Original Article

Adherence to the recommended physical activity duration among Saudis with type 2 diabetes mellitus

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Abstract

Background: Physical activity is important in managing type 2 diabetes, since it leads to better glycemic control, decreases macrovascular complications, and controls diabetes-related comorbidities. **Objective:** This study aimed to assess the levels of adherence to physical activity in Saudi adults with type 2 diabetes. **Method:** Participants with type 2 diabetes mellitus who visited diabetes centers in Riyadh, Jeddah, and Hofuf and completed interviewer-administered electronic questionnaires between May 15 and November 31 in 2017 were included in this study. Data related to sociodemographic information, medical history, level of physical activity, and depression and anxiety were collected. In addition, blood pressure, anthropometric measurements, and the most recent HbA1c, and fasting lipid profiles were obtained. **Results:** In total, 1,111 participants (65.2% women, mean age of 57.5 ± 11 years) were included in the analysis; 62.1% were obese (Body Mass Index [BMI] >30 kg/m^2). Mean duration of DM was 13.8 ± 8.3 years. Approximately 75% of participants had uncontrolled diabetes (i.e. HbA1c ≥7%). Furthermore, only 30% adhered to the recommended physical activity duration of 150 min/week. Non-adherence to physical activity was associated with female sex, older age, low education, low economic status, longer disease duration, absence of family support, poor education from the physician or DM educator, and follow-up in health institutions other than the diabetes center. **Conclusions:** The majority of patients with T2DM in Saudi do not adhere to the recommended duration of physical activity. Sex, age, level of education, monthly income, disease duration, follow-up institution, among others, influenced adherence to physical activity.

Keywords: BMI, HbA1C, Physical activity, Saudi Arabia, type 2 diabetes

Introduction

Diabetes mellitus (DM) is among the major noncommunicable diseases affecting a large portion of the population worldwide.[1] Its prevalence has continued to rise throughout the last few decades, making it one of the most pressing epidemics globally.[2] The World Health Organization (WHO) reported that approximately 422 million persons had diabetes in 2014, and approximately 1.6 million died of DM.[3]

Saudi Arabia is among the top 10 countries with the highest prevalence of DM.[4] In 2017, DM was prevalent in approximately 24% of Saudis, which was two times higher than the prevalence 20 years before.[4,5] An increase in the prevalence of obesity among the Saudi population plays a major role in the marked increase of DM prevalence as type 2 DM (T2DM) is strongly associated with obesity.[6] One study found that approximately 28.7% of the Saudi population was obese (body mass index [BMI] ≥ 30 kg/m^2).[7]

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Saudi Arabia, along with other Arabian Council Gulf countries, has undergone major socioeconomic transformations in the last three decades that carried some negative behavioral and lifestyle changes manifested in the lack of physical activity and a high consumption of a Western diet that ultimately led to an increase in the prevalence of both obesity and T2DM.[8,9] Lifestyle modification, primarily in the form of healthy diet and regular physical activity, plays a fundamental part in the management of T2DM. Studies have shown that regular sufficient physical activity can substantially lower blood glucose level.[10] Furthermore, many studies showed that intensive lifestyle modification can even prevent DM in high-risk individuals.[11-14]

In 2018, the American Diabetes Association recommended a moderate-intensity exercise of at least 150 min weekly for all diabetes patients and being physically active throughout the day and interrupting sedentary activities at least every 30 min.[15] This has been found to improve the glycemic control (A1C Level) and decrease associated macrovascular complications.[15] Furthermore, several studies showed a positive association between regular physical activity and lower incidence of other comorbidities such as hypertension, dyslipidemia, and depression.[16]

Although exercise is an important factor in managing DM, people with DM usually do not comply with the recommended exercise plans. A study conducted in the US reported that less than one-third of DM patients followed the recommended level of physical activity.[17] Some of the barriers that contribute to nonadherence to physical activity are lack of time, hot weather, presence of other chronic diseases, and automobile dependency.[18]

In Saudi Arabia, only few studies have been conducted to assess adherence to physical activity routines among people with T2DM and other comorbidities. Furthermore, these studies were limited to single canter and recruited a small sample size. Thus, our study aimed to (1) assess the level of adherence to the recommended physical activity duration (150 min/week) among Saudis with T2DM; (2) study the different sociodemographic and disease-related factors that influence adherence to physical activity; and (3) examine the effect of physical activity in the risk of different diabetes comorbidities including hypertension, obesity, high cholesterol levels, stroke, cardiovascular disease (CVD), retinopathy, depression, and anxiety.

Since managing diabetes is one of the essential roles of primary health care physicians in Saudi Arabia, this study will aid in identifying the main factors that associated with better adherence to physical activity in diabetes patients and ultimately will provide a scientific basis for developing appropriate measures to improve levels of physical activity in this population with the goal of improving glycemia control and patient outcomes.

