

Assessment of lifestyle risk factors in female citizens of Saudi-Arabia with type 2 diabetes: dietary factors and physical activity

Abstract

Type 2 diabetes mellitus (T2DM) is a major public health problem worldwide. The kingdom of Saudi Arabia is one of the top 10 countries for the development of this non-communicable disease. The aim of this study was to identify critical lifestyle risk factors in female Saudi citizens with and without type 2 diabetes mellitus (T2DM) by assessing dietary habits, physical activity patterns, sedentary behaviors and health-related quality of life. This cross-sectional case-control study was carried out in Jeddah city. A total of 100 Saudi females clinically diagnosed with T2DM aged between 30 to 65 years and another 100 gender- and age - matched non-diabetic controls were recruited. Data was collected through face-to-face interviews using a dietary habits questionnaire, the short-form of the International Physical Activity questionnaire (IPAQ) and the EuroQol instrument. Comparison of both groups revealed statistically significant differences in marital status, educational level, professional status and household income between diabetic and non-diabetic subjects. Obesity was more common in diabetic participants (64%) compared with non-diabetic (44%, $P < 0.05$). The majority of the diabetic subjects showed unhealthy dietary behaviors and did not meet the daily recommended intake from food groups and macronutrients compared with the control group. Physical activity assessment revealed that 20% of both diabetic subjects and controls were physically inactive with no significant differences in physical activity patterns or sedentary behavior between the groups. In conclusion, dietary habits, PA and sedentary behavior may act as powerful promoters of T2DM in Saudi females.

Keywords: type 2 diabetes, Saudi females, body mass index, obesity, dietary habits, guideline daily allowance amount, physical activity, international physical activity questionnaire, health-related quality of life

Volume 4 Issue 1 - 2017

Loubna M Ayman Al Sada,¹ Manahil Mohammad Bineid,² Hamzeh Awad,⁴ Amani A Alrasheedi,⁵ Hans Hauner³

¹Nutritional science Institute of Clinical Nutrition of Medicine, Klinikum rechts der Isar der TU München, Germany

²Nutritional science, Saudi Arabia

³Associate Professor in Health Science and Health Information Technology, KIC University, UAE

⁴Associated Professor in Nutrition and Food Science Food and Nutrition Department-Home Economics College, King Abdulaziz University, Saudi Arabia

⁵Institute of Clinical Nutrition of Medicine, Klinikum rechts der Isar der TU München, Germany

Correspondence: Hans Hauner, Else Kroener-Fresenius-Centre for Nutritional Medicine, Klinikum rechts der Isar, Technical University of Munich, Georg-Brauchle-Ring 62, 80992 München, Germany, Tel +49 89 289 24921, Fax +49 89 289 24922, Email hans.hauner@tum.de

Received: August 09, 2016 | **Published:** February 28, 2017

Abbreviations: BMI, body mass index; EQ-5D, euroqol five dimensions questionnaire; EQ VAS, vertical, visual analogue scale; GDAs, guideline daily amounts; GI, glycemic index; HRQOL, health-related quality of life; IDF, international diabetes federation; KAUH, king abdulaziz university hospital; MET, metabolic equivalent; MIPA, moderate-intensity physical activity; PA, physical activity; IPAQ, international physical activity questionnaire; T1DM, type 1 diabetes mellitus; T2DM, type 2 diabetes mellitus; USDA, united states department of agriculture; VIPA, vigorous-intensity physical activity; WC, waist circumference; WHO, world health organization; SD, standard deviation; SPSS, statistical package for social sciences

Introduction

Type 2 diabetes mellitus (T2DM) is a complex metabolic disorder of multiple etiologies, which is characterized by chronic hyperglycemia.¹ Diabetes is a rapidly growing health problem worldwide: the International Diabetes Federation recently estimated that 8.3% of all adults-382million people-have diabetes, and the number of people with the disease is expected to rise beyond 592million in less than 20years representing an increase of 55% by 2035.² According to IDF, Saudi Arabia is among the top 10 countries with the highest prevalence of T2DM. It was estimated that 3.8million individuals were diagnosed to have diabetes in Saudi Arabia in 2014.²

This increase in prevalence in the Kingdom may cause an

increasing financial burden to the Saudi healthcare system.³ Recent estimates from government authorities indicate that the costs of diabetes in the nation were \$0.9 billion in 2010 and are expected to increase to \$6.5 billion by 2020.^{3,4}

The Gulf area has experienced dramatic changes in the living conditions during the last 3 to 4 decades resulting in an obesogenic environment characterized by a high fat intake, a high consumption of refined carbohydrates, a sedentary lifestyle, and physical inactivity which may be responsible for the increased incidence of obesity and type 2 diabetes.^{5,6} There has been an increase in per capita energy and fat intake in all countries going along with the continuous transition from a traditional healthy food to a more Western diet.⁷ In addition, physical inactivity has become extremely prevalent in the different age groups and sexes of the Saudi society.^{8,9} WHO reported an overall prevalence of physical inactivity (defined by less than 5times 30minutes of moderate activity per week, or less than 3times 20minutes of vigorous activity per week, or equivalent) among the Saudi population aged more than 15year of 68.8% in 2008.¹⁰ The prevalence was higher in females than males (76.2% and 61.5%, respectively).¹⁰

There is an urgent need to assess the specific risk factors for T2DM in Arab societies with a high prevalence of the disease such as in Saudi Arabia. This is a prerequisite to establish effective culture-sensitive prevention and intervention programs. Aim of this study was

to explore the critical lifestyle risk factors characteristic of T2DM in female citizens of Saudi Arabia living in Jeddah city, focusing on the two major lifestyle components: dietary habits and physical activity (PA). A secondary aim was to investigate the relationship between levels of PA and health-related quality of life (HRQOL).

