

Relationship between Dietary habits, lifestyle risk factors and dysglycemia among patients with type 2 diabetes mellitus in Al Madinah Al Munawara, Saudi Arabia

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Type 2 Diabetes Mellitus is a chronic global health condition that affects people of all ages at an alarming rate. It's more widespread in Middle Eastern countries, especially Saudi Arabia which has the second-highest rate of diabetes in the Middle East, according to the World Health Organization. The purpose of the study is to investigate the relationship between dietary habits, lifestyle factors, and dysglycemia among type 2 diabetic patients in Al-Madinah Al-Munawara, Saudi Arabia. This cross-sectional study was conducted on 281 type 2 diabetic patients aged between 20 and 65 years old via an online survey. Sociodemographic, anthropometric, dietary habits, physical activity, and other lifestyle data were collected from patients of Al Madinah's King Fahad Hospital in Al Madinah Al Munawara. The highest age group of those surveyed was 41-65 years old. The majority (65.1%) were female. More than half of the surveyed population had university or college-level education. There was no association between family history and gender ($p=0.631$). There was a significant association between gender and intake of sweets ($p=0.001$), red meat ($p=0.002$), red tea ($p=0.013$), green tea ($p=0.031$), and consumption of grains ($p=0.027$). Male patients were more active compared to the female group (14.3% vs. 4.9%), ($p=0.043$). Food habits influenced hyperglycemia. Female hyperglycemic patients had considerably greater rates of insufficient physical activity and sweet consumption. Male dysglycemic patients consumed considerably more red meat and poultry. Future consideration should be given to increasing awareness and knowledge of dietary intake and lifestyle factors and their importance to prevent future complications.

Keywords: Dietary intake; Type 2 diabetes mellitus-dysglycemia-Al-Madinah Al-Munawara- lifestyle.

Type 2 diabetes mellitus (T2DM) is characterized by chronic hyperglycemia and impaired carbohydrates, lipids, and protein metabolism caused by complete or partial insufficiency of insulin secretion and/or insulin action, which alters the body's response to glucose

utilization normally¹. It is more frequent in Arab nations, particularly those in the Gulf Cooperation Council (GCC), such as Saudi Arabia. The temporal factor's coefficient suggested that the prevalence rate grew from 1982 to 2015. Saudi Arabia has the highest prevalence of T2DM (32.8%). The

prevalence is expected to rise to 35.37% in 2020, 40.37% in 2025, and 45.36% in 2030².

T2DM is defined as a combination of insulin resistance (reduced insulin's ability to stimulate glucose utilization in the body) and reduced insulin secretion. It begins with a resistance to insulin in the cells of the body. Because of this resistance and increased hepatic glucose synthesis, insulin levels are insufficient to normalize plasma glucose levels³. The risk of disease onset increased based on genetic background and environmental factors. It is one of the key contributors to an increased risk of developing cardiovascular disease and death⁴. Many risk factors have been associated with the onset of diseases that affect the body's ability to deal with glucose. Obesity, dietary habits, smoking, hypertension, family history, and a sedentary lifestyle have all been related to an increased risk of the disease⁵. To reduce the disease's burden, Saudi Arabia's national health strategy should incorporate diabetes prevention initiatives by raising awareness of all aspects of the disease, including the etiology of T2DM². Insulin resistance is believed to be associated with decreased physical activity and obesity⁶.

A family history of diabetes, obesity, or hypertension increases the risk of diabetes⁷. This is considered the hallmark of T2DM and the main cause of most complications of diabetes, like Retinopathy, Nephropathy, and heart disease. To prevent these microvascular and macrovascular diabetes complications, diabetics can control hyperglycemia through medication and dietary intervention, paying close attention to how much and what they eat. Dietary habits refer to how individuals eat in compliance with the dietary recommendations made by healthcare professionals. It promotes a diet high in fiber and low in salt, as well as the consumption of fish, low-fat meals, omega-3 fatty acids, fruits, and vegetables. Controlling diabetics' eating patterns can raise HbA1c, which can postpone the onset of diabetes complications⁸.