Materials and Methods

Summary

We analyzed secondary data collected in a previous research project that examined risk factors of poor glycemic control, complications, and poor quality of life among people with T2DM in Saudi Arabia. These data were collected in 2017 using an interviewer-administered structured questionnaire about various risk factors that affect glycemic control and diabetes complications including sociodemographic, behavioral, and clinical factors.[19]

Study design and population

This cross-sectional study evaluated adults (aged >18 years) with T2DM attending any of the Ministry of Health diabetes care centers in Riyadh, Jeddah, and Hofuf, between May 15 and November 31, 2017. The inclusion criteria were: confirmed T2DM for at least 1 year, and an HbA1c performed within 6 months in the medical records. The exclusion criteria were a T2DM diagnosis <1 year prior, unavailable laboratory results, other types of DM such as type 1, and gestational DM, as well as pregnant women with T2DM.

Sampling

The sample size was calculated for another outcome, that is, glycemic control.[17] The required sample size for evaluating glycemic control based on the results of previous studies was 1,082 participants. This sample size provided a power higher than 90% based on the findings of a similar study from the UAE that 3% of people with T2DM were adherent to the recommended physical activity guidelines.[20]

Data collection

A validated interviewer-administered electronic questionnaire was used to collect information. The original English version of the questionnaire was translated into Arabic and then translated back into English to check the translation accuracy. A pilot survey of the complete questionnaire was conducted among 29 participants attending the diabetes center in Hofuf 2 weeks before commencing the main study.[19] Other validated tools used for assessment included the modified World Health Association (WHO) STEPS questionnaire for assessment of physical activity,[21] the Patient Health Questionnaire-2 for depression screening,[22] and the generalized anxiety disorder scale for anxiety screening.[23]

Anthropometric measurements

Waist circumference was measured using a tape measure, with the participant in thin clothing (for cultural reasons), during exhalation, midway between the lower rib margin and the anterior superior iliac spine (hip bone), or narrowest abdominal point. Hip circumference was measured at the widest circumference around the hip bones. Blood pressure was measured via a digital blood pressure monitor: Information on the most recent weight and height measurements; fasting blood sugar levels; HbA1c; lipid profile (low-density lipoprotein, high-density lipoprotein, and triglyceride); and documented diagnosis of hypertension, coronary artery disease (CAD), and stroke were collected from medical records.

Statistics

All variables were coded before entry and were verified before analysis. A descriptive analysis was performed, and findings were summarized as the mean and standard deviation, or median and interquartile ranges for numerical variables, and percentage was reported for categorical variables. The association between all dependent and independent variables was tested via Chi-square-, and *t*-testing for categorical and continuous variables, respectively. All statistical analyses were performed using SPSS v. 20. A *P* value of <0.05 was considered statically significant. This study was approved by the Research Ethics Committee of the Ministry of Health in Saudi Arabia (in 08/12/2016), College of Medicine Institutional Review Board at Kind Saud University (in 22/01/2017) and Monash University Human Research Ethics Committee (in 01/11/2016).

Results

Demographic characteristics

In total, 1,111 participants with a mean age of 57.5 ± 11 years (range, 19–89 years) were included in the study. Of them, 239 participants (21.5%) were recruited from Hofuf diabetes center; 248 (22.3%) from the Jeddah diabetes center; and 624 (56.2%) from the Riyadh diabetes center (26%, and 30.2% were receiving treatment in King Abdul-Aziz University Hospital, and King Khalid University Hospital in Riyadh, respectively). Women comprised 65.2% of the population, while 34.8% were men [Table 1].

Disease history

The mean duration of DM was 13.8 ± 8.3 years (>30 years for approximately 5% of patients). More than half of the participants (53.8%) were using oral hypoglycemic agents alone. The majority of the participants' diabetes was uncontrolled (HbA1c ≥ 7%), and those with controlled disease made up less than one-fourth of the study population (23.7%). With respect to health care service utilization, around 70% of the participants reported receiving general education from their physician regarding DM in the last 12 months. When the participants were asked about whether they receive family support regarding physical activity, 28.5% responded "all the time," and 29.1% responded "some time," while the remaining participants (42.4%) stated that they received no family support [Table 2].

Table 1: Socio-demographic characteristics of the participants (*n*=1,111)

Characteristics	Frequency	Percentage
Sex		
Male	387	34.8%
Female	724	65.2%
Age (years)		
<40	77	6.9%
40-49	144	13%
50-59	450	40.5%
60-69	301	27.1%
>70	139	12.5%
Nationality		
Saudi	1059	95.3%
Non-Saudi	52	4.7%
Marital status		
Single	45	4.1%
Married	872	78.5%
Divorced	53	4.8%
Widowed	141	12.7%
Educational level		
Illiterate	335	30.1%
Primary	234	13.3%
Intermediate	148	21.1%
Secondary	196	17.6%
University/college	198	17.8%
Residency		
Urban	954	85.9%
Rural	95	8.6%
Remote	52	5.6%
Monthly income		
<3000 SAR	269	24.2%
3001-6000 SAR	245	22.1%
6001-9000 SAR	259	23.3%
9001-12000 SAR	146	13.1%
>12000 SAR	192	17.3%

