tools before actual data collection. First, it was designed in English then translated into Kinyarwanda (local language) as it is the main language spoken in the study area.

The questionnaire consisted of three parts: part 1 on socio-demographic and socio-economic characteristics; part 2 related to clinical factors; and part 3 was about the outcome of the study (adherence to recommended regimen to medication, diet and exercise). The socio-economic status was assessed using poverty social category established by Minister for Local Government and Social Affairs in 2015. These were four categories from 1 to 4 scale where category 3 and 4 indicates households with highest income while category 1 the lowest income.

The dependent variable which was adherence to recommended regimen included adherence to medication, adherence to diet and adherence to physical activity. The medication/drug adherence was measured using Morisky Medication Adherence Scale (MMAS).[31] Health dietary habits include consuming food items which have high fibers and whole grains and on the contrary foods with low fat, sugar and carbohydrates can improve in reducing blood glucose level and eventually decreasing the need of insulin.[32] Adherence to diet was measured according to healthy dietary recommendation which is eating fruits and vegetables as well as high fiber food and whole grain, but low carbohydrate, fats and sugars.[9] Individuals were considered adherent to diet if they ate the recommended health diet at least 4 days per week. The exercise adherence was measured by using 30 minutes of aerobic activities (walking, jogging, or cycling) per day.[28] To ensure that the quality of data collection was maintained, the researchers supervised and monitored the data collection activities on daily basis. Anthropometric measurements of weight and height were measured using standard calibrated scales with light clothing and without shoes. Then, the body mass index was calculated using the measured weight in kilogrammes divided by the square of height in metres. WHO reference standard was used to classify BMI into obesity, overweight and normal BMI index.[33]

Data analysis procedure

All captured data were double entered into Microsoft Excel validated and then exported for analysis to the Statistical Package for Social Sciences (SPSS) Version 25.0 IBM New York. Univariate analysis was computed using frequencies and percentages to describe the basic characteristics of the respondents. Pearson chi-square test was used for bivariate analysis to identify associated factors with adherence to recommended regimen. All the significance level was set at $p < 0.05$. Then the independent factors associated with adherence to recommended regimen during bivariate analysis were determined using multivariable logistic regression by controlling for the confounding variables. The factors controlled in the multivariable logistic regression include level of education, religion, marital status, smoking, obesity social category and taking alcohol, healthcare service accessibility, time since diagnose of diabetes mellitus and comorbidity.

Ethical considerations

Ethical clearance was obtained from the School of Postgraduate studies, Mount Kenya University (MKU04/PGS&R/0582/2022). Then permission to collect data was granted by the Director General of Rwinkwavu District Hospital. Before the actual data collection, respondents were provided with the detailed information about the purpose and objectives of the study. Then written informed consent was obtained from the respondents. Confidentiality and privacy were maintained and no names or other identifiers were used. The data were kept in a computer with a password.

Results

Socio-demographic attributes of the respondents

A total of 307 out of 329 were included in the analysis after removing incomplete data, which gives a response rate of 93.31%. The key socio-demographic characteristics distributions are presented in Table 1.

Table 1.Socio-demographic attributes of the respondents

Variables	Frequency	Percentage
Age in years		
<40	38	12.4
40 to 49	62	20.2
50 to 59	81	26.4
60 to 69	73	23.8
>=70	53	17.3
Sex		
Male	135	44.0
Female	172	56.0
Residence		
Urban	59	19.2
Rural	248	80.8
Education		
None	63	20.5
Primary	205	66.8
Secondary and above	39	12.7
Religion		
Christian	244	79.5
Muslim	63	20.5
Marital status		
Married	261	85.0
Single/separated	46	15.0
Social category		
Category 1	35	11.4
Category 2	90	29.3
Category 3 and 4	182	59.3
Smoking		
Yes	43	14.0
No	264	86.0
Taking alcohol		
Yes	98	31.9
No	209	68.1
Body mass index (BMI; Kg/m^2)		
Normal (18.5 to 24.99)	90	29.3
Overweight (25.0- 29.99)	201	65.5
Obese (30 and above)	16	5.2

The highest percentage (26.4%) of the respondents were aged 50 to 59 years, followed by those aged 60 to 69 years (23.8%).There were more females (56.0%) compared to males (44.0%), and most (80.8%) were from the rural area. Regarding the level of education, majority (66.8%) had primary level and 20.5% never attended school. Most (79.5%) of the respondents belonged to Christian religion and a large proportion (85.0%) were married.

More than half (59.3%) were from high social class (category 3 and 4). About 14.0% were smokers and 31.9% claimed that they were taking alcoholic drinks. Majority (65.5%) of the type 2 diabetes were overweight.

Clinical related factors

Most of the respondents (83.4%) and (84.4%) indicated that healthcare services were available and attended lifestyle modification in the health facilities respectively. Similarly, 79.5% were satisfied with their healthcare providers in terms of communication and 80.5% claimed that they had enough time with healthcare providers.

Large percentage of the respondents (93.5%) were taking anti-diabetic medication and most (82.6%) reported taking oral hypoglycemic drugs. Less than half (43.6%) indicated that they experienced side effects of the drugs. The duration of diabetes since being diagnosed was assessed where 30.3% had stayed with the disease 10 to 14 years while 16.6% had 15 years and above. The proportion of comorbidity with chronic disease was 37.5% as indicated in Table 2.