Insufficient data are available regarding dietary habits and lifestyle risk factors among patients with type 2 diabetes mellitus in Al Madinah Al Munawara across diabetic patients aged between 20 and 65 years old. Therefore, the objective of the current study was to determine the association between dietary habits and lifestyle risk factors

with dysglycemia and to explore and investigate gender differences in the dietary habits of type 2 diabetes mellitus patients aged 20–65 years old in Al Madinah Al Munawara.

Subjects and methods

Data were gathered for this analytical cross-sectional study via an online questionnaire. Participants were asked to fill out an online survey created via Google Forms and distributed through several social media applications, including WhatsApp, Twitter, and Snapchat. The survey link was sent to relatives, friends, and neighbors to encourage them to participate in the study and share the link with their contacts.

A minimum sample size of 58 male participants and 58 female participants with T2DM was required for this study. The number was estimated based on a two-sided test (alpha 0.01), beta 0.05, and a standardized effect size of 0.80⁹. The standard deviation of carbohydrate intake used in the sample size calculation was 4.26g, with a mean of 67.09¹⁰.

Ethical approval for this study was obtained from the Ethical Committee of the College of Applied Medical Sciences at Taibah University in Al-Madinah Al-Munawara with the approval number of 2021/107/203 CLN. All participants provided informed consent through a statement on the questionnaire to be included in the study.

This study recruited patients with T2DM aged between 20 and 65 years in Al-Madinah, Saudi Arabia. We excluded type 2 diabetic patients in the ICU and provided incomplete data. Dysglycemia in type 2 diabetic patients was diagnosed using a cutoff point of HbA1c 6.5%¹¹.

The data was collected between October 1, 2021, and January 27, 2022. The online survey included socio-demographic data including gender, age, anthropometrics, educational level, employment status, the region of residence, and family income. Other data includes information about family history of diabetes, hypertension, dyslipidemia, recorded HbA1c, duration of illness, physical activity level and patterns of exercise, smoking status, and sleeping duration.

Anthropometric data includes weight and height to calculate BMI. BMI describes a person's nutritional status by comparing their weight (kg) with the square of their height (m²).

Dietary data have been collected via food

frequency questions from all participants via the survey to estimate the participant's dietary intake. It includes the number of each food group and their consumption (fruits, vegetables, grains (starch), meat and poultry, etc.), frequency of added sugar and honey consumption, number of meals and the type of beverages they consume, frequency of desserts and snack consumption, and adherence to the diet.

A scientifically designed and validated questionnaire that has previously been used in a study in Saudi Arabia served as the data gathering method¹². By doing so, we can help customers receive the most precise diagnoses and efficient therapies, which will enhance patient outcomes and engagement.

No personal information was required, and all those included in the study were anonymous. The online questionnaire consisted of 40 questions. The questionnaire included data regarding the sociodemographic, anthropometric, and dietary intake of adults, which included food frequency questions and specified carbohydrate intake.

Statistical Analysis

The data was entered into Microsoft Excel, which cleaned it all up for analysis. Variables were then imported into SPSS (Statistical Package for Social Sciences, version 26) for statistical analysis. The Kolmogorov-Smirnov test was applied to determine the nature of continuous data distribution. The relationship between demographic characteristics, anthropometric measurements, and dietary intake variables was analyzed using the Fisher exact test. Multinomial Logistic regression models were used to assess the association between significant dietary variables and dysglycemia among male and female patients with type 2 diabetes mellitus. The Odds Ratio (OR) and 95% Confidence Interval (CI) were obtained from the regression model. The means of all continuous variables such as BMI, height, and weight were compared among males and females using the Mann-Whitney U test. A P-value <0.05 was considered statistically significant, and all the tests were two-sided.

RESULTS

Descriptive socio-demographics, anthropometric measurement and baseline

characteristics among female and male T2DM patients were analyzed. The study included 281 adult patients aged between 20 and 65. The highest age group of those surveyed was 41–65. The majority (n = 183; 65.12%) were females. More than half of the surveyed population had university- or college-level education. More than 30% of the male and female participants reported that they earned an income of more than 10,000 SAR (female = 30.1%, male = 43.9%). The mean BMI of those surveyed was 29.4 ± 10 kg/m², the mean height was 160 ± 15.7 cm, and the mean weight was 102 ± 47 kg. There was a significant difference in BMI and height between the male and female groups of patients (Table 1).