SAR, Saudi Riyal

Table 2: Disease-related background and characteristics (*n*=1,111)

Characteristics	Frequency	Percentage
Location of the diabetes center		
Hofuf	239	21.5%
Jeddah	284	22.3%
King Abdulaziz U.H.	289	26%
King Khalid U.H	335	30.2%
DM duration (years)		
<5	164	14.8%
5-9	230	20.7%
10-19	432	38.9%
20-29	228	20.5%
>30	56	5%
Management		
Diet only	18	1.6%
Oral tablets	598	53.8%
Insulin + oral	270	24.3%
Insulin	224	20.2%
Family history of DM		
Yes	830	74.7%
No	280	25.3%
Level of control (HbA1c <7%)		
Controlled	263	23.7%
Uncontrolled	829	74.6%
Received physician education about DM in the last 12 months		
Yes	788	70.9%
No	323	29.1%
Visited a DM educator in the last 12 months		
Yes	435	39.2%
No	676	60.8%
Family support regarding physical activity		
All of the time	317	28.5%
Sometime	323	29.1%
Never	471	42.4%

DM, diabetes mellitus; HbA1c, glycated hemoglobin

Comorbidities

More than one-third of the participants (36%) had high blood pressure (systolic ≥140 mmHg or diastolic ≥90 mmHg) during the interview. In total, 16.5% of the participants had a history of cardiovascular disease, and more than half (54.6%) of them had undergone surgical interventions. Meanwhile, only 3% had a history of previous cerebrovascular accidents. Approximately 43.1% were diagnosed with some stage of retinopathy, and approximately 16.7%, and 15.4% were screened positively for depression and general anxiety disorder, respectively [Table 3].

Adherence to physical activity

The mean duration of weekly physical activity in the overall population was 130.6 ± 202 min. There was a significant difference between men and women; men had a higher mean duration of physical activity than women (166 ± 241 min vs. 111 ± 167 min) ($P < 0.001$) [Tables 4 and 5].

Effect of sociodemographic factors on the level of adherence to physical activity

Table 6 shows that men had higher level of physical activity than women, and the association between sex and adherence to recommended physical activity was statistically significant ($P < 0.001$). Age was a significant influencing factor on the level of adherence to the recommended physical activity ($P < 0.001$), with younger patients typically more adherent to physical activity routines. Education levels had a positive effect on physical activity adherence. The greatest level of adherence was seen in patients with higher education (university/college). This association was statistically significant ($P < 0.001$). Economic status was significantly associated with the level of adherence to physical activity. The greater the monthly income, the higher the adherence to the recommended physical activity ($P < 0.001$).

There were no statistically significant associations between marital status, or place of residence and level of adherence to physical activity.

Effect of disease-related factors on the level of adherence to physical activity

Table 7 shows that patients who were diagnosed recently (<5 years) showed higher levels of adherence to physical activity than those with a longer duration of disease ($P < 0.001$). The place of follow-up was significantly associated with the level of adherence to physical activity ($P > 0.001$). Participants who were followed up in diabetes centers had greater levels of adherence than those in other healthcare institutions. Furthermore, people who were followed up in the Jeddah diabetes center showed a higher level of adherence to physical activity than those in other centers ($P > 0.001$).

A positive family history of DM in first degree relatives was insignificantly associated with adherence to physical activity ($P = 0.3$), while the presence of family support was significantly associated with the level of adherence to physical activity ($P = 0.016$). The level of physical activity was higher in those whose disease was managed via diet or oral medication ($P = 0.04$).

Patients who were educated about DM by their physician in the last 12 months demonstrated a greater level of adherence ($P < 0.001$). Visiting a DM educator was significantly associated with the level of adherence to physical activity ($P < 0.001$).

Table 3: Prevalence of comorbidities, related history, and diabetic complications (*n*=1,111)

	Frequency	Percentage
Hypertension		
Yes	405	36.5%
No	702	63.2%
Cardiovascular disease		
Yes	183	16.5%
No	928	83.5%
History of stroke		
Yes	34	3.1%
No	1077	96.9%
Retinopathy		
Yes	479	43.1%
No	632	56.9%
Smoking		
Yes	63	43.1%
No	1048	94.3%
Anxiety		
Yes	171	15.4%
No	940	84.6%
Depression		
Yes	185	16.7%
No	926	83.3%
BMI		
Normal	113	10.2%
Overweight	300	27%
Obese	690	62.1%

BMI, body mass index

Table 4: Adherence to the recommended duration of ≥150 min/week physical activity

	Frequency	Percentages	Mean±SD
Overall population			
Yes	328	29.5%	130.6±202.9
No	783	70.5%	
By sex			
Male	387		166.9±241.2
Female	724		111.1±176.2