Material and methods

A cross-sectional, case-control design was defined for this study. An interviewer-administered questionnaire was developed and applied to collect data from female patients with T2DM during a 3month period, from May through July 2013. The study was performed in Saudi citizens living in Jeddah City, West province of Saudi Arabia. Diabetic subjects were recruited at two places: The Department of Internal Medicine in King Abdulaziz University Hospital (KAUH) and the Hypertension & Diabetes Care Center of Jeddah Community Health Affairs, Ministry of Health. Female patients in the outpatient clinics of the two health care centers were consecutively invited to participate in the study. Informed consent was obtained from all individual participants included in the study. A total of 100 females aged between 30-65years and with the clinical diagnosis of T2DM were recruited. 38 subjects were excluded for several reasons, e.g. if they were non-diabetic, had T1DM or were unable to complete the interview for any reason.

A total of 100 gender- and age-matched Saudis were recruited as control group. Only subjects were included who did not have diabetes of any type, a parental history of diabetes and who were not taking any chronic medication for glucose metabolism. They were recruited at three locations: the Medical Clinics of the Art & Design College, the College of Science at King Abdulaziz University, and the Jeddah Rehabilitation Center for Females. All subjects were informed about the objectives of the study and had given informed consent. The study protocol was approved by the Research Ethics Committee of the National Committee of Medical and Bioethics (No. 00170).

The questionnaire developed for this study consisted of four main sections and a total of 41 questions. The first section was designed to obtain information on demographic and socio-economic characteristics, the onset of diabetes, smoking habits, and anthropometric measurements. The second section covered dietary habits including a 24h dietary recall form, the third and fourth sections were dealing with the assessment of PA and health-related quality of life (HRQOL), respectively.

Anthropometric measurements

Anthropometric measurements included height, weight and waist circumference (WC). Body mass index (BMI) was calculated as weight (in kilograms) divided by height (in meters) squared. Based on BMI, participants were classified as following: participants with BMI <18.5, 18.5-24.9, 25-29.9, as well as 30 and above were defined as underweight, normal weight, overweight and obese, respectively.¹¹

Dietary assessment

A dietary habits questionnaire was designed for this study on the basis of the specific food habits in Saudi Arabia. The questionnaire was developed, pre-tested, and validated in a pilot study (data not shown). The food items usually consumed by the Saudi population were grouped according to the USDA food guide pyramid. We used the recommended daily allowance values of the standard food pyramid to determine whether the participants' daily intake units were

adequate, inadequately low or inadequately high.¹² The food groups of fat, oil and sugar were assessed by frequency questions: food preparation methods, fat used for cooking, consumption of sugar, dates and desserts per day. Additionally, inquiries regarding food habits were added including other questions about the number of meals per day, snacks while watching TV and the daily consumption of hot and cold beverages. There were also GI-related questions. These questions were divided based on the traditional food frequently eaten in Saudi Arabia; bread, sugar, dates and desserts. In the 24h dietary recall, participants recorded all food eaten during the previous 24hour and a hand portion size guide was used. The records were analyzed using the Arab Food Analysis Program (Arab Center for Nutrition 2007). The program is based on a large database including 1500 traditional foods, international foods as well as popular fast foods. The program contains nutrient information for each item as well as tables of food composition in the Arab Cooperation Council. The results were compared with standard Guideline Dietary Amounts recommendations (GDA).¹³

Physical activity assessment

A standard validated interviewer-administered questionnaire was used to assess PA patterns and sedentary behavior. The official Arabic short-version telephone format of the International Physical Activity Questionnaire (IPAQ) was used in this study. This version is also appropriate for face-to-face interviews and is available at www.ipaq.ki.se. IPAQ was designed to measure PA across all domains of leisure-time, work, transportation, and household tasks among adults (age range of 15-69years). The IPAQ short form asks about frequency and duration of walking, moderate-intensity PA (MIPA) and vigorous-intensity PA (VIPA) performed for at least 10minutes duration per session for the last 7days. It also collects information on total sitting time.

Weekly minutes of walking, MIPA and VIPA were calculated separately by multiplying the number of days/week by minutes/day. The result of total minutes/week for each category was weighted by a metabolic equivalent (MET). VIPAs are those activities taking hard physical effort and making the breath harder than normal, such as heavy lifting, digging, and aerobics or fast bicycling. MIPAs refer to these activities taking moderate physical efforts and make the breath somewhat harder than normal such as carrying light load, bicycling at regular pace, or doubles tennis. This is roughly equivalent to 4.0 METs. Total MET-minutes/week for the combination of walking, MIPA, and VIPA was then calculated. Subjects were categorized into three patterns of PA: "inactive", "minimally active" and "active".

"Active" represents a health-enhancing level of PA and describes participants who have met one of the two following criteria:

- VIPA on at least 3days achieving a minimum total PA of at least 1500 MET-minutes/week
- 7 or more days of any combination of walking, MIPA or VIPA achieving a minimum total PA of at least 3000 MET-minutes/week.