In both male and female patients, most of them had a history of T2DM (77% and 74.5%). There was no significant difference in the family history by gender ($p=0.631$). Of female participants, 19.1% had been suffering from T2DM for 20 or more years, compared to 17.3% in males. A total of 132 patients were suffering from T2DM for less than 10 years. Most of the patients, both male and female, had received education about T2DM. There was a significant association found between male and female patients regarding their physical activity ($p = 0.043$). Male patients were more active in physical activity compared to the female group (60.2% and 47.5%, respectively). Only 14.3% of males and 4.9% of females were doing more than two hours of physical activity per week.

Of the total male patients, 27.5% were smokers, among whom 21.4% had been smoking for more than 5 years. There was a significant association between smoking status and the gender of T2DM patients. In terms of T2DM patients' sleeping patterns, 88.6% slept for less than 8 hours. Of female patients, 27.5% were hospitalized in the past five years. Most of the male and female patients had normal blood pressure which was significant ($p = 0.003$, female = 74.7%, male = 69.2%). There was no significant difference observed in the HbA1C level or cholesterol among the male and female T2DM patients (Table 1 & Figure 1).

A questionnaire method was used to assess the patients' dietary intake. There was a significant association between gender and intake of sweets ($p= 0.001$), red meat ($p= 0.002$), red tea ($p=$

Table 1. Comparison between female and male type 2 diabetic patients as regards their sociodemographic, anthropometric measurement, and other baseline characteristics (n = 281)

Variables	Female patients n=183 n (%)	Male patients n=98 n (%)	Total	p- values
Age				
20-40 years	54 (29.5%)	27 (27.6%)	81	0.73
41-65 years	129 (70.5%)	71 (72.4%)	200	
Education level				
Illiterate	26 (14.2%)	6 (6.1%)	32	0.005**
Elementary school	36 (19.7%)	10 (10.2%)	46	
High school	21 (11.5%)	22 (22.4%)	43	
University/college degree	100 (54.6%)	60 (61.2%)	160	
Income per month				
<SAR 3000	38 (20.8%)	10 (10.2%)	48	0.013*
SAR3000-6000	42 (23%)	28 (28.6%)	70	
SAR7000-10000	48 (26.2%)	17 (17.3%)	65	
>SAR10000	55 (30.1%)	43 (43.9%)	98	
Family history of type 2 diabetes mellitus				
No	42 (23%)	25 (25.5%)	67	0.631
Yes	141 (77%)	73 (74.5%)	214	
Years of suffering from type 2 diabetes mellitus				
< 10 years	84 (45.9%)	48 (49%)	132	0.874
10-19 years	64 (35%)	33 (33.7%)	97	
e"20 years	35 (19.1%)	17 (17.3%)	52	
Educated regarding type 2 diabetes mellitus				
No	39 (21.3%)	21 (21.4%)	60	0.982
Yes	144 (78.7%)	77 (78.6%)	221	
Physical activity				
No	96 (52.5%)	39 (39.8%)	135	0.043*
Yes	87 (47.5%)	59 (60.2%)	146	
Physical activity hours/week				
No	70 (38.3%)	29 (29.6%)	99	0.042*
Half an hour or less	56 (30.6%)	30 (30.6%)	86	
1 -2 hours	48 (26.2%)	25 (25.5)	73	
> 2 hours	9 (4.9%)	14 (14.3%)	23	
Smoking history				
< 5 years	4 (2.2%)	6 (6.1%)	10	<0.001**
e"5 years	175 (95.6%)	21 (21.4%)	25	
Not applicable	175 (95.6%)	71 (72.4%)	246	
Sleeping pattern				
< 8 hours per day	166 (90.7%)	83 (84.7%)	249	0.130
e" 8 hours per day	17 (9.3%)	15 (15.3%)	32	
Hospitalized in the past 5 years				
Yes	49 (27.5%)	15 (16.5%)	64	0.044*
No	129 (72.5%)	76 (83.5%)	205	
Blood pressure				
More than 150/90	30 (16.9%)	8 (8.8%)	38	0.003**
Normal value 120/80	133 (74.7%)	63 (69.2%)	196	
Less than 120/80	15 (8.4%)	20 (22.0%)	35	
HbA1c level in the past three months				
7%-10%	83 (46.6%)	34 (37.4%)	117	0.347
> 10%	21 (11.8%)	13 (14.3%)	34	