Table 2. Clinical related factors

Variables	Frequency	Percentage
Healthcare services accessibility		
Yes	256	83.4
No	51	16.6
Attending lifestyle modification education		
Yes	259	84.4
No	48	15.6
Satisfied with the healthcare provider's communication		
Yes	244	79.5
No	63	20.5
Getting enough time with primary healthcare provider		
Yes	247	80.5
No	60	19.5
Weather under diabetes mellitus medication		
Yes	287	93.5
No	20	6.5
Type of medication (n= 287)		
Insulin	32	11.1
Oral	237	82.6
Both	18	6.3
Duration with diabetes since diagnosed		
5 years	88	28.7
5 to 10 years	75	24.4
10 to 14 years	93	30.3
> =15 years	51	16.6
Co-morbidity with chronic disease		
Yes	115	37.5
No	192	62.5
Side effect of the drugs		
Yes	134	43.6
No	173	56.4

Level of adherence to recommended regimen

The levels of adherence to recommended regimen (medication, diet and exercise) are presented in Figure 1. The level of high and moderate adherence to medication were 28.7% and 57.0% respectively while 14.3% had low adherence to medication. The distribution of parameter used for assessing the medication adherence are as follows: 37.1% ever forgot their medication, 35.8% ever had problems of remembering taking medication, 35.2% stop if feeling better and 35.8% stop if feeling worse because of the drugs. The level of good adherence to diet was 27.0% while the 77.0% had poor adherence. Five items were used where 20.2% were taking high fiber, 45.3% fruits/vegetables, 56.4% had low saturated fat and caloric intake, 14.0% less sugar/carbohydrate and fat meals and 9.4% indicated that they were eating any kind of food. The Figure further shows that the level of adherence to recommended exercise was 38.8%.

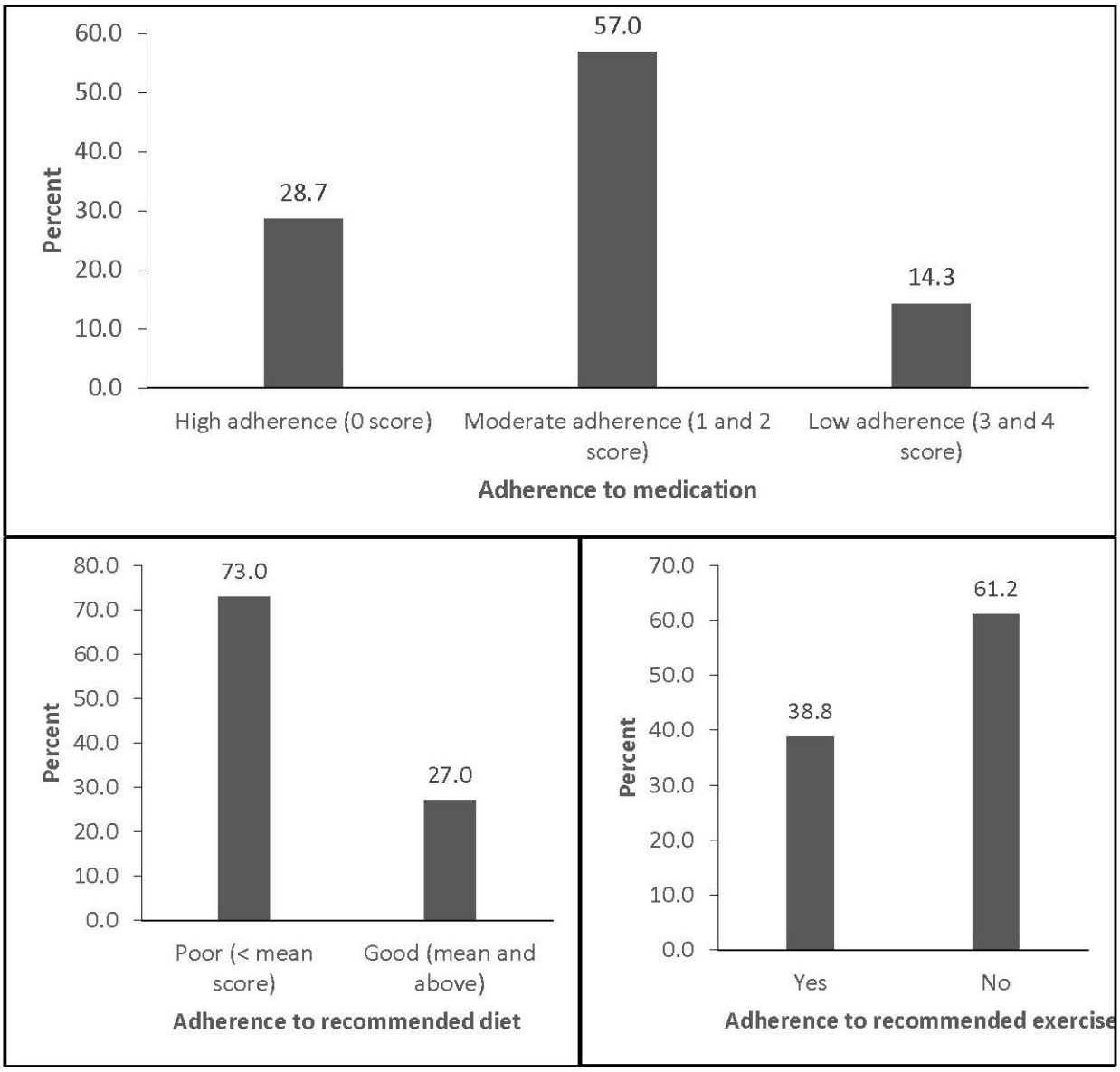

Figure 1. Level of adherence to recommended regimen

Bivariate analysis for participants' characteristics associated with adherence to recommended regimen

As indicated in Table 3, there was a significant association of the level of education (p =0.003), social category (p = 0.024) and taking alcohol (0.015) with medication adherence. Moreover, the demographic factors that significantly associated with adherence of recommended diet were religion (p = 0.011) and marital status (p = 0.006). Level of education was marginally significantly associated with high level of diet adherence (p = 0.051). Furthermore, the socio-demographic factors statistically associated with high level of exercise were education status (p = 0.020), religion (p = 0.031), smoking (p = 0.024) and Obesity (p = 0.022).