Participants were categorized under the "Moderate" level of PA when they met one of the following criteria:

- 3 or more days of VIPA of at least 20 minutes/day
- 5 or more days of MIPA and/or walking of at least 30 minutes/day
- 5 or more days of any combination of walking, MIPA or VIPAs

achieving minimum total PA of at least 600 MET-minutes/week

Individuals who did not meet any of the previous listed criteria were considered to have a “low” PA level. The categories were based on standard scoring criteria provided by IPAQ.¹⁴

Health-related quality of life assessment

Health-related quality of life was assessed using the standard EuroQol instrument, which consists of EQ-D5 and EQ-VAS. The EQ-D5 describes the health status according to five dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. There are three levels for each dimension: no problems, some problems, severe problems. The EQ VAS is a vertical, visual analogue scale where the endpoints are labeled ‘best imaginable health state’ and ‘worst imaginable health state’. The participants were asked to record the self-rated health on the scale. We used the Arabic-Language version provided by EuroQol, which is a validated instrument.^{15,16} Information on use of these instruments and data scoring was obtained from: www.euroqol.org.

Statistical analysis

Descriptive statistical methods were used for data analysis. Statistical package for social Sciences SPSS version 20 was utilized for data analysis, and different tests were used including mean \pm SD values, Chi squared and T test. Relationships between PA expressed by MET-minutes/week and HRQOL variables were established using Pearson’s correlations. Differences were considered statistically significant at p value ≤ 0.05 .

Results

Characteristics of the study populations

The socio-demographic and other basal characteristics of the samples are shown in Table 1. All participants from both groups were not pregnant at the time of the study. However, there was a significant difference between the mean number of former pregnancies between the diabetic and non-diabetic women (6.7 ± 3.1 vs. 4.5 ± 2.6 , $P<0.05$). As none of the control subjects had - by definition - a parental history of diabetes, more than half of the diabetics had either one parent or two parents with diabetes (46% and 13%, respectively). The two groups showed significant differences in BMI and WC ($P<0.05$ for both variables, Table 1). A significant difference was also present after classification of BMI ($P<0.05$). The majority of participants were either overweight or obese in both groups. While the prevalence of obesity was higher in the diabetic subjects compared with the controls (64% and 44%, respectively), there were more overweight participants in the control group (44% vs. 25%). Only 7% and 12% of diabetic and non-diabetic subjects were in the normal BMI category.

There was a significant difference in the overall marital status between the two groups ($P<0.05$). A significant difference was also found in the educational levels ($P<0.05$). Whereas three quarters of non-diabetic subjects were graduated, only one quarter of the diabetic women had completed their education after high school. A high percentage of diabetic patients (61%) were either not educated or did not reach high school. The same significant difference appeared in the professional status of the participants ($P<0.05$). Only 20% of the diabetic women were employed compared with 80% of the non-diabetic participants. The difference in monthly income was even more pronounced between the two groups ($P<0.05$). While 52% of the dia-

betic women were from the lowest economical class with a monthly income of less than 3000 Saudi Riyal (1 Euro=5 Saudi Riyal at the time of the study), more than half of controls were from the highest class with more than 10,000 Saudi Riyal income per month. Only 11% of the diabetic and 13% of the non-diabetic participants smoke on a regular basis, and there was no significant difference in regular smoking across the two groups. Questions about participant’s health status revealed that only 20% of the diabetic subjects considered themselves as being in good health with no chronic health problems compared with 49% of non-diabetic subjects. About half of the diabetic subjects reported hypertension and high cholesterol levels.

Food intake and dietary habits

In Table 2, the results of defined intake of servings from the My Pyramid food groups by the participants are shown. In some food groups, there was a healthier choice by the participants with type 2 diabetes. For example, there was a significantly higher daily consumption of fresh fruits and vegetables in the participants with diabetes as compared to the controls (Table 2).

The majority of women in both groups consumed white sugar. A total of 61% diabetics and 53% of non-diabetics reported to eat between 1-4 dates a day. Only 45% and 49% of the diabetics and non-diabetics, respectively, reported to eat 1-2 desserts (chocolate - cakes - sweet pastries) a day, respectively. The differences between daily dates and dessert consumption were statistically significant between the 2 groups ($p=0.011$, $p=0.001$), respectively, with the diabetic women consuming less sweets.

Concerning the consumption of sugar-sweetened beverages, 63% of the diabetic women and 76% of the non-diabetic women reported to consume fruit juices daily. This difference was statistically significant ($p=0.007$) (Table 3). In addition, 27% of the diabetics and 32% of the non-diabetics were found to consume sugar-sweetened soft drinks. The daily consumption of sweetened coffee and tea was 78% and 81% in the diabetic and 83% and 85% in the non-diabetic group, respectively.

Total energy intake derived from the 24h dietary recalls is presented in Table 4. 84% of the diabetic and 67% of the non-diabetic participants reported to consume less than 1800 kcal per day. The difference between the 2 groups was significant ($p=0.009$). With regard to carbohydrate and fat intake, the majority of diabetic women took less than 230 g/day from carbohydrates and 51% took less than 40g/day from fats. Compared to the non-diabetic women, carbohydrate and fat intake were lower, whereas protein intake was higher in the diabetic women (Table 4). Fiber intake was comparably low in both groups (88% and 87% with a fiber intake of less than 15g per day (Table 4).