Not performed	74 (41.6%)	44 (48.4%)	118	
Serum cholesterol level				
≥200 mg/dl	27 (15.2%)	12 (13.2%)	39	0.586
< 200 mg/dl	41 (23.0%)	17 (18.7%)	58	
Not performed	110 (61.8%)	62 (68.1%)	172	
Anthropometric measurements	Female	Male	Total Participant	p -values
	Mean ±SD		Mean ±SD	
BMI	29.36 ± 7.74	29.9 ± 6.23	29.48 ± 10	<0.001*
Height	156 ± 12.78	169 ± 17.3	160.39 ± 15.69	<0.001*
Weight	115 ± 55.5	78.6 ± 19.0	102.11 ± 47.77	0.066*

*Significant difference at $P < 0.05$, **highly significant difference at $P < 0.01$.

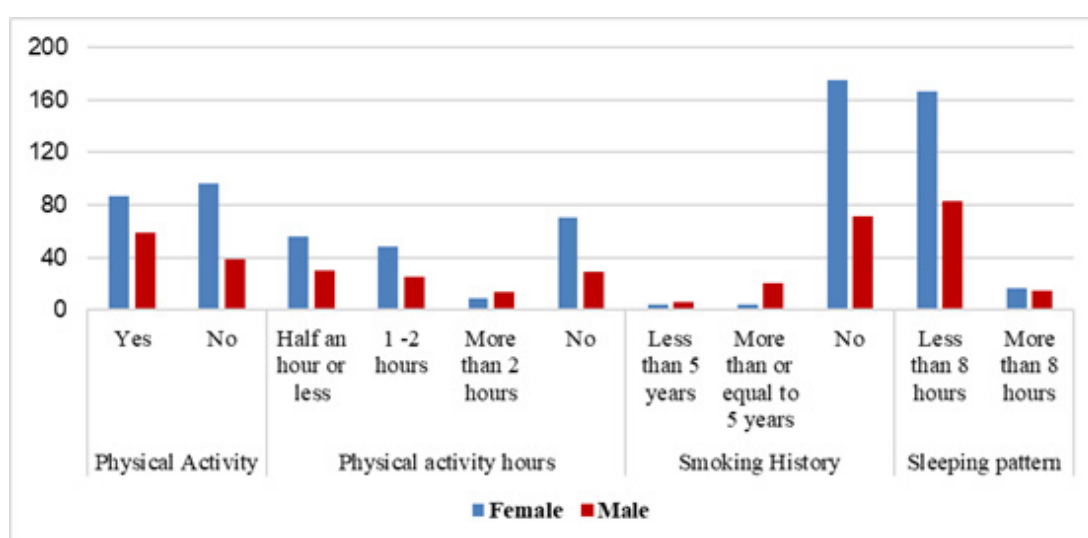


Fig. 1. Lifestyle factors among female and male patients with type 2 diabetes mellitus

0.013), green tea ($p=0.031$), and consumption of grains ($p=0.027$). Of the total participants, 67.2% were committed to taking a diabetic diet. Most of the male and female patients were eating 1 to 3 snacks between the main meal similarly most of the patients were most likely consuming fruits 1 to 3 times a week including dates. There was no significant difference in vegetable and whole-grain consumption in male and female patients. Red meat consumption was higher in male patients; 71.4% of them were eating red meat 1-3 times a week, and 18.4% were eating it more than 4 times a week. There was no significant difference in poultry products, seafood, processed foods, or natural juice between male and female participants. More than half of the participants did not drink green tea, and most of them were drinking red tea. Male patients were drinking more black tea

than female patients. There was no significant difference in the consumption of other types of coffee, sugar, honey, or carbohydrates among the two comparative groups of patients. There was a significant association with grain consumption among male and female patients. A total of 199 patients consumed 1-3 grains per week, most of them were female patients (Table 2) (Figure 2).