There was significant association between healthcare service accessibility and medication adherence (p = 0.001) as well as drug side effects and medication adherence (p value <0.001). There were five healthcare related factors associated with the adherence of recommended diet. These include accessibility of healthcare services (p = 0.019), attending lifestyle modification education (p <0.001),getting enough time with primary healthcare provider (p <0.001), duration with the disease (p = 0.004) and comorbidity (p <0.001). There were also six healthcare factors associated with adherence of exercise including healthcare service accessibility (p = 0.041), satisfaction with the primary healthcare provider communication (p = 0.003), getting enough time with primary healthcare provider (p = 0.006), those under medication (p value= 0.006), duration with diabetes (p <0.001) and side effect of drugs (p = 0.002).

Table 3. Bivariate analysis for participants' characteristics associated with adherence to recommended regimen

Variables	Medication adherence			Diet adherence			Exercise adherence		
	Moderate to high, n (%)	Low, n (%)	p value	High, n (%)	Low, n (%)	p value	High, n (%)	Low, n (%)	p value
Age [years]									
<40	33 (86.8)	5 (13.2)	0.062	13 (34.2)	25 (65.8)	0.614	10 (26.3)	28 (73.7)	0.335
40 to 49	55 (88.7)	7 (11.3)		13 (21.0)	49 (79.0)		24 (38.7)	38 (61.3)	
50 to 59	74 (91.4)	7 (8.6)		22 (27.2)	59 (72.8)		32 (39.5)	49 (60.5)	
60 to 69	62 (84.9)	11 (15.1)		22 (30.1)	51 (69.9)		34 (46.6)	39 (53.4)	
>=70	39 (73.6)	14 (26.4)		13 (24.5)	40 (75.5)		19 (35.8)	34 (64.2)	
Sex									
Male	119 (88.1)	16 (11.9)	0.272	31 (23.0)	104 (77.0)	0.155	47 (34.8)	88 (65.2)	0.209
Female	144 (83.7)	28 (16.3)		52 (30.2)	120 (69.8)		72 (41.9)	100 (58.1)	
Residence									
Urban	50 (84.7)	9 (15.3)	0.822	13 (22.0)	46 (78.0)	0.336	19 (32.2)	40 (67.8)	0.250
Rural	213 (85.9)	35 (14.1)		70 (28.2)	178 (71.8)		100 (40.3)	148 (59.7)	
Education									
None	61 (96.8)	2 (3.2)	**0.003**	24 (38.1)	39 (61.9)	0.051	24 (38.1)	39 (61.9)	**0.020**
Primary	166 (81.0)	39 (19.0)		47 (22.9)	158 (77.1)		72 (35.1)	133 (64.9)	
Secondary	36 (92.3)	3 (7.7)		12 (30.8)	27 (69.2)		23 (59.0)	16 (41.0)	
Religion									
Christian	211 (86.5)	33 (13.5)	0.427	74 (30.3)	170 (69.7)	**0.011**	102 (41.0)	142 (58.2)	**0.031**
Muslim	52 (82.5)	11 (17.5)		9 (14.3)	54 (85.7)		17 (27.0)	46 (73.0)	
Marital status									
Married	227 (87.0)	34 (13.0)	0.120	63 (24.1)	198 (75.9)	**0.006**	97 (37.2)	164 (62.8)	0.171
Single/ separated	36 (78.30)	10 (21.7)		20 (43.5)	26 (56.5)		22 (47.8)	24 (52.2)	
Social category									
Category 1	33 (94.3)	2 (5.7)	**0.024**	6 (17.1)	29 (82.9)	0.290	16 (45.7)	19 (54.3)	0.480
Category 2	70 (77.8)	20 (22.2)		23 (25.6)	67 (74.4)		31 (34.4)	59 (65.6)	
Category 3	160 (87.9)	22 (12.1)		54 (29.7)	128 (70.3)		72 (39.6)	110 (60.4)	
Smoking									
Yes	36 (83.7)	7 (16.3)	0.694	9 (20.9)	34 (79.1)	0.331	10 (23.3)	33 (76.7)	**0.024**
No	227 (86.0)	37 (14.0)		74 (28.0)	190 (72.0)		109 (41.3)	155 (58.7)	

Table 3. Bivariate analysis for participants' characteristics associated with adherence to recommended regimen