SD, standard deviation

Table 5: Adherence to the recommended physical activity duration by sex

	Total Physical activity ≥150 min/week		*P*
	Yes	No	
Sex			
Male	148 (38.2%)	239 (61.8%)	<0.001
Females	180 (24.9%)	544 (75.1%)	

Table 6: Effect of socio-demographic factors on the level of adherence to physical activity

Factor	Total physical activity ≥150 min/week		*P*
	Yes	No	
Sex			
Male	148 (38.2%)	239 (61.8%)	<0.001
Female	180 (24.9%)	544 (75.1%)	
Marital status			
Married	275 (31.5%)	597 (68.5%)	0.05
Single	15 (33.3%)	30 (66.7%)	
Divorced	14 (26.4%)	39 (73.6)	
Widowed	24 (17%)	117 (83%)	
Age, years			
<40	41 (53.2%)	36 (46.8%)	<0.001
40-49	63 (43.8%)	81 (56.2%)	
50-59	146 (32.4%)	304 (67.6%)	
60-69	61 (20.3%)	240 (79.7%)	
>70	17 (12.2%)	122 (87.8%)	
Level of education			
Illiterate	53 (15.8%)	282 (84.2%)	<0.001
Primary	63 (26.9%)	117 (73.1%)	
Intermediate	45 (30.4%)	103 (69.4)	
Tertiary	70 (35.7%)	126 (64.3%)	
University	97 (49%)	101 (51%)	
Residency			
Remote	15 (24.2%)	47 (75.8%)	0.5
Rural	31 (32.6%)	64 (67.4%)	
Urban	282 (29.6%)	672 (70.4%)	
Monthly income			
>12000 SAR	86 (44.8%)	106 (55.2%)	<0.001
9001-12000 SAR	45 (30.8%)	101 (69.2%)	
6001-9000 SAR	75 (29%)	184 (71%)	
3000-6000 SAR	56 (22.9%)	189 (77.1%)	
<3000 SAR	66 (24.5%)	203 (75.5%)	

SAR, Saudi Riyal

Effect of adherence to physical activity on disease control and other comorbidities

Table 8 shows that the level of diabetes control was significantly associated with adherence to the recommended level of physical activity ($P = 0.013$), with patients who were adherent to the recommended level of physical activity showing better diabetes control (HbA1c <7%). Patients who adhered to the recommended level of physical activity tended also to have a lower BMI ($P = 0.002$).

Thirty-four participants had a history of stroke, and they tended to have lower adherence to recommended physical activity levels. The level of adherence to physical activity was significantly associated with the risk of stroke ($P = 0.02$). Similarly, as the ability to maintain glycemic control is linked to physical activity, patients with high adherence had a lower risk of developing retinopathy ($P > 0.001$). Participants who adhered to the recommended level of physical activity had a lower risk of developing depression than those with poor adherence ($P = 0.016$).

There were no statistically significant differences between either blood pressure level, or the level of adherence, to physical activity and anxiety. Furthermore, the level of adherence to physical activity was not significantly associated with CAD ($P = 0.08$).

The mean difference of cholesterol levels, abdominal and hip circumferences between the two groups were statistically significant. [Tables 9, 10, 11, and 12 respectively]

Amount of time spent in sedentary activities

The mean time spent in sedentary activities per day was 6.1 ± 2 h. Although men were found to be more physically active than women, mean sitting time was essentially identical (6.0 ± 2.9 h for men vs. 6.1 ± 3.9 h for women; $P = 0.7$). The factors that influenced physical activity similarly affected sedentary time, but in reversible order: younger participants, those with high level of education, those who received good family support and a recent advice from their physician regarding physical activity, and those who were following up in the diabetes centers had less daily sedentary time. By contrast, obese patients and those with history of stroke or CVD were spending longer sedentary time. [Table 13].

Discussion

This study investigated the level of adherence to physical activity and the different factors that may affect the adherence to recommended activity levels among Saudi Arabian patients with T2DM. In our population, 30% of participants were adherent to the recommended physical activity duration of 150 min/week. Female sex, older age, low education level, low economic status, longer duration of the disease, absence of family support, not receiving education from the physician or DM educator, and follow-up in health institutions other than the diabetes center all were significantly associated with no adherence to physical activity.

Physical activity is considered to be a principal lifestyle-related strategy in the control of T2DM.[24] However, less than one-third of the participants with diabetes adhered to the recommended amounts of physical activity. This finding was similar to that of many international studies on the topic. For instance, a survey of over 1,480 adults with T2DM in the USA revealed that only 31% reported sufficient levels of physical activity.[25] Another similar study in the USA conducted in 2003 reported that 39% of patients engaged in regular physical activity.[26] A study in the UK reported similar findings: only 34% were involved in regular exercise routine and were considered to be active. However, only 9% from those who exercise regularly achieved a sufficient amount of physical activity in which there is significant heart and breathing rate acceleration.[27] A 2014 study among Nepalese T2DM patients showed that only 21.3% of the patients had good adherence to physical activity.[28]