All the significant factors found to be associated with dysglycemic patients were analyzed using logistic regression. In the multinomial logistic regression model, sweet consumption ($OR=2.928$; $CI: 1.618 - 5.299$) was the strongest factor associated with type 2 diabetes mellitus in dysglycemic females. Patients lacking physical activity were higher in females compared to males ($OR=1.497$; $CI: 0.888 - 2.522$), while red meat ($OR=5.400$; $CI: 2.049 - 14.231$), and

Table 2. Comparison between female and male type 2 diabetic patients as regards of their dietary habits

Variables	Categories	Female patients	Male patients	Total	P- values
How committed are you to the diabetic diet?	Committed	128 (70%)	61 (62.2%)	189	0.189
	Not Committed	55 (30%)	37 (37.8%)	92	
How often do you eat snacks between the main meal in the day?	No	70 (38.3%)	34 (43.7%)	104	0.714
	1-3 times	107 (58.5%)	62 (63.3%)	169	
	4 times or more	6 (3.3%)	2 (2%)	8	
How many times a week do you eat sweets?	No	30 (16.4%)	34 (34.7%)	64	0.001**
	1-3 times	124 (67.8%)	48 (49%)	172	
	4 times or more	29 (15.8%)	16 (16.3%)	45	
How many times a week do you eat fruit including dates?	No	26 (14.2%)	9 (9.2%)	35	0.136
	1-3 times	99 (54.1%)	47 (48%)	146	
	4 times or more	58 (31.7%)	42 (42.9%)	100	
How many times do you eat vegetables in a week?	No	14 (7.7%)	6 (6.1%)	20	0.727
	1-3 times	83 (45.4%)	49 (50%)	132	
	4 times or more	86 (47%)	43 (43.9%)	129	
How many times do you eat red meat per week?	No	45 (24.6%)	10 (10.2%)	55	0.002**
	1-3 times	123 (67.2%)	70 (71.4%)	193	
	4 times or more	15 (8.2%)	18 (18.4%)	33	
How many times do you eat poultry in a week?	No	9 (4.9%)	3 (3.1%)	12	0.173
	1-3 times	114 (62.3%)	52 (53.1%)	166	
	4 times or more	60 (32.8%)	43 (43.9%)	103	
How many times do you eat seafood in a week?	No	81 (44.3%)	41 (41.8%)	122	0.775
	1-3 times	98 (53.6%)	56 (57.1%)	154	
	4 times or more	4 (2.2%)	1 (1%)	5	
How many times do you consume natural juices per week?	No	112 (61.2%)	49 (50%)	161	0.127
	1-3 times	58 (31.7%)	43 (43.9%)	101	
	4 time or more	13 (7.1%)	6 (6.1%)	19	
How many times do you consume for processed juices per week?	No	108 (59%)	57 (58.2%)	165	0.278
	1-3 times	61 (33.3%)	28 (28.6%)	89	
	4 time or more	14 (7.7%)	13 (13.3%)	27	
How many times do you consume black tea in a week?	No	48 (26.2%)	12 (12.2%)	60	0.013*
	1-3 times	62 (33.9%)	33 (33.7%)	95	
	4 times or more	73 (39.9%)	53 (54.1%)	126	
How many times do you consume green tea in a week?	No	106 (57.9%)	42 (42.9%)	148	0.031*
	1-3 times	52 (28.4%)	33 (33.7%)	85	
	4 times or more	25 (13.7%)	23 (23.5%)	48	
How many times do you consume Arabic coffee in a week?	No	37 (20.2%)	21 (21.4%)	58	0.729
	1-3 times	49 (26.8%)	22 (22.4%)	71	
	4 times or more	97 (53%)	55 (56.1%)	152	
How many times do you consume other types of coffee per week?	No	109 (59.6%)	54 (55.1%)	163	0.265
	1-3 times	47 (25.7%)	22 (22.4%)	69	
	4 times or more	27 (14.8%)	22 (22.4%)	49	
How many times do you consume can of soft drink/energy per week?	No	120 (65.6%)	61 (62.2%)	181	0.238
	1-2 cans	47 (25.7%)	22 (22.4%)	69	
	More than 3 cans	16 (8.7%)	15 (15.3%)	31	
How many times do you consume a spoonful of sugar per day?	No	90 (49.2%)	44 (44.9%)	134	0.067
	1-3 small spoons	74 (40.4%)	34 (34.7%)	108	
	More than 3 small spoons	19 (10.4%)	20 (20.4%)	39	
How many times do you eat honey in a week??	No	124 (67.8%)	58 (59.2%)	182	0.077
	1-3 small spoons	52 (28.4%)	30 (30.6%)	82	
	More than 3 small spoons	7 (3.8%)	10 (10.2%)	17	
How many times do you eat carbohydrates per day?	No	12 (6.6%)	9 (9.2%)	21	0.182
	1-3 times	130 (71%)	59 (60.2%)	189	
	4 times or more	41 (22.4%)	30 (30.6%)	71	
How many times do you consume grains per week?	No	43 (23.5%)	20 (20.4%)	63	0.027*
	1-3 times	133 (72.7%)	66 (67.3%)	199	
	4 times or more	7 (3.8%)	12 (12.2%)	19	

