Original Article :

The Risk Factors for Physical Activity among Individuals Diagnosed with Type 2 Diabetes in Saudi Arabia

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Abstract

Background and Aims:
In Saudi Arabia, diabetes is prevalent. Lack of physical activity (PA) is a known risk factor for type 2 diabetes mellitus (T2DM) worldwide. However, there is little research on PA among Saudis with T2DM. The study aimed to investigate personal and cognitive-perceptual factors for PA among Saudis with T2DM.

Methods:
A cross-sectional study was conducted with a sample size of 808 Saudi adults with T2DM from the Saudi Health Interview Survey (SHIS) for 2013. Bivariate and multivariate logistic regressions were applied to examine the risk factors for PA among Saudis with T2DM.

Results:
The prevalence of physical activity was 9.1% in Saudi adults with T2DM. In the adjusted models, younger age (AOR = 2.77), higher education (AOR = 3.14), and health professional support for treatment (AOR = 0.35) were predictors of physical activity.

Conclusions:
The study suggested further investigation on elders' physical function and those who had low education. Healthcare providers should consider balancing between treatment and promoting lifestyle change for Saudi individuals with T2DM. In addition, Longitudinal studies with large sample size at national and regional levels are needed to further examine the personal and psychological risk factor in Saudis with T2DM.

Keywords:
Physical activity; prevalence; risk factors; Saudi Arabia; T2DM

Introduction

According to the International Diabetes Federation (IDF) in 2019, the prevalence of diabetes in Saudi Arabia (SA) had doubled since 2010 with an estimated 4.28

million people suffering from diabetes.[1,2] If this trend continues, the number of individuals with diabetes is expected to double by 2025. In addition, undiagnosed cases of diabetes were estimated to be 1.67 million in 2019 with a 49% increase since 2011.[2,3] In 2015, diabetes-related deaths accounted for 19% of 116,934 crude deaths, a 66% increase since 2010.[3,4] Thus, diabetes was ranked fourth as a leading cause of death in SA according to the Institute for Health Metrics and Evaluation (IHME).[5] The estimated cost of treating a Saudi diabetic patient was $1,172 annually and the cost had significantly increased, almost doubled since 2010. The current economic burden of diabetes was estimated at $5 billion in 2019.[2]

The uncontrolled blood glucose levels among the diabetic population is another evolving issue. A recent systematic review showed 78% of Saudis with type 2 diabetes mellitus (T2DM) had poor glycemic control.[6] This indicates that a significant portion of the population with T2DM did not maintain their blood glucose at normal levels which may lead to diabetes related complications.[7-9] It is known that diabetes is a complex disease, and several factors contribute to its vast spread even among younger generation.[10] Physical activity (PA) among these factors that are highly related to the improvement of glycemic control and well-being.[11] In Saudi Arabia, lack of PA in the general population is evident and some studies showed that physical inactivity exceeds 80% of the adult population.[12] The issue extends to Saudis with T2DM where only low percentages of Saudis with diabetes were found to be physically active.[18-20]

There is a little known about risk factors related to PA among Saudis with T2DM and there were few local or regional studies and none of them were at national level.[13-15] For example, Elbur[13] study has predicted age as the only personal factor associated with a specific exercise session, while the study had only focused on personal factors (e.g., age, gender, and education),and small population of local hospital in Taif city. While two studies have examined family, social, and physician support factors, in addition to socioeconomic factors, with physical activity but they did not consider other cofounding factors in the analysis.[14,15] Additionally, all these aforementioned studies did not follow a theoretical approach on understanding relevant risk factors for physical activity among Saudis with T2DM.

This study is guided by the health promotion model (HPM). HPM is a conceptual framework and its initial purpose was to provide support to nurses in recognizing the determinants of health behaviors that

could be fundamental for health promotion change at the individual level.[16] what differentiated the HPM is that it does not account for threat factors as a direct influence on health behaviors and support for self-actualization rather than health protection.[16] The theoretical basis for the HPM model focuses on major concepts: individual characteristics and experience, behavior-specific cognitions and affect, and behavioral outcomes.[16] The HPM has been adapted in health research to investigate several health issues and evaluate health promotion programs (e.g., exercise and diet among adolescents and adults with chronic disease and injury).[16] The model improves thoroughness and adds value in understanding the link between variables and outcomes. Eventually, the model helps inform healthcare providers of the importance of considering such factors in their treatment plan for diabetic patients.