This current study showed that the situation in Saudi Arabia is different from that in the Middle East region. The level of adherence in our study is considered high, and it could probably be associated with the improvement in the health care system

Table 7: Effect of disease-related factors on the level of adherence to physical activity

Factor	Total physical activity ≥150 min/week		*P*
	Yes	No	
DM duration in years			
<5	73 (44.5%)	91 (55.5%)	<0.001
5-9	76 (33%)	154 (67%)	
10-19	119 (27.5%)	313 (72.5%)	
20-29	53 (23.2%)	175 (67.8%)	
>30	7 (12.5%)	49 (87.5%)	
Follow-up institution			
Diabetes center	139 (26%)	396 (74%)	<0.001
PHCC	165 (36.7%)	285 (63.3%)	
Private center	1 (20%)	4 (80%)	
Public hospital	23 (19.2%)	97 (80.8%)	
Diabetes center			
Hofuf diabetes center	60 (25.1%)	179 (74.9%)	<0.001
Jeddah diabetes center	113 (45.6%)	135 (54.4%)	
King Abdulaziz U.H	81 (28%)	208 (72%)	
King Khalid U.H	74 (22.1%)	261 (77.9%)	
Family history of DM			
Yes	273 (32.3%)	593 (67.7%)	0.37
No	91 (25.7%)	189 (74.3%)	
management of DM			
Diet only	8 (44.4%)	10 (55.6%)	0.04
Oral tablet	195 (32.6%)	403 (67.4%)	
Insulin + oral tablet	64 (23.7%)	206 (76.3%)	
Insulin	61 (27.2%)	163 (72.8%)	
Received education about DM in the last 12 months			
Yes	267 (33.9%)	521 (66.1%)	<0.001
No	61 (18.9%)	262 (81.1%)	
Visited a DM educator in the last 12 months			
Yes	163 (37.5%)	272 (62.5%)	<0.001
No	165 (24.4%)	511 (75.6%)	
Family support regarding physical activity			
Yes	207 (32.3%)	433 (67.7%)	0.016
No	121 (25.7%)	350 (74.3%)	

DM, diabetes mellitus; PHCC, public health care center; U.H, university hospital

and the efforts for creating awareness regarding the importance of physical activity in managing diabetes. However, a study in Tabuk in 2017 found that only 12% of the participants with diabetes followed the recommended exercise routine, compared to the 20% of the participants in the healthy control group.[29] In Riyadh, a questionnaire survey about adherence to diabetes self-care activities completed by patients with T2DM from King Abdulaziz Medical City, found that of all self-care activities, such as taking medications, foot care, and following specific diet, the lowest level of adherence was for exercise.[30] A study from the UAE found a markedly lower rate of physical activity among people with DM at only 3%.[20] Serour *et al.* showed that almost two-thirds of the patients with diabetes in Kuwait were not doing the recommended physical activity,[18] and this was primarily attributed to a lack of time, presence of a comorbid condition, and harsh weather.

In the present study, the level of adherence to the recommended physical activity duration was significantly associated with sex, age, level of education, monthly income, disease duration, follow-up place, the location of diabetes centers, family support, and visits to a DM educator. The proportion of men doing regular exercise was higher than that of women, and this could be attributed to cultural factors in the Saudi Arabian society, where women's outdoor activities requires the companionship of men. Similar results were also reported in the general Saudi population.[31] Kuwait, which has similar sociocultural contexts, has a similar outcome.[18] Compliance with the recommended physical activity levels may be hindered by sociocultural milieus in a certain area. Cultural factors play a critical role in determining the inclination toward doing physical activity; divorcees are less likely to be physically active.[29]

Younger subjects were found to be more compliant with doing physical exercise than older participants. We found a high level of adherence to physical activity in participants younger than 40 years old. This is consistent with findings in the Saudi general population.[31] The level of education and the financial status were also significantly associated with performing regular physical activity. Similar associations were found in Kuwait[18] and Nepal.[28] By contrast, other studies[20,26] found no significant association between educational level and adherence to physical activity.

Table 8: Effect of adherence to physical activity on disease control and other comorbidities

Factor	Total physical activity ≥150 min/week		*P*
	Yes	No	
HbA1c <7%			
Yes	94	230	0.013
No	169	599	
Hypertension (≥140/≥90)			
Yes	117	211	0.7
No	288	495	
BMI category			
Normal (<25)	40	73	0.002
Overweight (25-29.9)	108	192	
Obese (≥30)	178	512	
CVD			
Yes	39	144	0.08
No	289	639	
History of Stroke			
Yes	4	30	0.02
No	324	753	
History of Retinopathy			
Yes	106	373	<0.001
No	222	410	
Depression			
Yes	41	144	0.016
No	287	639	
History of Anxiety			
Yes	47	124	0.5
No	281	659	