Physical activity

Table 5 shows the proportions of participants who were engaging in walking, moderate and vigorous PA for at least 10 min a time. There were no significant differences in walking, MIPA or VIPA between diabetics and controls. Nevertheless, 37% of the diabetic and 44% of the non-diabetic women were not engaging in walking during the week, and only 22% and 15% of both groups walked on a daily basis. The proportion of subjects participating in at least 10minutes of MIPA on all weekdays was 43% and 42% for diabetics and non-diabetics, respectively. However, high percentages of participants from both groups were not doing any kind of MIPA during the week. Almost none of the subjects were practicing VIPA on a regular basis. Just

about half of the diabetics and slightly more than half of controls have reached or exceeded 150min/week of MIPA. None of the diabetes patients reached 75minutes/week of VIPA and only 2% of controls achieved this level. In addition, measurements of total MET-minutes/week for walking, MIPA, and VIPA did not show significant differences between the groups (diabetics: 1901.5 ± 1816.5 vs. non-diabetics: 1744.9 ± 1532.8 , $p > 0.05$). Categorization of PA levels showed that 20% of diabetic subjects as well as of control subjects were inactive.

Only half of the diabetic women and less than half of the non-diabetic women (42%) reached the minimally active level. The proportion of diabetes patients who reached a health-enhancing level of activity was 30% compared with 38% of non-diabetics. Chi-square analysis revealed no significant difference between the groups (n.s.). Concerning sedentary behavior the two groups showed no significant difference in sitting hours per day (7.7 ± 3.3 vs. 7.6 ± 2.3 , n.s.).

Table 1 Characteristics of the diabetic and non-diabetic participants

Variables	Diabetic(n=100)	Non-Diabetic(n=100)	X ²	P value
Age (Years)	53.31±6.13	45.46±5.91	0.968	0.000*
WC (cm)	106.15±13.12	93.54±12.61	0.966	0.000*
BMI (kg/m ²)	33.30±6.39	30.80±5.48	0.175	0.000*
BMI Class (%)			11.691	0.003**
Underweight	0	0		
Normal	7	12		
Over Weight	25	44		
Obese	64	44		
Marital status (%)				
Single	2	4		
Married	70	83	9.997	0.019**
Divorced	9	8		
Widow	19	5		
Number of former pregnancies	6.74±3.12	4.53±2.60	0.156	0.000*
Education qualification (%)				
Less than High School	61	11		
High school	14	10	63.462	0.000**
Graduate	24	75		
Post Graduate and Above	1	4		
Profession status (%)				
Employed	20	80	72	0.000**
Non-employed	80	20		
Total monthly income (in Saudi Riyal) (%)				
Less than 3000 SR	52	14		
3100-6000 SR	19	19		
6110-9000 SR	9	6	54.099	0.000**
9100-10.000 SR	4	52		
More than 10.000	16			
Regular smoking (%)				
Yes	11	13	0.189	0.663**
No	89	87		
Other chronic health problems (%)				
Hypertension	51	20		
Heart disease	9	1		

Table continued...

Variables	Diabetic(n=100)	Non-Diabetic(n=100)	X ²	P value
Gout disease	1	0		
High Cholesterol	53	10		
Other problems	35	34		
No problems	20	49		

* T-test

** Chi-square

Table 2 My Pyramid food group serving intake of participants

Variables (%)		Diabetics(N=100)	Non diabetics(N=100)	p-value
Cereals and Legumes**	0	31	51	0.015*
	2-Jan	67	47	
	4-Mar	2	2	
	5 and More	0	0	
Vegetables***	0	5	9	0.043*
	2-Jan	70	56	
	4-Mar	25	30	
	5 and More	0	5	
Fruits***	0	14	27	0.018*
	2-Jan	72	52	
	4-Mar	14	19	
	5 and More	0	2	
Dairy Products***	0	5	8	0.565
	2-Jan	75	69	
	4-Mar	20	22	
	5 and More	0	1	
Meat , Poultry and Fish**	0	10	6	0.467
	2-Jan	87	89	
	4-Mar	3	5	
	5 and More	0	0	
Eggs**	0	35	51	0.002*
	2-Jan	61	37	
	4-Mar	3	12	
	5 and More	1	0	
Cooking fats	Plant Fats	81	87	0.364
	Animal Fats	1	0	
	Both	18	13	
	White Sugar	74	72	
Sugar	Brown Sugar	3	8	0.335
	Sugar Substitutes	22	20	
	Honey	1	0	

Table continued...

Variables (%)		Diabetics(N=100)	Non diabetics(N=100)	p-value
Dates	0	26	16	0.011*
	2-Jan	21	14	
	4-Mar	40	39	
	5 and More	13	31	
Desserts	0	55	32	0.001*
	2-Jan	45	49	
	4-Mar	0	18	
	5 and More	0	1	

Data presented as percent (%) of the total number in each category

*Chi-square $p < 0.05$ significant differences between diabetics and non-diabetics.