Therefore, the study aimed to identify risk factors for PA among Saudis with T2DM, utilizing HPM. Two research questions were answered in this study: First, what personal factors were associated with PA in Saudis with T2DM? Second, what cognitive-perceptual factors were associated with PA in Saudis with T2DM after adjusting for personal factors?

Methods

Study Design

A cross-sectional study was performed using secondary data from the Saudi Health Interview Survey (SHIS) of 2013. The SHIS is a nationally representative data of all the 13 administrative regions in Saudi Arabia for individuals age 15 years or older, using a stratified multistage sampling technique.[17] This survey was part of a major project in Saudi Arabia to establish a population-based surveillance system for monitoring chronic diseases. The survey included data that covers socio-economic and health-related risk factors, inpatient-outpatient, and intervention-related information.[17] The SHIS has a total of 10,827 subjects and only 808 subjects had T2DM and were adults (18 years or older). Permission was obtained from General Directorate for Control of Genetic and Chronic Disease at the Ministry of Health to use SHIS 2013 data. The study was approved from the Institutional Review Board at Old Dominion University. The study followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist.[18]

Variables

There were 17 variables included in the study and the extraction of the variables followed the modified HPM model

(see Figure 1), which breaks down variables into three main categories. First, personal factors included age, gender, family history, diabetes duration, obesity, marital status, education, income, region of residence, and perceived health status (PHS) which were used as independent variables in the study. The age factor was categorized into ≥ 54 years old and < 54 years old.[6] Family history was defined whether each participant had a family member who were diagnosed with diabetes including parents, children, brothers, and/or sisters. The diabetes duration was classified into < 5 years, 5 – 9 years, and ≥ 10 years.[19] Obesity was defined as body mass index (BMI) of ≥ 30.[20] Marital status was defined as married or others (e.g., never married, separated, divorced, or widowed). Education was categorized into low (primary school or below), middle (intermediate or high school), and high (college degree or higher). Income was classified as low (< $1,333), middle (≥ $1,333 to < $4,000), and high (≥ $4,000). Region of residence was classified into five groups including central, southern, Northern, eastern, and western regions. PHS was a single question to rate participants' health in general. The variable was defined as poor or good using median split technique. Second, Cognitive-perceptual factors included vigorous activity barriers (VAB), house activity barriers (HAB), physical activity barriers (PAB), health professional support for treatment (HPST), health professional support lifestyle change (HPSL), and multiple healthcare providers (MHP). VAB was defined as low and high barriers that whether patients' current health limits them from doing vigorous activities, such as running or participating in strenuous sports. HAB was also defined as low and high barriers but related to performing work or household activities. PAB defined as low and high barriers related to doing activities such as standing from a seated position, standing and for a long time, and/or stair climbing. HPST was related to whether diabetic patients received insulin or medication treatment by health professionals. HPSL was related to whether diabetic patients received treatment or advice for lifestyle change (e.g., stop smoking, lose weight, diet, and exercise). Finally, MHP was about whether or not participants have multiple healthcare providers. Third category was physical activity (PA) as the outcome variable. PA was defined according to American Diabetes Association (ADA) guidelines for high PA (i.e., perform at least 150 minutes per week of moderate to intensive activity and the activity is spread over at least three days per week) and low PA (i.e., less than 150 minutes per week of moderate to intensive

activity or activity is spread over less than three days per week).[21] Responses with "don't know" or "decline to respond" were considered missing. All variables obtained from SHIS were modified according to the study design. Further details about the classification and coding of the variables were presented in Supplemental Table 1.