Variables	Medication adherence		p value	Diet adherence		p value	Exercise adherence		p value
	Moderate to high,	Low,		High,	Low,		High,	Low,	
	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)	
Taking alcohol									
Yes	77 (78.6)	21(21.4)	**0.015**	22 (22.4)	76 (77.6)	0.215	35 (35.7)	63 (64.3)	0.453
No	186 (89.0)	23(11.0)		61 (29.2)	148(70.8)		84 (40.2)	125(59.8)	
Body mass index (BMI)									
Normal	77 (85.6)	13(14.4)	0.238	28 (31.1)	62 (68.9)	0.306	41 (45.6)	49 (54.4)	**0.022**
Overweight	170 (84.6)	31(15.4)		49 (24.4)	152(75.6)		68 (33.8)	133 (66.2)	
Obese	16 (100.0)	0 (0.0)		6 (37.5)	10 (62.5)		10 (62.5)	6 (37.5)	
Healthcare services accessibility									
Yes	227 (88.7)	29(11.3)	**0.001**	76 (29.7)	180 (70.3)	**0.019**	107(41.8)	149(58.2)	**0.014**
No	36 (70.6)	15(29.4)		7 (13.7)	44 (86.3)		12 (23.5)	39 (76.5)	
Attending lifestyle modification education									
Yes	220 (84.9)	39(15.1)	0.399	80 (30.9)	179(69.1)	**<0.001**	103(39.8)	156(60.2)	0.401
No	43 (89.6)	5 (10.4)		3 (6.3)	45 (93.8)		16 (33.3)	32 (66.7)	
Satisfied with the primary healthcare provider communication									
Yes	211 (86.5)	33 (13.5)	0.427	72 (29.5)	172 (70.5)	0.055	105 (43.0)	139(57.0)	**0.003**
No	52 (82.5)	11 (17.5)		11(17.5)	52 (82.5)		14 (22.2)	49 (77.8)	
Getting enough time with primary healthcare provider									
Yes	212 (85.8)	35 (14.2)	0.869	79 (32.0)	168 (68.0)	**<0.001**	105(42.5)	142(57.5)	**0.006**
No	51 (85.0)	9 (15.0)		4 (6.7)	56 (93.3)		14(23.3)	46 (76.7)	
Are you under diabetes mellitus medication									
Yes	244(85.0)	43(15.0)	0.218	80 (27.9)	207 (72.1)	0.21	117(40.8)	170 (59.2)	**0.006**
No	19(95.0)	1(5.0)		3 (15.0)	17 (85.0)		2 (10.0)	18 (90.0)	
Duration with diabetes since diagnosis [years]									
<5	81(92.0)	7(8.0)	0.207	35 (39.8)	53 (60.2)	**0.004**	49 (55.7)	39 (44.3)	**<0.001**
5 to 10	61(81.3)	14(18.7)		22 (29.3)	53 (70.7)		29 (38.7)	46 (61.3)	
10 to 14	79(84.9)	14(15.1)		16 (17.2)	77 (82.8)		24 (25.8)	69 (74.2)	
> =15	42(82.4)	9(17.6)		10 (19.6)	41 (80.4)		17 (33.3)	34 (66.7)	
Comorbidities of chronic diseases									
Yes	96(83.5)	19(16.5)	0.397	46 (40.0)	69 (60.0)	**<0.001**	49 (42.6)	66 (57.4)	0.284
No	167(87.0)	25(13.0)		37 (19.3)	155 (80.7)		70 (36.5)	122(63.5)	
Side effect of the drugs									
Yes	100(74.6)	34(25.4)	**<0.001**	32 (23.9)	102 (76.1)	0.273	39 (29.1)	95 (70.9)	**0.002**
No	163(94.2)	10(5.8)		51 (29.5)	122 (70.5)		80 (46.2)	93 (53.8)	

Multivariable analysis for factors associated with recommended regimen adherence

The factors independently associated with high medication adherence were not taking alcohol (aOR= 2.21; 95% CI = 1.11-4.42; p = 0.024), accessibility of healthcare services (aOR = 2.59; 95% CI = 1.21-5.53; p = 0.014) and no drug side effects (OR = 5.27; 95%CI = 2.46-11.32; p <0.001). Type 2 diabetes patients who indicated to have accessible healthcare services (aOR = 2.93; 95% CI= 1.20-7.17; p = 0.019), those who attended lifestyle modification sessions (aOR = 3.56; 95%CI = 1.02-12.46; p = 0.019) and those with comorbidities of chronic diseases (aOR = 2.36; 95% CI = 1.37-4.08; p = 0.002) were more likely to have high adherence to recommended diet. Similarly, respondents with education level of secondary and above (aOR = 2.64; 95% CI = 1.05-6.67; p = 0.040), accessible healthcare services (aOR= 2.83; 95%CI= 1.31-6.09; p = 0.019) and those with shorter time since diagnosis of type 2 diabetes (<5 years) (aOR = 2.09; 95% CI = 1.08-4.51; p = 0.041) were more likely to have high adherence to recommended exercise as shown in Table 4.

Table 4.Multivariable analysis for factors associated with recommended regimen adherence

Variables		95% Confidence Interval (CI)		p value
	Adjusted odds ratio (aOR)	Lower	Upper	
Adherence to medication				
Taking alcohol				
Yes	Ref			
No	2.21	1.11	4.42	**0.024**
Healthcare services availability				
Yes	2.59	1.21	5.53	**0.014**
No	Ref			
Side effect of the drugs				
Yes	Ref			
No	5.27	2.46	11.32	**<0.001**
Adherence to diet				
Marital status				
Married	Ref			
Single/separated	2.05	1.01	4.15	**0.046**
Healthcare services accessibility				
Yes	2.93	1.20	7.17	**0.019**
No	Ref			
Attending lifestyle modification education				
Yes	3.56	1.02	12.46	**0.047**
No	Ref			
Chronic disease other than DM				
Yes	2.36	1.37	4.08	**0.002**
No	Ref			
Adherence to exercise				
Education				
None	Ref			
Primary	0.89	0.47	1.68	0.724
Secondary	2.64	1.05	6.67	**0.040**
Healthcare services accessibility				
Yes	2.83	1.31	6.09	**0.008**
No	Ref			
Duration with diabetes since diagnosis				
<5 years	2.09	1.08	4.51	**0.041**
5 to 10 years	0.97	0.43	2.16	0.932
10 to 14 years	0.60	0.27	1.32	0.205
> =15 years	Ref			