** Weekly serving unit's intake

*** Daily serving units intake

Table 3 Daily beverage intake of the participants

Variables(%)		Diabetics(N=100)	Non diabetics(N=100)	p-Value
Hot and cold beverages(%)				
Coffee	0	13	8	0.178
	2-Jan	56	50	
	5-Mar	25	36	
	6 or More	6	6	
Tea	0	18	25	0.729
	2-Jan	67	60	
	5-Mar	14	15	
	6 or More	1	0	
Juices	0	37	24	0.007*
	2-Jan	59	68	
	5-Mar	4	8	
	6 or More	0	0	
Soft Drinks	0	73	64	0.369
	2-Jan	27	32	
	5-Mar	0	4	
	6 or More	0	0	

Data presented as percent (%) of the total number in each category

*Chi-square $p < 0.05$ significant differences between Diabetics and Non diabetics

Table 4 Nutrient intake frequency from 24 Hour dietary recall of participants

Variables(%)	Macronutrient	Diabetics (N=100)	Non Diabetics (N=100)	p-Value*
Calories(kcal)	<1800	84	67	0.009*
	1800-2000	10	14	
	>2000	6	19	
Carbohydrate(g)	< 180	68	42	0.000*
	180-230	21	28	
	>230	11	30	

Table continued...

Variables(%)	Macronutrient	Diabetics (N=100)	Non Diabetics (N=100)	p-Value*
Protein(g)	<30	17	42	0.019*
	30-45	17	28	
	>45	66	30	
Fat(g)	<40	51	29	0.002*
	40-70	33	38	
	>70	16	33	

Data presented as percent (%) of the total number in each category

*Chi-square $p < 0.05$ significant differences between diabetics and non-diabetics

Data presented as mean \pm standard deviation

Table 5 Proportions (%) of participants who are engaging in walking, moderate and vigorous PA for at least 10min a time, based on the number of days per week and minutes per week

		Walking(%)		Moderate activity(%)		Vigorous activity(%)	
		Diabetic	Non-diabetic	Diabetic	Non-diabetic	Diabetic	Non-diabetic
Number of days per week*	0	37	44	45	38	97	95
	1	5	2	1	2	2	0
	2	12	9	1	6	1	3
	3	13	14	2	4	0	1
	4	6	4	3	5	0	0
	5	4	11	4	3	0	0
	6	1	1	1	0	0	0
	7	22	15	43	42	0	1
	Total(%)	100	100	100	100	100	100
Number of minutes per week**	0	37	44	45	39	97	95
	30-Oct	8	5	0	0	1	0
	31-60	10	4	0	1	2	0
	61-149	10	7	1	5	0	0
	150-299	13	22	10	8	0	2
	300 or More	22	18	44	47	0	0
	Total(%)	100	100	100	100	100	100

Walking: $X^2=7.347$; two-sided level of significant $P=0.394$

*Moderate activity: $X^2=6.816$; two-sided level of significant $P=0.448$

*Vigorous activity: $X^2=5.021$; two-sided level of significant $P=0.285$

**Walking: $X^2=7.112$; two-sided level of significant $P=0.212$

**Moderate activity: $X^2=4.416$; two-sided level of significant $P=0.353$

**Vigorous activity: $X^2=8.021$; two-sided level of significant $P=0.091$

Health related quality of life

Chi-square analysis revealed significant differences in all aspects of HRQOL between the two study groups except for self-care, which was almost similar between the groups (Table 6). More than half of diabetic subjects (57%) have some problems in mobility compared with 40% of non-diabetics. None of the two groups complained from severe mobility problems. Furthermore, 42% of diabetics had some problems in usual activity compared with 22% of controls. No severe problems in usual activity were reported from controls, whereas 4% of diabetic subjects had severe problems in usual activity. Around half

of both groups reported some problems in pain/discomfort and 20% of diabetic complained from severe problems in this dimension compared with 3% of non-diabetics. Moreover, diabetics tended to have more anxiety and depression problems. Mean and standard deviation for EQ-VAS of the diabetic group were 65.56 ± 22.107 and non-diabetics 69.90 ± 19.974 with no significant difference ($p > 0.05$).

Associations between physical activity and health-related quality of life

Pearson's correlation analysis was performed to find relationships

between total MET-minutes/week from all forms of PA and HRQOL of participants. Among the diabetic group, a higher weekly PA was related with fewer problems in both mobility ($r=-0.223$; $p<0.05$) and usual activity dimensions ($r=-0.119$; $p<0.05$). This negative relationship was not significant for pain/discomfort ($r=-0.156$; $p<0.05$) and

anxiety/depression ($r=-0.120$; $p<0.05$) dimensions. However, among controls, a negative relationship was only found for self-care and anxiety/depression dimensions, although it was not significant. Additionally, data showed no significant relationship between total MET-minutes/week and EQ VAS scoring among both groups.

Table 6 Differences in health-related quality of life dimensions

Dimensions		Diabetic	Non-diabetic	X ²	P Value
Mobility	No Problems	43	60	5.785	0.016
	Some Problems	57	40		
	Severe Problems	0	0		
Self-Care	No Problems	98	96	0.687	0.407
	Some Problems	2	4		
	Severe Problems	0	0		
Usual Activities	No Problems	54	78	14.614	0.001
	Some Problems	42	22		
	Severe Problems	4	0		
Pain/Discomfort	No Problems	31	46	15.527	0.000
	Some Problems	49	51		
	Severe Problems	20	3		
Anxiety/Depression	No Problems	37	59	12.18	0.002
	Some Problems	38	31		
	Severe Problems	25	10		

Discussion

Saudi Arabia has witnessed rapid modernization and social changes over the last three decades. This has also resulted in a decrease of PA, a more sedentary lifestyle, a change to an energy-dense Western diet, and consecutively to a dramatically increasing obesity rate, particularly in women.^{8,9,17} These lifestyle changes were suggested to be responsible for the dramatic increase in the prevalence of T2DM among the Saudi population.⁶