*Significant difference at $P < 0.05$, **highly significant difference at $P < 0.01$.

poultry consumption were significantly higher in male patients (OR= 3; CI: 1.180 – 7.627). Sweet consumption was associated with 2.928 increased odds in female patients compared to males (Table 3).

DISCUSSION

In view of the high prevalence of type 2 diabetes mellitus in Saudi Arabia, analyzing the associated dietary habits with the condition is

Table 3. Multinomial Logistic Regression analysis for the associated factors of type 2 Diabetes in female and male patients

Variables	Females group OR (95% CI)	Males group OR (95% CI)	p-value
Physical activity			
No	1.497 (0.888 – 2.522)	0.038 (0.396 – 1.126)	0.038*
Yes	—	—	
Sweets			
1-3 times	2.928 (1.618 - 5.299)	0.342 (0.189 - 0.618)	<0.001*
4 or more	2.054 (0.939 - 4.496)	0.487 (0.222 - 1.066)	0.072
No	—	—	
Red Meat			
1-3 times	0.390 (0.185 - 0.823)	2.561 (1.215 - 5.397)	0.013*
4 or more	0.185 (0.070 - 0.488)	5.400 (2.049 - 14.231)	0.001**
No	—	—	
Poultry			
1-3 times	0.483 (0.186 – 1.254)	2.071 (0.797 – 5.382)	0.135
4 or more	0.333 (0.131 – 0.847)	3.0 (1.180 – 7.627)	0.021*
No	—	—	

OR : Odds Ratio ; CI : Confidence Interval.

*Significant difference at P < 0.05, **Highly significant difference at Pd” 0.01.

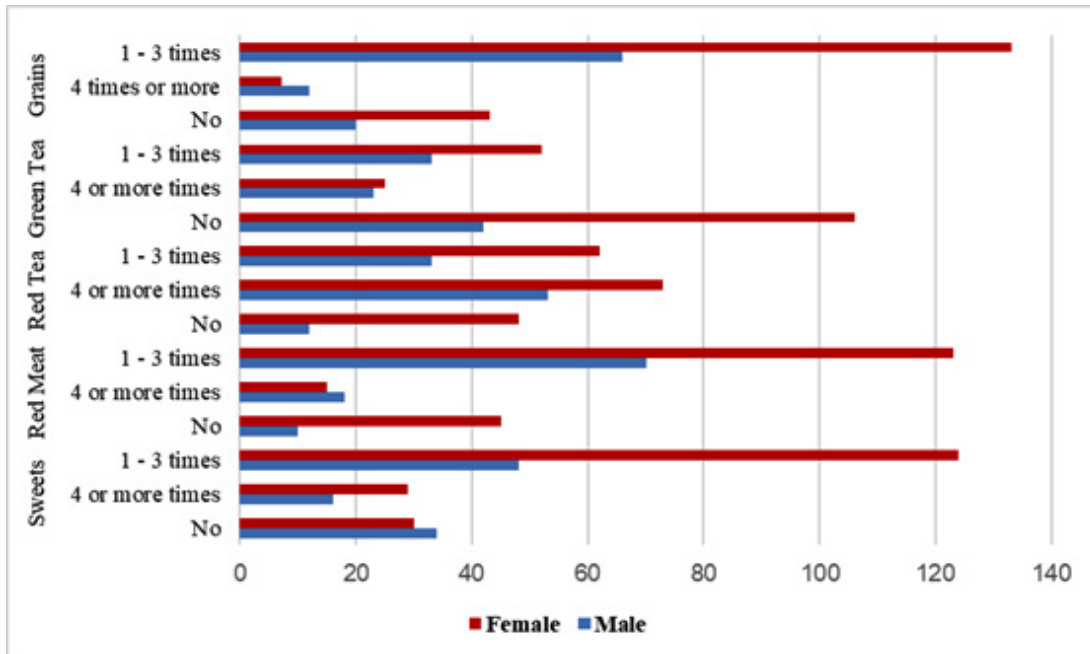


Fig. 2. Comparison of dietary habits among female and male patients with type 2 diabetes mellitus