Discussion

This study attempted to assess the level of adherence to recommended regimen and its associated factors among type 2 diabetes patients in Rwinkwavu District Hospital and its catchment area. The findings from this study have demonstrated an overall low adherence to the recommended regimen among type 2 diabetes, with less than three patients in ten adhering to medications, less than three in ten adhering to the recommended diet and just below four in ten adhering to the recommended exercise regimen. Similarly, another study done in Rwanda, among type 2 diabetes mellitus patients attending Kirehe District Hospital revealed that only 35.4% were adequately adhering to medication regimen.[34] This high non-adherence to medication, diet and exercise regime mirrors the situation across many countries in the region and Africa in general. For instance, studies done in Africa which showed low level of adherence include Botswana at 41.8%,[35] Zambia at 44.2%,[12] Ghana at 53.5%,[36] Nigeria at 50.2% at 34.0%,[37] Ethiopia,[38] Uganda at 38.1%,[39] and Tanzania at 60.2%,[40]. This is a concern particularly because the rate of type 2 diabetes in Africa is on the rise where it was 24 million in 2021 and is projected to reach 33 million by 2030. [41,42]

Further afield in the Middle East, similar studies have shown mixed levels of adherence to the recommended regimen among type 2 diabetes patients. For instance, a study done in Yemen revealed that 70% of the participants were adhering to the recommended medication[13], while another study in the same country showed low level of adherence to diet (21.0%) and exercise (15.2%).[5] In the same context, a study carried out in Palestine on adherence to drugs and associated factors among type 2 diabetes patients reported a higher adherence at 58.0%.[43] However, in a study conducted in Saudi Arabia low level of adherence to medication at 32.1% was reported.[11]

Studies in India have demonstrated moderate adherence at 57.7% [44] and 55.1% [45] respectively. In the latter study,[44] among those not adhering to medication, a considerable proportion (59.5%) failed to take the medication in time, majority of them (85.7%) were not following the recommended diet and about 46.6% were not monitoring their blood glucose level regularly. The possible explanation for these differences in similar context could be variation in sample size, methods of data collection, availability and accessibility of healthcare facilities and levels of health care professional training on diabetes management.

The findings from the multivariable analysis of this study revealed that respondents who were not taking alcohol were 2.2 times more likely to have medication adherence than those taking alcohol. This is in agreement with other studies that alcohol consumption is negatively associated with adherence to medication.[46–48] The main possible reason is that alcohol consumption is linked to forgetfulness and memory loss as evidenced by different studies which demonstrated that respondents taking alcohol are more likely to miss appointments and important dates.[49,50]

In the present study, it was revealed that diabetes patients who experienced drug side effects tended not to adhere to medication. Similar studies also showed that mediation adherence is lower among type 2 diabetes patients who experienced drug side effects.[51–53] It is obvious that the medication side effects including nausea, vomiting, weaknesses or headaches can dissuade diabetes patients from complying with medication regimen. Therefore, pharmaceutical industry should consider broadening the type of diabetes medications available for patients with other different health conditions.

From the findings of this study, healthcare service accessibility is associated with adherence to medication, diet and exercise. Mirroring these findings, a study conducted in Nigeria,

found that limited access to healthcare was significantly associated with low adherence to recommended regimen.[37] Another study on contributing factors for non-adherence among adult diabetes patients in Ethiopia found that the independent predictor for the adherence was cost of transport to the hospital.[38] Cost of transport to the hospital can directly influence health care accessibility especially in resource-limited settings such as Rwanda.

In addition, in our study, the single or separated were significantly more likely to have high level of adherence to dietary recommended regimen. This result accords with other studies conducted in India, Botswana and Ethiopia where high frequency to family gatherings was the main barrier to adhere for dietary recommended regimen.[6,19,20] The challenge of eating against the social expectations or the result of pressure from partners or family members could the possible explanation for not adhering to the recommended diet. Attending lifestyle adjustment training including nutrition education was also one of the factors significantly associated with adherence to the recommended diet in the present study. This is evidenced by other studies that dietary adherence among type 2 diabetes patients is positively influenced by nutrition training.[30,54] This could be that type 2 diabetes patients receiving lifestyle education are more likely to be aware about the importance of diet recommended adherence or may they feel being more at risk if not compliant.[19]

In our multivariable logistic regression, diabetes patients with chronic co-morbidities were also about 2 times significantly more likely to adhere to dietary recommendation, which is accord with a study done in India. [55] A systematic review indicates that the presence of co-morbidities could increase self-care practices.[56] Moreover, the fear of complications due to chronic co-morbidities other than diabetes may contribute to increased adherence to the recommended diet. However, this is contrary to other studies which suggest that presence of co-morbidities is negatively associated with diet recommended adherence due to complex dietary and medication regimen recommendations.[57]

These results have further revealed that respondents with higher level of education were significantly 2.64 times more likely to adhere to recommended exercise compared to those who never attended school. This finding is consistent with a study conducted in Ethiopia,[9] which asserted that a key predictor of non-adherence with physical exercise among type 2 diabetes patients was lack of education. Likewise, our study corroborates those done in Kuwait, Saudi Arabia and Nepal.[20,58,59] The reason could be that diabetes patients with high education level have more knowledge on the benefits of regular exercise to control blood glucose level.