The present study is the first to perform a comprehensive comparison of relevant lifestyle factors such as dietary habits, PA patterns and sedentary behaviors between diabetic and non-diabetic Saudi females between the age of 30 and 65 years. The data obtained from this cross-sectional study show statistically significant differences in marital status, educational level, professional status and economical class between diabetic and non-diabetic women. Diabetic patients tended to be less educated and more frequently unemployed. The prevalence of T2DM appeared to be higher in those with the lowest income. The majority of non-diabetic subjects belonged to the higher income class. The impact of income level on developing T2DM could be explained by the fact that women from lower income classes are more likely to experience additional life stress and to have a poorer diet than women from the higher income class.¹⁸ This socioeconomic influence appears to be rather similar to findings reported from industrialized countries.^{19,20}

Although the correlation between parity and risk of diabetes is controversial,²¹ data from our study suggest a positive relationship between parity and the risk of developing T2DM among females from the target age group. The reasons for this association are not fully known, but pregnancy is associated with an intermittent state of insulin resistance and many women have significant weight retention

after delivery,²² which may contribute to an increased risk of type 2 diabetes.

In agreement with many other studies,²³ obesity was more common in diabetic participants compared with non-diabetic. As expected, present data reported significant differences in BMI and WC between diabetic and non-diabetic Saudi females ($P<0.05$). Notably, mean BMI of the diabetic group (33.30kg/m^2) was higher than the WHO estimate for Saudi females for 2009 (29.7).²⁴ Diabetic subjects showed higher obesity rate (64%) and higher mean WC ($106.2\pm13.1\text{cm}$) compared with non-diabetics (44%, $93.5\pm12.6\text{cm}$). Therefore, obesity appears to be an important underlying factor for developing T2DM in the study population. Moreover, both groups reported a mean WC greater than 80cm, which can be considered as an indicator for an elevated diabetes risk.²⁵

A major finding was that the dietary habits assessed in the diabetic women were slightly “healthier” than those of the non-diabetic women, probably as a result of treatment. This was particularly true for important food groups such as cereals and legumes, vegetables, fruits, eggs, and desserts. However, a Western-type diet was seen in both groups, which is known to promote many civilization diseases and reflecting the dramatic food shift that has been observed in the last three decades in the Gulf Countries including Saudi Arabia.⁷ In general, dietary habits were not adequate and do not consider the current guidelines for dietary management of T2DM.¹² This finding is in agreement with other studies,^{26,27} which reported that in Saudi Arabia dietary management and food choices are currently inadequate.

Our results report that the number of meals eaten per day was adequate. The majority of diabetic and non-diabetic women had three main meals per day, however, half of both groups had unhealthy snacks, e.g. while watching TV, including potato chips, popcorn, and

candies. The quality of consumed carbohydrates is at least equally important as the quantity in determining the ability to raise glucose levels, and foods with a high GI may result in rapid postprandial increases of blood glucose.²⁸ Our data show that the majority of women in both groups consume large amounts of white sugar. Additionally, 75% of both groups drink sugar-sweetened coffee and tea more than 1-2 cups daily, which increase the consumption of white sugar as sweetener. Besides that, sugar consumption from high daily juice consumption (63% in diabetic and 76% in non-diabetic women) was substantial. Beside benefits of dates, as the most traditional fruit consumed in Saudi Arabia, excessive consumption by diabetic patient may promote high blood glucose.²⁹ In our study, 40% of women in both groups consumed a moderate amount of 3-4 dates daily. In contrast, 45% of diabetics consumed 1-4 desserts per day, while 67% from the non-diabetic group consumed double the amount of desserts such as biscuits, chocolate, cakes and sweet pastries.

According to our analysis of the 24h dietary recalls kabsa as a main traditional meal containing rice and meat³⁰ and a variety of carbohydrate-rich foods such as rice and wheat bread were consumed daily. Excess consumption of carbohydrates and animal source protein, as also seen in our data, is associated with an increased risk of developing diabetes.^{31,32} In addition, routine consumption of certain food items, which are rich in carbohydrates, and a high saturated and Trans fat intake could lead to weight gain, thereby promoting obesity.^{7,30,33}

Despite many unfavorable eating habits, some health behavior among the population was observed: such as being interested in fruit and vegetables consumption, and attempting to make them a part of their daily meals. Also, eating whole grain bread instead of only brown bread, consumption of low fat dairy products as well as replacing normal sugar consumption with sugar substitutes. These healthy dietary habits were attained from nutritional awareness programs which are held in hospitals for each diabetic patient which raised their awareness to change their unhealthy habits to more healthy habits. However, our data suggest that such efforts and activities should be intensified to achieve an adequate diet.

Concerning physical activity as a major component of energy expenditure and positive modulator of metabolic and cardiovascular health our data show that, based on the results of the IPAQ, 20% of both diabetic subjects and controls were physically inactive. Half of the diabetic group was minimally active and only one third reached a health enhancing level of activity. For the non-diabetic group, our data reported percentages of 42% and 38% for a minimally active level and an active level, respectively. Former national studies reported even higher prevalence rates of physical inactivity in Saudi females.^{9,34} Notably, data from the present study showed that, among diabetics and non-diabetics, 37% and 44% never walked, 45% and 39% never did any MIPA, and 97% and 95% were never engaged in a VIPA during the last 7days. Thereby, about 46% of both groups did not meet the WHO recommendation, which state that adults aged between 18-64years should achieve at least 150minutes of MIPA or 75minutes VIPA per week.³⁵ In contrast to differences in dietary habits, no significant difference in PA levels was noted between the diabetic and the non-diabetic women indicating that an increase in physical activity is harder to achieve than a change in the eating pattern.