BMI, body mass index; CVD, cardiovascular disease; HbA1c, glycated hemoglobin

Table 9: Adherence to the recommended physical activity duration by mean HbA1c

Total physical activity ≥150 min/week	HbA1c			95% CI	
	Mean	S.D	S.E.M	Lower	Upper
Yes	8.21	1.73	0.096	0.11	0.6
No	8.57	1.91	0.069		

P=0.004. The mean difference in HbA1c level between the two groups was statistically significant (*P*=0.004). SD, standard deviation; CI, confidence interval; SEM, standard error of the mean

People with higher levels of education and higher economic status tended to be more physically active. However, this seems contrary to the findings in the Saudi general population, where a lower level of physical activity was observed among people with higher education levels.[29] Nonetheless, several studies from other countries showed that people with high income are more inclined to participate in physical activity.[20,25,26,28]

In the present study, family support also positively influenced the motivation to be physically active. This is in concurrence with one peer review among Mexican Americans that revealed that family involvement in patient care was strongly associated with more compliance to physical exercise.[32] The management strategy for diabetes also related to the levels of physical activity. Patients who managed diabetes by diet alone were more likely to exercise.

Several studies have demonstrated the effect of regular patient education in the motivation for regular exercise.[24] In the current study, the level of physical activity was significantly different between those who attended educational programs, and those who did not.

Table 10: Effect of adherence to the recommended physical activity duration on the level of total cholesterol

Total physical activity ≥150 min/week	Cholesterol (mmol/dl)			95% CI	
	Mean	S.D	S.E.M	Lower	Upper
Yes	4.6	1.2	0.04	-0.42	-0.1
No	4.8	1.2	0.06		

P=0.001. SD, standard deviation; CI, confidence interval; SEM, standard error of the mean

Table 11: Effect of adherence to the recommended physical activity duration on the waist circumference

Total physical activity ≥150 min/week	Waist circumference (cm)			95% CI	
	Mean	S.D	S.E.M	Lower	Upper
Yes	104	14.2	0.81	1.003	5.2
No	107	16	0.61		

P=0.004. SD, standard deviation; CI, confidence interval; SEM, standard error of the mean

Diabetes control is positively influenced by the level of physical activity. Our study support these findings. People with regular physical activity had significantly lower HbA1c and BMI values. During exercise, muscle contraction, through stimulation of glucose transporter type 4 (GLUT4) and translocation to the muscle cell surface, increases glucose uptake. The functional recruitment of GLUT4 transporters can lead to a greater rate of glucose utilization by the muscles in people with T2DM.[33] Insulin action is also directly enhanced by muscle contraction via activation of post-insulin receptor signaling.[34]

A meta-analysis to assess the effects of structured exercise intervention in the level of HbA1c and body mass in people with T2DM showed a significantly lower HbA1c after 8 weeks of either aerobics or resistance training in the exercise group, than in the control group (7.65% vs. 8.31%, $P < 0.001$). By contrast, there was no difference in body weight between the two groups. Therefore, structured exercise programs had a statistically and clinically significant beneficial effect on glycemic control, and this effect was not mediated primarily by weight loss,[10,17] although some studies found no difference in glycemic control between those who are physically active and inactive.[20,27]

This study also found that adherence to the recommended levels of physical activity influences the risk of retinopathy among patients with T2DM. The mean cholesterol level of individuals with diabetes who adhered to the recommended physical activity was significantly different from those who did not. Similarly, there was a significant difference in the mean waist and hip circumferences between the two groups. However, we found no significant association between the level of physical activity and the control of blood pressure or occurrence of CAD.

Depression has a measurable negative affect on the disease course; patients with diabetes with major depression had poorer

glycemic control, less adherence to proper diet and physical activity, and were eventually more susceptible to end-organ damage and diabetes complications.[34-36] In the current study, 16.7% of the patients screened positively for major depression. Women had higher rates of major depression than men, with a ratio of 2.5:1.0 With respect to adherence to physical activity, patients with depression are less likely to be active and engaged in regular physical activity. This result is consistent with another study conducted by Egede *et al.* (2010).[37] However, we found no such effect when comparing adherence to physical activity on anxiety.

Table 12: Effect of adherence to the recommended physical activity duration on the hip circumference

Total physical activity ≥150 min/week	Hip circumference (cm)			95% CI	
	Mean	S.D	S.E.M	Lower	Upper
Yes	108	16.1	0.9	1.6	6.1
No	112	16.4	0.6		

P=0.001. SD, standard deviation; CI, confidence interval; SEM, standard error of the mean

The strength of this study lies on the relatively large sample size of patients that was recruited from multiple centers from different regions of Saudi Arabia. The consideration of several potential risk factors and the use of a validated electronic questionnaire, which reduce data errors, also add strength to this study. However, our study design also has some limitations. Because of the lack of temporality in cross-sectional studies, we can only reveal the association and cannot establish a cause-and-effect relationship.