In our study it was found that patients with a shorter time since diagnosis of type 2 diabetes (<5 years) were more adherent to regular exercise than those with longer time (> 15 years). This observation confirms the work done in Saudi Arabia which indicated that patients with longer duration diabetes mellitus were negatively associated with adherence to recommended exercises.[58] The reason could be that type 2 diabetes patients with a longer time since diagnosis might develop fatigue resulting in poor adherence to regular exercise.

The main strength of the study is considering three domains of recommended regimen including adherence to medication, diet and exercise while most other studies consider these separately. However, attention should be given to some limitations including self-report which may be associated with social desirability and recall biases. Another limitation is the nature of cross-sectional study which is impossible to provide cause-effect relationship between the different independent variables and outcomes (adherence to recommended regimen).

Conclusion and Recommendations

The aim of this study was to determine the level of adherence to recommended regimen and associated factors among type 2 diabetes mellitus patients in Rwinkwavu district hospitals and its catchment area. The study concludes that the level of adherence to recommended regimen among type 2 diabetes mellitus patients in Rwinkwavu district hospitals and its catchment area is low in relation to medication regimen adherence, diet regimen adherence, and physical exercise regimen adherence. This low level of adherence portends a potential setback in the management of diabetes mellitus type 2 management.

The study also concludes that individual factors such as low level of education and alcohol consumption negatively influence adherence to medication regimen and exercise regimen respectively. Alcohol consumption and education level are factors that can be modified and presents public health practitioners with an opportunity to positively influence patient outcomes.

The third conclusion is that clinical factors are also associated with adherence to recommended regimen; healthcare service accessibility positively influences adherence to medication regimen; diet regimen and exercise regimen and drug side effects limit medication regimen adherence; while chronic disease comorbidities and lifestyle modification training are associated with increased diet regimen adherence. Some clinical factors such as accessibility of healthcare services and lifestyle modification can be addressed through health systems strengthening and consequently improve adherence and patient outcomes.

It is therefore recommended that the Ministry of Health and other health stakeholders provide a comprehensive lifestyle modification education package that can be easily accessed and delivered to the diabetes patients by continuous professional training of more personnel. In addition, there is need to conduct a longitudinal study to determine the causality and its direction in relation to the factors affecting adherence to the recommended regimen.

Conflict of interest

No conflict

Authors' contribution

All authors have contributed to this article.

References

1. Centers for Disease Control and Prevention. National diabetes statistics report: estimates of diabetes and its burden in the United States, 2014. *Atlanta GA US Dep Health Hum Serv*. 2014;2014.
2. Alotaibi A, Perry L, Gholizadeh L, Al-Ganmi A. Incidence and prevalence rates of diabetes mellitus in Saudi Arabia: An overview. *J Epidemiol Glob Health*. 2017;7:211–8.
3. Cho NH, Shaw JE, Karuranga S, Huang Y, da Rocha Fernandes JD, Ohlrogge AW, et al. IDF Diabetes Atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Res Clin Pract*. 2018;138:271–81.
4. WDA. World Data Atlas (WDA). Rwanda - Diabetes prevalence as a share of population aged 20-79 years. *knoema*. 2019. Accessed from https://knoema.com/atlas/Rwanda/topics/Health/Nutrition/Diabetes-prevalence.
5. Alhariri A, Daud F, Almaiman A, Saghir S. Factors associated with adherence to diet and exercise among type 2 diabetes patients in Hodeidah city, Yemen. *Life*. 2017;7:264–71.
6. Ganiyu AB, Mabuza LH, Malete NH, Govender I, Ogunbanjo GA. Non-adherence to diet and exercise recommendations amongst patients with type 2 diabetes mellitus attending Extension II Clinic in Botswana. *Afr J Prim Health Care Fam Med. AOSIS*; 2013;5:1–6.