We further compared sedentary behavior between the diabetic and the non-diabetic participants. The mean sitting hours/day for both groups were considerable (7.7±3.3 and 7.6±2.3, respectively). Although our data did not show any significant difference in the mean daily sitting hours, it is important to mention that these rates clearly

indicate the sedentary lifestyle of Saudi females in this age group. In relation to obesity and T2DM, Hu et al. reported that 2 hours/day increased sitting at work was associated with a 5% increase in obesity and a 7% increase risk for diabetes among women from the Nurse's Health Study. Such associations have been previously reported in other studies.³⁶ Saudi social norms limit the opportunities of women for engaging in several types of PA or attending health centers.³⁷

This cross-sectional study further investigated the correlation between HRQOL and participants' PA behaviors. In agreement with several studies.³⁸⁻⁴⁰ The data obtained from the diabetic subjects clearly show that a higher level of regular PA is likely to be related to higher levels of HRQOL. On the other hand, data obtained from the non-diabetic females revealed non-significant negative relationships between MET-minutes/week and only two HRQOL dimensions: self-care and anxiety/depression. There was no significant difference in EQ VAS scores between the two groups. Furthermore, no relationship between EQ VAS scores and PA levels of the participants has been found. However, the present study confirms the association between PA levels and HRQOL among diabetes patients as well as controls. The strengths of our study lies in the use of a broad set of appropriate and validated tools for data collection and recruiting representative samples of Saudi females from different locations in Jeddah, which allowed for assessing differences due to demographic and social variation. The IPAQ instrument as well as the EuroQol instrument were validated in Saudi adults and have been used in former studies.^{9,41} Furthermore, using female interviewers was culturally appropriate and helped to obtain high responder rates.

Nevertheless, there are some limitations in this study. The generalizability of research findings is limited because of the small study population. As statistical analysis normally requires larger sample sizes to ensure a more representative distribution of the population, however, the aim of this case-control study was to compare many lifestyle behaviors between diabetic and non-diabetic women. Moreover, due to financial limitations, it was not possible to carry out blood tests for the control subjects in order to ensure that they were non-diabetic. Therefore, the controls were defined as non-diabetics based on their statements. Third, due to the high prevalence of T2DM among the target age group, it was difficult to find age-matched non-diabetic subjects, which resulted in a difference in mean age between the case and the control group.

Conclusion

In conclusion, the findings of this study provide evidence that Saudi females with T2DM exhibit a high prevalence of obesity and unhealthy lifestyle factors. However, in the age-matched control females the prevalence of obesity and unhealthy lifestyle factors was almost similar, suggesting that the presence of genetic factors may determine who will develop T2DM. This was indirectly assessed by the family history of the disease. Thus, genetic factors may be essential determinants of developing T2DM, although dietary habits, PA and sedentary behavior may act as powerful promoters of the disease.

There is an urgent need to intensify efforts to encourage the Saudi general population to improve their dietary habits and to increase their physical activity. Therefore, we recommend the promotion of a national prevention program which should be expanded with the support of further research and the engagement of the government sector of health care, targeting high-risk subjects aiming to modify lifestyle towards an adequate balanced diet, improving the quality of diet, increasing PA and decreasing obesity and overweight rates.

Acknowledgments

The research was supported by the Department of Nutritional Medicine at Technical University of Munich (TUM), Rehabilitation Research Chair at King Saud University (KSU), the Department of Internal Medicine in King Abdulaziz University Hospital (KAUH), the Hypertension & Diabetes Care Center of Jeddah Community Health Affairs, Ministry of Health and the Cultural Bureau of Saudi Arabia in Berlin. The research was self-granted.

Conflict of interest

Author declares that there is no conflict of interest.