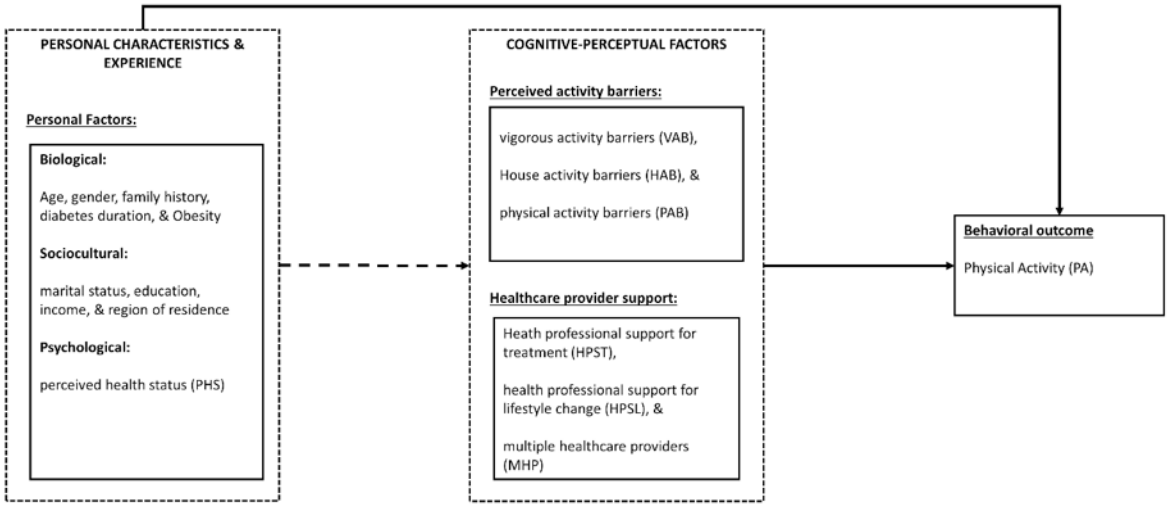


Figure 1: Proposed Model for Risk Factors Associated with Physical Activities Adapted from Pender's Health Promotion Model.

Statistical Analysis

In order to treat missing data, multiple imputation (MI) with fully conditional specification (FCS) method was performed.[22] Additionally, including all variables in the MI was necessary to prevent biased estimation of the parameters after MI.[23,24] The study followed the rule of thumb for the number of imputations that depends on the percentage of missing cases.[25] A comparison between imputed and original data for possible variations was performed after MI. In the final analysis, only pooled imputed data was used.

The study provided descriptive analysis to give an overview of the characteristics of the study population and was presented in numbers and weighted percentages. Bivariate and multivariate logistic regression were conducted to address the research questions and the results were presented in Odds Ratio (OR), 95% confidence interval (CI), and p value with alpha level set at 0.05. All analysis was weighted using post-stratification weight to maintain generalizability of the results to the Saudi national population. Variance inflation factor (VIF) and tolerance tests were used to assess multicollinearity. For model accuracy and fit, the study used Receiver Operating Characteristic (ROC) and Wald test, respectively. SPSS (IBM Corp.) was used for data preparation (i.e., cleaning, merging, and recoding data) and MI. For final

data analysis, Stata 16 (Stata Corp.) was utilized due to limitation in SPSS to perform this kind of complicated analysis.

Results

Total of 808 participants were included in the analysis. Fifty multiple imputations were utilized in the analysis according to the percentage of missing cases and the missingness was assumed to be missing at random (MAR). High percentages of missingness were found in diabetes duration (21.7%), income (17.2%), and family history (15.2%). Further analysis showed high missingness in these variables were related to men except women for income, low education, age $\geq$ 54 years, and reside in central region (see Supplemental Table 2 and 3).

No discrepancy was noticed in the data before and after MI. The analysis showed T2DM were more prevalent in men, individuals age 54 or older, married, obese, low educated, had middle income, had family history of diabetes, had diabetes duration equal or more than 10 years, had good perceived health, and living in central region (see Table 1). The percentages of Saudis with T2DM who had high house activity barriers (HAB), high physical activity barriers (PAB), and high vigorous activity barriers (VAB) were 27.9%, 23.6%, and 49.4%, respectively. Furthermore, the percentage of Saudis with T2DM who had received health professional support for treatment (HPST) and lifestyle change (HPSL) were 87.8% and 92%., respectively. The percentage of those who had multiple healthcare providers (MHP) was 41%. The prevalence of physical activity among Saudis with T2DM was 9.1%.