In conclusion, our findings have found factors that affect adherence to the recommended physical activity in Saudi adults with T2DM. Further efforts are needed to increase awareness on the importance of adherence to physical activity in the

Table 13: Mean time spent in sedentary activities and its associations with different factors

Factor	Sedentary mean time±SD	Frequency	*P*
Sex			
Male	6.0±2.9	387	0.744
Female	6.1±3.9	724	
Age, years			
<40	4.6±2.5	77	
40-49	5.1±3.1	144	0.000
50-59	6±3.6	450	
60-69	6.5±3.9	301	
>70	6.9±3.5	139	
Level of education			
Illiterate	6.6±4.1	335	
Primary	6.2±3.8	234	0.003
Intermediate	5.7±3	148	
Tertiary	5.5±3.1	196	
University	5.7±3.1	198	
Follow-up institution			
Diabetes center	5.5±3.4	450	
PHCC	6.1±3.4	535	0.000
Private center	8±4.8	5	
Public hospital	7.6±4.6	120	
BMI category			
Normal	5.1±2.8	113	0.002
Overweight	5.8±3.1	300	
Obese	6.3±3.9	690	
Received education about DM in the last 12 months			
Yes	5.8±3.4	788	0.001
No	6.6±3.9	323	
Family support regarding physical activity			
All the time	5.1±3.2	317	0.000
Some time	6.4±3.1	323	
No	6.5±4	417	
Total physical activity≥150 min/week			
Yes	4.6±2.6	328	0.000
No	6.6±3.8	783	
History of stroke			
Yes	7.9±5.5	34	0.002
No	6±3.5	1077	
History of CVD			
Yes	7.5±4.4	183	0.000
No	5.8±3.3	928	

SD, standard deviation; PHCC, primary health care center; DM, diabetes mellitus; CVD, cardiovascular disease; BMI, body mass index

management of diabetes in Saudi Arabia. Identifying influencing factors of physical activity adherence is the first crucial step in controlling them and motivating T2DM patients to be more physically active, which in return will improve blood glucose control and prevent diabetes complications.

The primary care setting may be a successful place for the application of behavioral counseling interventions to motivate patients' engagement with the recommended duration of physical activity.

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Conflicts of interest

There are no conflicts of interest.

References

1. Whiting DR, Guariguata L, Weil C, Shaw J. IDF diabetes atlas: Global estimates of the prevalence of diabetes for 2011 and 2030. Diabetes Res Clin Pract 2011;94:311-21.
2. Shaw JE, Sicree RA, Zimmet PZ. Global estimates of the prevalence of diabetes for 2010 and 2030. Diabetes Res Clin Pract 2010;87:4-14.
3. Mathers CD, Loncar D. Projections of global mortality and burden of disease from 2002 to 2030. PLoS Med 2006;3:e442.
4. Florencia A, Alex B, Ho CN, Dahlquist G, Dodd Sheree, Dunning Trisha, Hirst Michael, *et al.* IDF Diabetes Atlas: Sixth edition. 6th ed.. Basel, Switzerland: International Diabetes Federation; 2013.
5. Al-Nuaim AR. Prevalence of glucose intolerance in urban and rural communities in Saudi Arabia. Diabet Med 1997;14:595-602.
6. Al-Rukban MO. Obesity among Saudi male adolescents in Riyadh, Saudi Arabia. Saudi Med J 2003;24:27-33.
7. Memish ZA, El Bcheraoui C, Tuffaha M, Robinson M, Daoud F, Jaber S, *et al.* Obesity and Associated Factors—Kingdom of Saudi Arabia, 2013. Prev Chronic Dis 2014;11:E174.
8. Arab M. The economics of diabetes care in the Middle East. In: Alberti K, Zimmet P, Defronzo R, editors. International Textbook of Diabetes Mellitus. 2nd ed. Chichester: John Wiley and Sons Ltd; 1997.
9. International Diabetes Federation. Diabetes Atlas. 8th ed.ition 2017; chapter 4:s72-73. Available from: http://www.diabetesatlas.org/resources/2017-atlas.html.
10. Umpierre D, Ribeiro PA, Kramer CK, Leitão CB, Zucatti AT, Azevedo MJ, *et al.* Physical activity advice only or structured exercise training and association with HbA1c levels in type 2 diabetes: A systematic review and meta-analysis. JAMA 2011;305:1790-9.
11. Pronk NP, Remington PL. Combined diet and physical activity promotion programs for prevention of diabetes: Community Preventive Services Task Force recommendation statement. Ann Intern Med 2015;163:465-8.
12. Aune D, Norat T, Leitzmann M, Tonstad S, Vatten LJ. Physical activity and the risk of type 2 diabetes: A systematic review and dose–response meta-analysis. Eur J Epidemiol 2015;30:529-42.
13. Sigal RJ, Kenny GP, Wasserman DH, Castaneda-Sceppa C, White RD. Physical activity/exercise and type 2 diabetes. Diabetes Care 2004;27:2518-39.
14. Villegas R, Shu XO, Li H, Yang G, Matthews CE, Leitzmann M, *et al.* Physical activity and the incidence of type 2 diabetes in the Shanghai women's health study. Int J Epidemiol 2006;35:1553-62.
15. American Diabetes Association. Lifestyle management: Standards of medical care in diabetes-2018. Diabetes Care 2018;41:S38-50.
16. Colberg SR, Sigal RJ, Fernhall B, Regensteiner JG, Blissmer BJ, Rubin RR, *et al.* Exercise and type 2 diabetes: The American College of Sports Medicine and the American Diabetes Association: Joint position statement. Diabetes Care 2010;33:e147-67.
17. Boule NG, Haddad E, Kenny GP, Wells GA, Sigal RJ. Effects of exercise on glycemic control and body mass in type 2 diabetes mellitus: A meta-analysis of controlled clinical trials. JAMA 2001;286:1218-27.
18. Serour M, Alqhenaei H, Al-Saqabi S, Mustafa AR, Ben-Nakhi A. Cultural factors and patients' adherence to lifestyle measures. Br J Gen Pract 2007;57:291-5.
19. Alramadan MJ, Afroz A, Batais MA, Almigbal TH, Alhamrani HA, Albaloshi A, *et al.* A study protocol to assess the determinants of Glycaemic control, complications and health related quality of life for people with type 2 diabetes in Saudi Arabia. J Health Educ Res Dev 2017;5:2.
20. Al-Kaabi J, Al-Maskari F, Afandi B, Parkar H, Nagelkerke N. Physical activity and reported barriers to activity among type 2 diabetic patients in the United Arab Emirates. Rev Diabet Stud 2009;6:271.
21. WHO STEPwise approach to chronic disease risk factor surveillance- Instrument v2.1. Available from: http://www.who.int/ncds/surveillance/steps/STEPS_Instrument_v2.1.pdf.
22. Kroenke K, Spitzer RL, Williams JB. The patient health questionnaire-2: Validity of a two-item depression screener. Med Care 2003;41:1284-92.
23. Skapinakis P. The 2-item Generalized Anxiety Disorder scale had high sensitivity and specificity for detecting GAD in primary care. Evid Based Med 2007;12:149.
24. Qui S, Sun Z, Cai X, Liu L, Yang B. Improving patients adherence to physical activity in diabetes mellitus: A review.