required to prevent dysglycemia. Sex differences in dietary habits may play a role. In this study, we aimed to explore the association between dietary habits and other lifestyle factors and dysglycemia in male and female type 2 diabetic adult patients in Al-Madinah Al-Munawara. Blood sugar control is crucial for diabetics, and choosing foods and beverages that optimize healthy blood sugar control is crucial.

In our study, most of the patients exceeded the HbA1c level by more than 7%. A previous study reported that the most common risk factors that might be used to identify those who were most at risk of developing dysglycemia included high age, abdominal obesity, BMI, decreased physical activity, smoking status, and low vegetable intake¹²⁻¹³. In this study's gender comparison, physical activity was significantly lower in female patients.

Among the lifestyle factors, male patients were more active compared to the female group, and a lower percentage of both males and females were doing more than two hours of physical activity per week. This was in line with the study conducted on the Saudi population¹³. They reported that, in male patients, dysglycemia was linked to decreased physical activity. In male patients, it served as a dysglycemia predictor. According to the study, physical activity has a significant protective impact on dysglycemia. The interplay between insulin sensitivity and insulin resistance plays a key role in the development and persistence of the diabetic state, which can be directly linked to levels of physical activity. This association could be explained by how exercise improves insulin sensitivity¹⁴. Markers of vascular inflammation and insulin resistance decreased when obese individuals lost body weight through lifestyle changes. For obese people, exercise training is a crucial part of changing their way of life¹⁵. The smoking history was significantly higher in male patients compared to female patients. Smoking promotes the transition from normoglycemia to impaired glucose tolerance status, possibly by inducing the onset of insulin resistance, which raises smokers' risk of developing diabetes¹⁶.

Among the investigated dietary habits, intake of sweets, red meat, red tea, green tea, and grains was significantly different among male and female patients. Sweet intake was higher in

female patients. Red meat was associated with type 2 diabetes in male patients in this study. Our finding was consistent with another study¹⁷. Red meat was a significant predictor of dysglycemia in male type 2 diabetic patients. Agreeing with our study findings, several international studies have explained that red meat consumption is a significant risk factor for dysglycemia¹⁸⁻¹⁹. Poultry consumption in dysglycemic patients in our study was found to be higher in female patients²⁰. In their meta-analysis, they found that poultry consumption is not associated with type 2 DM, at least when used unprocessed. However, additional analyses are warranted to clearly define the risk factors associated with the different meat types and processed and unprocessed meat.

Opting for calorie-free or very-low-calorie beverages like unsweetened tea over sugary beverages like sweetened coffee drinks is an excellent way to optimize diabetic control²¹. In our study, the consumption of red and green tea was higher in male patients compared to female patients. According to a meta-analysis, daily tea consumption (3 cups/day) is associated with a lower risk of type 2 DM²².

The large sample size and the selection of 281 online scenarios were two of the study's primary strengths. We acknowledge that the cross-sectional design of the study limited our ability to investigate "cause-effect" linkages. Furthermore, data obtained only once may be subject to recall bias and seasonal volatility. Second, because our data was based on self-reported food and lifestyle habits, reporting inaccuracies is to be expected. This is true of all similar articles that rely on surveys to gather data.

CONCLUSION

In our study, food habits among the adult Saudis studied influenced dysglycemia. Female hyperglycemic patients had considerably greater rates of insufficient physical activity and sweets consumption. Male dysglycemic patients consumed considerably more red meat and poultry. Future consideration should be given to increasing awareness of dietary habits and the importance of physical activity among females through in-clinic education sessions using flyers that include information about what exercises can be performed

and include basic information for patients with type 2 diabetes mellitus to understand the disease and how to prevent future complications.

Conflict of Interest

There is no conflict of interest

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