The findings showed several factors

Table 1: Characteristics of Personal, Cognitive-Perceptual, and Behavioral Factors before and after multiple imputations, n = 808

	Original data	Completed data
Variable	n (weighted %)	n (weighted %)
Sample size	-	808
Age		
<54 years	321 (47.9)	324 (47.9)
≥54 years	481 (52.1)	484 (52.1)
Gender		
Women	331 (38.7)	331 (38.7)
Men	477 (61.3)	477 (61.3)
Family history		
Yes	483 (70.8)	556 (69.7)
No	202 (29.2)	252 (30.3)
Diabetes duration		
<5 years	211 (36.2)	245 (32.9)
5-9 years	164 (25.9)	207 (26.7)
≥ 10 years	258 (37.9)	356 (40.4)
Obesity		
Yes	409 (53.1)	419 (53.2)
No	381 (46.9)	389 (46.8)
Marital status		
Married	619 (81.5)	621 (81.5)
Others	187 (18.5)	187 (18.5)
Education		
Low	477 (52.8)	477 (52.7)
Middle	221 (34.1)	221 (34.0)

	Original data	Completed data
Variable	n (weighted %)	n (weighted %)
Sample size	-	808
High	108 (13.2)	110 (13.3)
Income		
Low	274 (34.8)	326 (34.8)
Middle	304 (49.5)	364 (49.1)
High	91 (15.7)	118 (16.1)
Region of residence		
Central	181 (34.2)	181 (34.2)
Western	202 (31.0)	202 (31.0)
Eastern	48 (13.9)	48 (13.9)
Northern	153 (8.6)	153 (8.6)
Southern	224 (12.3)	224 (12.3)
PHS		
Poor	179 (17.5)	179 (17.5)
Good	627 (82.5)	629 (82.5)
VAB		
Low	366 (50.6)	374 (50.6)
High	426 (49.4)	434 (49.4)
HAB		
Low	538 (72.3)	555 (72.1)
High	241 (27.7)	253 (27.9)
PAB		
Low	576 (76.6)	580 (76.4)
High	225 (23.4)	228 (23.6)
HPST		
Yes	705 (87.8)	707 (87.8)
No	101 (12.2)	101 (12.2)
HPSL		
Yes	732 (92.3)	740 (92.0)
No	65 (7.7)	68 (8.0)
MHP		
Yes	326 (41.5)	338 (41.2)
No	444 (58.5)	470 (58.8)
Physical Activity		
Active	66 (9.1)	66 (9.1)
Inactive	741 (90.9)	742 (90.9)

Abbreviations: HAB, house activity barriers; HPSL, health professional support for lifestyle change; HPST, health professional support for treatment; MHP, Multiple healthcare providers; PAB, physical activity barriers; PHS, perceived .health status; VAB, vigorous activity barriers

were associated with physical activity in the bivariate analysis (see Table 2). Those under age 54 had 4 times higher odds to be physically active compared those age 54 or older. Higher odds of physical activity were found in diabetic Saudis with high (OR = 6.15; 95% CI = 2.60–14.54) and middle (OR = 3.07; 95% CI = 1.41–6.69) education compared to those with low education. Those with diabetes duration less than five years had higher odds of physical activity compared to those with 10 years of diabetes duration (OR = 2.25; 95% CI = 1.01–5.02). The odds of physical activity was higher among diabetic Saudis with high income comparted to low income (OR = 4.19; 95% CI = 1.75–10.1). In addition, diabetic Saudis with high VAB had lower odds of physical activity compared to low VAB (OR = 0.46; 95% CI = 0.23–0.93). Diabetic Saudis with high HAB had lower odds of physical activity compared to low HAB (OR = 0.22; 95% CI = 0.07–0.72). Diabetic Saudis who received HPST had lower odds to be physically active compared to those who did not receive HPST (OR = 0.42; 95% CI = 0.19–0.91).