Diabetes Metab J 2012;36:1-5.

25. Nelson KM, Reiber G, Boyko EJ; NHANES III. Diet and exercise among adults with type 2 diabetes: Findings from the third national health and nutrition examination survey (NHANES III). Diabet Care 2002;25:1722-8.
26. Morrato EH, Hill JO, Wyatt HR, Ghushchyan V, Sullivan PW. Physical activity in US adults with diabetes and at risk for developing diabetes, 2003. Diabetes Care 2007;30:203-9.
27. Thomas N, Alder E, Leese GP. Barriers to physical activity in patients with diabetes. Postgrad Med J 2004;80:287-91.
28. 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.
29. Al-Mountashiri NA, Al-Zahrani AM, Ibrahim SFH, Mirghani HO. Dietary habits, physical activity and diabetes perception among patients with type 2 diabetes mellitus in Tabuk city, Saudi Arabia. Electron Physician 2017;9:5179-84.
30. Albargawi M, Snethen J, Gannass AAL, Kelber S. Perception of persons with type 2 diabetes mellitus in Saudi Arabia. Int J Nurs Sci 2016;3:39-44.
31. Al-Zalabani AH, Al-Hamdan NA, Saeed AA. The prevalence of physical activity and its socioeconomic correlates in Kingdom of Saudi Arabia: A cross-sectional population-based national survey. J Taibah Univ Sci 2015;10:208-15.
32. Mier N, Medina AA, Ory MG. Peer reviewed: Mexican Americans with type 2 diabetes: Perspectives on definitions, motivators, and programs of physical activity. Preventing chronic disease. Prev Chronic Dis 2007;4:A24.
33. Lund S, Holman GD, Schmitz O, Pedersen O. Contraction stimulates translocation of glucose transporter GLUT4 in skeletal muscle through a mechanism distinct from that of insulin. Proc Natl Acad Sci USA 1995;92:5817-21.
34. Richter EA. Glucose utilization. In: Rowell LB, Shepherd JT, editors. Handbook of Physiology. New York: Oxford University Press; 1996. p. 912-95.
35. Lustman PJ, Anderson RJ, Freedland KE, de Groot M, Carney RM, Clouse RE. Depression and poor glycemic control: A meta-analytic review of the literature. Diabetes Care 2000;23:934-42.
36. Lin EH, Rutter CM, Katon W, Heckbert SR, Ciechanowski P, Oliver MM, *et al.* Depression and advanced complications of diabetes: A prospective cohort study. Diabetes Care 2010;33:264-9.
37. Egede LE, Osborn CY. Role of motivation in the relationship between depression, self-care, and glycemic control in adults with type 2 diabetes. Diabetes Educ 2010;36:276-83.