References

- Alberti KG, Zimmet PZ. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. *Diabet Med*. 1998;15(7):539–553.
- International diabetes Federation. Diabetes Atlas 6th ed. 2013.
- Alhawaish AK. Economic costs of diabetes in Saudi Arabia. *J Family Community Med*. 2013;20(1):1–7.
- The latest Economic Developments. 48 Annual Report. Saudi Arabian Monetary Agency. Riyadh, Saudi Arabia: Research and Statistics Departments. 2012.
- Alqurashi KA, Aljabri KS, Bokhari SA. Prevalence of diabetes mellitus in a Saudi community. *Ann Saudi Med*. 2011;31(1):19–23.
- Al Nozha MM, Al Maatouq MA, Al Mazrou YY, et al. Diabetes mellitus in Saudi Arabia. *Saudi Med J*. 2004;25(11):1603–1610.
- Musaiger AO. Overweight and obesity in the Eastern Mediterranean Region: can we control it? *East Mediterr Health J*. 2004;10(6):789–793.
- Al Hazzaa HM. Prevalence of physical inactivity in Saudi Arabia: a brief review. *East Mediterr Health J*. 2004;10(4–5):663–670.
- Al Hazzaa HM. Health-enhancing physical activity among Saudi adults using the International Physical Activity Questionnaire (IPAQ). *Public Health Nutr*. 2007;10(1):59–64.
- World Health Organization. Global Infobase- Physical Activity Indicator. 2015.
- World Health Organization. Global database on body mass index. 2015.
- United states Department of agriculture. My pyramid. 2015.
- Food and Drink Federation. Guideline Daily Amount GDA. 2015.
- International Physical Activity Questionnaire. Guidelines for data processing and analysis of the International Physical Activity Questionnaire (IPAC)-short and long forms. 2005.
- Brooks R. EuroQol: the current state of play. *Health Policy*. 1996;37(1):53–72.
- EuroQol Group. EuroQol-a new facility for the measurement of health-related quality of life. *Health Policy*. 1990;16(3):199–208.
- Al Nozha MM, Al Mazrou YY, Al Maatouq MA, et al. Obesity in Saudi Arabia. *Saudi Med J*. 2005;26(5):824–829.
- Pouwer F, Kupper N, Adriaanse MC. Does emotional stress cause type 2 diabetes mellitus? A review from the European Depression in Diabetes (EDID) Research Consortium. *Discov Med*. 2010;9(45):112–118.
- Koo BK, Kim SW, Yi KH, et al. Low Economic Status Is Identified as an Emerging Risk Factor for Diabetes Mellitus in Korean Men Aged 30 to 59 Years in Korean National Health and Nutrition Examination Survey 2008 to 2010. *Diabetes & Metab J*. 2015;39(2):137–146.
- Rabi DM, Edwards AL, Southern DA, et al. Association of socioeconomic status with diabetes prevalence and utilization of diabetes care services. *BMC Health Serv Res*. 2006;6:124.
- Hanley AJ, McKeown Eyssen G, Harris SB, et al. Association of parity with risk of type 2 diabetes and related metabolic disorders. *Diabetes Care*. 2002;25(4):690–695.
- Nehring I, Schmoll S, Beyerlein A, et al. Gestational weight gain and long-term postpartum weight retention: a meta-analysis. *Am J Clin Nutr*. 2011;94(5):1225–1231.
- El Hazmi M, Al Swailem A, Warsy A, et al. A study of diabetes mellitus in Saudi Arabia. Saudi Arabia: King Abdulaziz City for Science & Technology. 2002.
- World Health Organization. Global Health Observatory Data Repository. 2015.
- Alberti KG, Zimmet PZ, Shaw J. International diabetes federation: a consensus on type 2 diabetes prevention. *Diabet Med*. 2007;24(5):451–463.
- Midhet FM, Al Mohaimeed AA, Sharaf FK. Lifestyle related risk factors of type 2 diabetes mellitus in Saudi Arabia. *Saudi Med J*. 2010;31(7):768–774.
- Mohieldein AH, Alzohairy M, Hasan M. Risk estimation of type 2 diabetes and dietary habits among adult Saudi Non-diabetics in Central Saudi Arabia. *Glob J Health Sci*. 2011;3(2):123.
- Buyken AE, Mitchell P, Ceriello A, et al. Optimal dietary approaches for prevention of type 2 diabetes: a life-course perspective. *Diabetologia*. 2010;53(3):406–418.
- Alkaabi JM, Al Dabbagh B, Ahmad S, et al. Glycemic indices of five varieties of dates in healthy and diabetic subjects. *Nutr J*. 2011;10:59.
- Al Othaimen AI, Al Nozha M, Osman AK. Obesity: an emerging problem in Saudi Arabia. Analysis of data from the National Nutrition Survey. *East Mediterr Health J*. 2006;13(2):441–448.
- Sluijs I, Beulens JW, Spijkerman AM, et al. Dietary intake of total, animal, and vegetable protein and risk of type 2 diabetes in the European Prospective Investigation into Cancer and Nutrition (EPIC)-NL study. *Diabetes Care*. 2010;33(1):43–48.
- Nanri A, Mizoue T, Noda M, et al. Rice intake and type 2 diabetes in Japanese men and women: the Japan Public Health Center-based Prospective Study. *Am J Clin Nutr*. 2010;92(6):1468–1477.
- Badran M, Laher I. Type II diabetes mellitus in Arabic-speaking countries. *International Journal of Endocrinology*. 2012;2012(2012):11.
- Al Refaee SA, Al Hazzaa HM. Physical activity profile of adult males in Riyadh City. *Saudi Med J*. 2001;22(9):784–789.
- World Health Organization (WHO). Global Recommendation on Physical Activity for Health. Geneva, Switzerland: World Health Organization. 2010.
- Fogelholm M, Kukkonen Harjula K. Does physical activity prevent weight gain-a systematic review. *Obesity reviews*. 2000;1(2):95–111.
- Al Eisa E. Indicators of adherence to physiotherapy attendance among Saudi female patients with mechanical low back pain: a clinical audit. *BMC Musculoskelet Disord*. 2010;11:124.
- Brown DW, Balluz LS, Heath GW, et al. Associations between recommended levels of physical activity and health-related quality of life findings from the 2001 Behavioral Risk Factor Surveillance System (BRFSS) survey. *Prev Med*. 2003;37(5):520–528.
- Brown DW, Brown DR, Heath GW, et al. Associations between physical activity dose and health-related quality of life. *Med Sci Sports Exerc*. 2004;36(5):890–896.

40. Vuillemin A, Boini S, Bertrais S, et al. Leisure time physical activity and health-related quality of life. *Prev Med.* 2005;41(2):562–569.
41. Abdalla SA, Osman BI, Abdoon IH, et al. Quality of life assessment: A comparative study between hemodialysis and peritoneal dialysis. University of Khartoum Dspace, Sudan; 2015.