Table 2: Odds Ratio or Prevalence Ratio, 95% CIs, and P Values from Bivariate Analysis of the Association Between Risk Factors and Physical Activity among Saudis with T2DM, n = 808

Variable	Physical Activity				
	Active n (%)	Inactive n (%)	OR	(95% CI)	P Value
Unweighted sample	66 (8.17)	742 (91.83)			
Weighted sample	65,763 (9.08)	658,611 (90.92)			
Age					
≥54 years	18 (4.05)	466 (95.95)	Ref.		
<54 years	48 (14.55)	276 (85.45)	4.03	(2.03–8.02)	< 0.001
Gender					
Women	16 (6.38)	315 (93.62)	Ref.		
Men	50 (10.78)	427 (89.22)	1.77	(0.84–3.74)	0.130
Family history					
No	15 (5.83)	237 (94.17)	Ref.		
Yes	51 (10.49)	505 (89.51)	1.89	(0.89–4.02)	0.096
Diabetes duration					
≥ 10 years	18 (5.91)	338 (94.09)	Ref.		
5-9 years	17 (9.89)	190 (90.11)	1.75	(0.71–4.35)	0.227
<5 years	31 (12.31)	214 (87.69)	2.25	(1.01–5.02)	0.049
Obesity					
No	26 (7.36)	363 (92.64)	Ref.		
Yes	40 (10.59)	379 (89.41)	1.49	(0.79–2.82)	0.220
Marital status					
Others	10 (4.92)	177 (95.08)	Ref.		
Married	56 (10.02)	565 (89.98)	2.15	(0.92–5.04)	0.078
Education					
Low	17 (4.21)	460 (95.79)	Ref.		
Middle	29 (11.87)	192 (88.13)	3.07	(1.41–6.69)	0.005
High	20 (21.26)	90 (78.74)	6.15	(2.60–14.54)	< 0.001
Income					
Low	18 (4.98)	308 (95.02)	Ref.		
Middle	32 (9.07)	332 (90.93)	1.90	(0.90–4.03)	0.094
High	16 (17.99)	102 (82.01)	4.19	(1.75–10.01)	0.001
Region of residence					
Central	14 (9.53)	167 (90.47)	Ref.		
Western	24 (11.82)	178 (88.18)	1.27	(0.58–2.80)	0.550
Eastern	2 (3.28)	46 (96.72)	0.32	(0.07–1.56)	0.161
Northern	11 (4.99)	142 (95.01)	0.50	(0.20–1.22)	0.130
Southern	15 (10.35)	209 (89.65)	1.10	(0.46–2.59)	0.835
PHS					
Poor	8 (7.37)	171 (92.63)	Ref.		
Good	58 (9.44)	571 (90.56)	1.31	(0.51–3.38)	0.575

Variable	Physical Activity				
	Active n (%)	Inactive n (%)	OR	(95% CI)	P Value
Unweighted sample	66 (8.17)	742 (91.83)			
Weighted sample	65,763 (9.08)	658,611 (90.92)			
VAB					
Low	51 (12.13)	323 (87.87)	Ref.		
High	15 (5.95)	419 (94.05)	0.46	(0.23–0.93)	0.030
HAB					
Low	62 (11.51)	493 (88.49)	Ref.		
High	4 (2.80)	249 (97.2)	0.22	(0.07–0.72)	0.012
PAB					
Low	59 (10.17)	521 (89.83)	Ref.		
High	7 (5.56)	221 (94.44)	0.52	(0.20–1.32)	0.168
HPST					
No	15 (17.12)	86 (82.88)	Ref.		
Yes	51 (7.96)	656 (92.04)	0.42	(0.19–0.91)	0.027
HPSL					
No	6 (7.98)	62 (92.02)	Ref.		
Yes	60 (9.17)	680 (90.83)	1.16	(0.43–3.17)	0.766
MHP					
No	39 (8.48)	431 (91.52)	Ref.		
Yes	27 (9.93)	311 (90.07)	1.19	(0.62–2.29)	0.604

Abbreviations: CI, confidence interval; HAB, house activity barriers; HPSL, health professional support for lifestyle change; HPST, health professional support for treatment; MHP, Multiple healthcare providers; PAB, physical activity barriers; PHS, perceived health status; VAB, vigorous activity barriers. Only weighted data was used for the analysis.