7. Ghimire S. Barriers to Diet and Exercise among Nepalese Type 2 Diabetic Patients. *Int Sch Res Not*. 2017;2017:1273084.
8. Malik S, Basit R, Naz S, Mawani M, Masood Q, Akhter J. Adherence to Lifestyle Advice and reatments in Pakistani Patients with Type 2 Diabetes Mellitus. *J Diabetes Mellit*. 2016;6:49.
9. Zeleke Negera G, Charles Epiphanio D. Prevalence and Predictors of Nonadherence to Diet and Physical Activity Recommendations among Type 2 Diabetes Patients in Southwest Ethiopia: A Cross-Sectional Study. *Int J Endocrinol*. 2020;2020:1512376.
10. Ahmad NS, Ramli A, Islahudin F, Paraidathathu T. Medication adherence in patients with type 2 diabetes mellitus treated at primary health clinics in Malaysia. *Patient Prefer Adherence*. 2013;7:525–30.
11. Khan AR, Al-Abdul Lateef ZN, Al Aithan MA, Bu-Khamseen MA, Al Ibrahim I, Khan SA. Factors contributing to non-compliance among diabetics attending primary health centers in the Al Hasa district of Saudi Arabia. *J Fam Community Med*. 2012;19:26–32.
12. Nyirongo S, Mukwato PK, Musenge EM, Kalusopa VM. Adherence to Treatment by Patients with Type 2 Diabetes Mellitus at Monze Mission Hospital, Monze, Zambia. *Open J Nurs. Scientific Research Publishing*. 2021;11:184–203.
13. Othman G, Ali F, Ibrahim MIM, Al-Worafi YM, Ansari M, Halboup AM. Assessment of Anti-Diabetic Medications Adherence among Diabetic Patients in Sana'a City, Yemen: A Cross Sectional Study. *J Pharm Res Int*. 2020;114–22.
14. Sankar UV, Lipska K, Mini GK, Sarma PS, Thankappan KR. The adherence to medications in diabetic patients in rural Kerala, India. *Asia Pac J Public Health*. 2015;27:NP513-523.
15. Musee CN, Omondi DO, Odiwuor W. Dietary Adherence pattern in the context of type 2 diabetic management within clinical setting, Kenya. *Int J Diabetes Res*. 2016;5:26–34.
16. Mao W, Yip C-MW, Chen W. Complications of diabetes in China: health system and economic implications. *BMC Public Health*. 2019;19:269.
17. Megeid FYA, El-Sayed MMA. Health education intervention improves knowledge, attitude and practices of mothers of insulin dependent diabetes mellitus. *World Appl Sci J*. 2012;17:1398–404.
18. WHO. "Global report on diabetes." World Health Organization. *https://apps.who.int/iris/handle/10665/204871, 2016*; Accessed 22 Jan 2020. 2016.
19. Mohammed MA, Sharew NT. Adherence to dietary recommendation and associated factors among diabetic patients in Ethiopian teaching hospitals. *Pan Afr Med J. 2019*;33:260.
20. Parajuli J, Saleh F, Thapa N, Ali L. Factors associated with nonadherence to diet and physical activity among Nepalese type 2 diabetes patients; a cross sectional study. *BMC Res Notes*. 2014;7:758.
21. WHO WHO. Diet, nutrition and the prevention of chronic diseases. *World Health Organization Tech Rep Ser*, 2013; 916:(i–viii). Retrieved from http://health.euroafrica.org/books/dietnutritionwho.pdf Accessed 28 May 2019. 2013.
22. Mukeshimana M, Hakizimana G, Mwali C, Umuhoza C, Uwambajimana J, Asingizwe D. The knowledge and practice of self-care management among patients attending a diabetes clinic in Kigali, Rwanda. *Rwanda J*. 2015;2:24–30.
23. Kabanda AM, Phillips JS. Physical activity among adults with diabetes mellitus in Rwanda. *Afr J Phys Health Educ Recreat Dance. AFAHPER-SD*; 2011;17:239–47.
24. Murwanashyaka J de D, Ndagijimana A, Biracyaza E, Sunday FX, Umugwaneza M. Non-adherence to medication and associated factors among type 2 diabetes patients at Clinique Medicale Fraternite, Rwanda: a cross-sectional study. *BMC Endocr Disord*. 2022;22:219.

25. National Institute of Statistics of Rwanda (NISR).Rwanda Fourth Population and Housing Census-2012.*NISR*.2012
26. Israel, Glen D. "Determining Sample Size." Program Evaluation and Organizational Development, IFAS, University of Florida. PEOD-6. National Science Foundation, Research and Development in Industry: 1992, NSF 95-324. *Arlington*, VA. 1992;
27. Abate HK, Ferede YM, Mekonnen CK. Adherence to physical exercise recommendations among type 2 diabetes patients during the COVID-19 pandemic. *Int J Afr Nurs Sci*. 2022;16:100407.
28. American Diabetes Association. Standards of Medical Care in Diabetes-2019 Abridged for Primary Care Providers. *Clin Diabetes Publ Am Diabetes Assoc*. 2019;37:11–34.
29. Van der Feltz-Cornelis CM, Van Oppen P, Van Marwijk HWJ, De Beurs E, Van Dyck R. A patient-doctor relationship questionnaire (PDRQ-9) in primary care: development and psychometric evaluation. *Gen Hosp Psychiatry*. 2004;26:115–20.
30. Worku A, Mekonnen Abebe S, Wassie MM. Dietary practice and associated factors among type 2 diabetic patients: a cross sectional hospital based study, Addis Ababa, Ethiopia. *SpringerPlus*. 2015;4:15.
31. Morisky DE, Green LW, Levine DM. Concurrent and predictive validity of a self-reported measure of medication adherence. *Med Care. JSTOR*; 1986;67–74.
32. Hamdy O, Goodyear LJ, Horton ES. Diet and exercise in type 2 diabetes mellitus. *Endocrinol Metab Clin North Am*. 2001;30:883–907.
33. WHO. : Physical status. The use and interpretation of anthropometry. *WHO Tech Rep Ser*. 1995;854.
34. Habtu M, Uwingabire S, Mureithi C, Gashegu M. Knowledge and Attitude of Diabetes Mellitus and Adherence to Treatment Regimen among Diabetic Patients Attending Kirehe District Hospital, Rwanda. *J Diabetes Clin Prac* .2019. 2:2
35. Fadare J, Moshomo T, Godman B, Meyer JC, Gollakota S, Gaenamong M, et al. Antidiabetic medication adherence and associated factors among patients in Botswana; implications for the future. *Elsevier*; https://www. elsevier. com/; 2017;
36. Afriyie G. Non-Adherence to Medication and Associated Factors among Type 2 Diabetes Mellitus Patients Attending Tema General Hospital. [PhD Thesis]. *University of Ghana*; 2019.
37. Jackson IL, Adibe MO, Okonta MJ, Ukwe CV. Medication adherence in type 2 diabetes patients in Nigeria. D*iabetes Technol Ther*. 2015;17:398–404.
38. Boshe BD, Yimar GN, Dadhi AE, Bededa WK. The magnitude of non-adherence and contributing factors among adult outpatient with Diabetes Mellitus in Dilla University Referral Hospital, Gedio, Ethiopia. *PloS One*. 2021;16:e0247952.
39. Faisal K, MEKURIYA T, Tusiimire J. Factors Associated With Non-Adherence To Antidiabetic Medication Among Patients at Mbarara Regional Referral Hospital, Mbarara, Uganda. *Patient Prefer Adherence*. 2021.
40. Rwegerera GM. Adherence to anti-diabetic drugs among patients with Type 2 diabetes mellitus at Muhimbili National Hospital, Dar es Salaam, Tanzania- A cross-sectional study. *Pan Afr Med J*. 2014;17:252.
41. IDF. "International Diabetes Federation. IDF diabetes atlas. 7th ed. Brussels: International Diabetes Federation; 2015." *IDF*. 2015.
42. International Diabetes Federation. IDF diabetes atlas. 10th ed. Brussels: International Diabetes Federation. Available from: *http://www.diabetesatlas.org. 2021.*