The results from the analysis of model 1 only showed that age and education were associated with PA (see Table 3) after adjusting for other personal factors. Diabetic Saudis who were under the age of 54 years old had 2.84 times higher odds of PA compared to those more than or equal the age of 54 years old after adjusting for other personal variables (95% CI = 1.25–6.45). The odds of PA were greater in diabetic Saudis with higher education compared with those with lower education (AOR = 3.14; 95% CI = 1.02–9.71). Model 2 revealed that Saudis with T2DM who received HPST had lower odds of PA compared to those who did not receive HPST (AOR = 0.35; 95% CI = 0.14–0.85) while age remained consistent risk factor for PA. Both models had fair to good model accuracy with area under the curve (AUC) of 0.78 and 0.81. In addition, only model 1 showed adequate fit from Wald test.

Table 3: Adjusted Odds Ratio, 95% CIs, and P Values from Multivariate Analysis of the Association Between Personal, Cognitive-Perceptual Factors and Physical Activity among Saudis with T2DM, n = 808

	Model-1			Model-2		
Variable	AOR	(95% CI)	P Value	AOR	(95% CI)	P Value
Age < 54 years old	2.84	(1.25–6.45)	0.013	2.77	(1.18–6.51)	0.019
Men	1.57	(0.67–3.68)	0.304	1.68	(0.71–3.95)	0.234
Family history (yes)	1.55	(0.69–3.50)	0.293	1.53	(0.68–3.45)	0.305
Diabetes duration <5 years	1.40	(0.60–3.29)	0.442	1.17	(0.48–2.85)	0.738
Diabetes duration 5-9 years	1.56	(0.56–4.33)	0.390	1.53	(0.52–4.48)	0.438
Obese	1.44	(0.75–2.79)	0.272	1.54	(0.77–3.09)	0.221
Married	1.19	(0.44–3.18)	0.734	1.14	(0.43–3.01)	0.788
Middle education	2.23	(0.92–5.40)	0.075	2.02	(0.85–4.81)	0.112
High education	3.14	(1.02–9.71)	0.047	2.88	(0.97–8.57)	0.058
Middle income	0.96	(0.40–2.31)	0.930	0.92	(0.37–2.30)	0.854
High income	1.83	(0.65–5.12)	0.251	1.85	(0.66–5.20)	0.245
Western region	1.45	(0.58–3.60)	0.428	1.28	(0.50–3.31)	0.604
Eastern region	0.39	(0.08–1.99)	0.258	0.30	(0.05–1.61)	0.159
Northern region	0.80	(0.31–2.06)	0.643	0.83	(0.31–2.25)	0.718
Southern region	1.49	(0.58–3.86)	0.411	1.19	(0.48–2.98)	0.707
Good PHS	0.67	(0.27–1.71)	0.405	0.57	(0.19–1.77)	0.335
High VAB				0.77	(0.33–1.81)	0.547
High HAB				0.27	(0.06–1.23)	0.090
High PAB				2.56	(0.54–12.14)	0.235
HPST (yes)				0.35	(0.14–0.85)	0.021
HPSL (yes)				0.68	(0.22–2.11)	0.499
MHP (yes)				1.02	(0.47–2.19)	0.960
AUC	0.78			0.81		
Wald test	F(16, 791.6) = 3.53, p < .001			F(6, 789.1) = 1.74, p > .05		

Reference categories for categorical predictors are: Age (≥ 54 years); Gender (women); Family history (no); Diabetes duration (≥ 10 years); obesity (no); Marital status (others); Education (low); Income (low); Region of residence (central); PHS (poor); VAB (low); HAB (low); PAB (low); HPST (no); HPSL (no); MHP (no). Abbreviations: CI, Confidence Interval; AOR, adjusted odds ratio; AUC = Area under the receiver operator characteristic curve; HAB, house activity barriers; HPSL, health professional support for lifestyle change; HPST, health professional support for treatment; MHP, Multiple healthcare providers; PAB, physical activity barriers; PHS, perceived health status; VAB, vigorous activity barriers.

Discussion

The study indicated that the majority of Saudis with T2DM had low levels of PA according to the American Diabetes Association (ADA) recommendations.[21] The results were consistent with the literature.[14,15] For example, studies showed nearly one-third of Saudis with T2DM adhered to the recommended Physical activity (PA; ≥ 150 min/week).[14,15] Nevertheless, these studies were not nationally representative to the Saudi diabetic individuals. The low levels

of PA extends to the general population of Saudi Arabia as well.[12,26] This may cause a burden on the healthcare system in the country as low level of PA is considered a risk factor for several chronic diseases including diabetes. In addition, some studies pointed out the scarcity of health promotion programs to raise awareness among Saudis about the importance of performing exercise.[27,28]

In this study, older Saudis with T2DM were not physically active which was consistent with other studies.[14,15] Ramadan[16] have studied PA among a large sample of diabetic patients from three diabetic centers from three different cities in Saudi Arabia. The results showed significant adherence to PA in younger diabetic individuals compared to older but no odds ratio values was presented in the study. Elbur[13] showed the odds ratio of participating in at least 30 minutes of PA for more than 5 days was almost two times more for younger than 50 years old diabetic patients compared to older than or equal to 50 years old. However, these studies did not account for other risk factors in their analysis. The study suggests, after adjusting for other predictors, that older adults could have functional decline with or without clear contributing factors.[29] Unfortunately, there is a lack of literature that focuses on geriatric research in Saudi Arabia. A systematic review on geriatric research in Saudi Arabia did not find a single study that had addressed the issue of PA among elders.[30] In addition, the low level of PA goes beyond through questioning the effectiveness of current governmental initiatives in promoting PA in the general population.[27] Therefore, health care professionals and researchers should give attention to the vulnerable population through a proper evaluation of functional disability and design of intervention programs provided to this important segment of the society.[31]

Education was another important predictor related to PA. All other studies had similar results of the importance of educational level in performing exercise.[13,15] The study suggested that those with lower education and elderly can be targeted through designed educational programs that promotes awareness about healthy behaviors.32 Furthermore, health professional support for treatment (HPST) was inversely association with PA. The study suggested that those who receive treatment (i.e., insulin or medicine) may reduce exercises because treatment lower blood glucose level and combine both exercise and treatment may lead to hypoglycemic events.[33] Other studies showed healthcare providers have positive association with patients' perceptions about the management of their diabetes.[15,34,35] Therefore, healthcare

providers should give priority for promoting lifestyle change prior to giving treatment for individuals with T2DM at least for those who do not experience unstable blood glucose level.

Although the results did not show significance for some of the known risk factors for PA such as gender, and BMI. However, there were discrepancies in the literature about the significance of gender and BMI among Saudis with diabetes. For instance, Elbur did not show significance between gender and PA while Ramadan et al. showed significance but was not adjusted for other predictors.[13,15] This could be an indication that there were no actual differences between women and men in the specific population of T2DM in Saudi Arabia. However, the differences could be obvious when considering the whole population of Saudi Arabia.

The study had several limitations. First, the variation between diabetic Saudis with who were on insulin treatment versus non-insulin was not addressed in the study because the required data was not available. Second, the study may not be generalized to the national level because the cluster variable was missing from the data which could underestimate the standard errors. Third, the study did not examine the causality because the study design was cross-sectional. The study used data that was collected in 2013; however, to the best of our knowledge, this is the only available national data until now.

Conclusion and recommendations

Overall, low prevalence of active PA was seen in Saudis with T2DM. PA is crucial for diabetic individuals to maintain normal blood glucose level. In addition, there were several factors showed association with PA includes age, education, and HPST. Due to lack in the literature about intervention and health promotion for T2DM in Saudi Arabia,[36] there is an urgent need to focus on treatment plans and health prevention and promotion programs considering the differences in the characteristics of individuals and considering the importance healthcare providers' roles in the management of diseases. In addition, further longitudinal studies are needed to address the most common risk factors that contribute to the low levels of PA among diabetic Saudis. These suggestions could be linked directly to support the country vision 2030 to increase the percentage of people who do physical activity up to 40%.

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