43. Elsous A, Radwan M, Al-Sharif H, Abu Mustafa A. Medications adherence and associated factors among patients with type 2 diabetes mellitus in the Gaza Strip, Palestine. *Front Endocrinol. Frontiers*; 2017;8:100.
44. Mukherjee S, Sharmasarkar B, Das KK, Bhattacharyya A, Deb A. Compliance to anti-diabetic drugs: observations from the diabetic clinic of a medical college in kolkata, India. *J Clin Diagn Res JCDR*. 2013;7:661–5.
45. Bhattarai B, Bista B, Shrestha S, Budhathoki B, Dhamala B. Contributing Factors of Non-Adherence to Treatment among the Patients with Type II Diabetes Mellitus. J *Manmohan Meml Inst Health Sci*. 2019;5:68–78.
46. Ahmed AT, Karter AJ, Liu J. Alcohol consumption is inversely associated with adherence to diabetes self-care behaviours. *Diabet Med J Br Diabet Assoc*. 2006;23:795–802.
47. Thapa BP, Pokharel PK, Jha N, Paudel IS, Sharma SK, Shyangwa PM, et al. Alcohol consuming habits and its effects on adherence and blood glucose level in type-2 diabetes mellitus in a town population in eastern region of Nepal. *Health Renaiss*. 2011;9:95–101.
48. Aminde LN, Tindong M, Ngwasiri CA, Aminde JA, Njim T, Fondong AA, et al. Adherence to antidiabetic medication and factors associated with non-adherence among patients with type-2 diabetes mellitus in two regional hospitals in Cameroon. *BMC Endocr Disord*. 2019;19:35.
49. Ling J, Heffernan TM, Buchanan T, Rodgers J, Scholey AB, Parrott AC. Effects of Alcohol on Subjective Ratings of Prospective and Everyday Memory Deficits. *Alcohol Clin Exp Res*. 2003;27:970–4.
50. Rose ME, Grant JE. Alcohol-induced blackout. Phenomenology, biological basis, and gender differences. *J Addict Med*. 2010;4:61–73.
51. Mirghani HO. An evaluation of adherence to anti-diabetic medications among type 2 diabetic patients in a Sudanese outpatient clinic. *Pan Afr Med J*. 2019;34:34.
52. Mroueh L, Ayoub D, El-Hajj M, Awada S, Rachidi S, Zein S, et al. Evaluation of medication adherence among Lebanese diabetic patients. *Pharm Pract Granada. SciELO Espana*; 2018;16.
53. Gatti ME, Jacobson KL, Gazmararian JA, Schmotzer B, Kripalani S. Relationships between beliefs about medications and adherence. *Am J Health Syst Pharm*. 2009;66:657–64.
54. Hjelm K, Mufunda E. Zimbabwean diabetics' beliefs about health and illness: an interview study. *BMC Int Health Hum Rights*. 2010;10:7.
55. Deshmane AR, Muley AS. Adherence and Barriers to Medical Nutrition Therapy and the Effect on Glycemic Control among Individuals with Type 2 Diabetes in India. *Curr Res Nutr Food Sci J*. 2022;10.
56. Aga F, Dunbar SB, Kebede T, Gary RA. The role of concordant and discordant comorbidities on performance of self-care behaviors in adults with type 2 diabetes: a systematic review. *Diabetes Metab Syndr Obes Targets Ther*. 2019;12:333–56.
57. Ayele AA, Emiru YK, Tiruneh SA, Ayele BA, Gebremariam AD, Tegegn HG. Level of adherence to dietary recommendations and barriers among type 2 diabetic patients: a cross-sectional study in an Ethiopian hospital. *Clin Diabetes Endocrinol*. 2018;4:21.
58. Ramadhan BJA, Alramadan MJ, Alhassan RE, Almajed HA, Khamseen MAB, Billah B. Adherence to the recommended physical activity duration among Saudis with type 2 diabetes mellitus. *J Fam Med Prim Care*. 2019;8:3668–77.
59. Serour M, Alqhenaei H, Al-Saqabi S, Mustafa A-R, Ben-Nakhi A. Cultural factors and patients' adherence to lifestyle measures. *Br J Gen Pract J R Coll Gen Pract*. 2007;57:291–5.