ORIGINAL ARTICLE

Nutritional Status, Vitamin D and Lifestyle of Adults with and without Type 2 Diabetes in Baghdad, Iraq: A Comparative Cross-Sectional Study

Mahmood S[a], Omar N[b,e], Al-Bayaty M[c], Zohari Zahira[d], Sallehuddin H[d,e], Mohd Yusof BN[b]*

[a]MSc Student, Department of Nutrition and Dietetics, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia
[b]Department of Nutrition and Dietetics, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia
[c]Department of Family and Community Medicine, Al-kindy Medical College, University of Baghdad, Iraq
[d]Geriatric Unit, Department of Medicine, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia
[e]Malaysian Research Institute on Ageing (MyAgeingTM), Universiti Putra Malaysia, Serdang, Selangor, Malaysia

ABSTRACT

INTRODUCTION: Understanding the status of diabetes is important to predict the variables that affect risks due to diabetes or can be used to prevent diabetes. This study aimed to compare the socio-demographic characteristics, nutritional status, vitamin D (VitD) levels, and lifestyles of diabetic versus non-diabetic adults in Baghdad, Iraq. **MATERIALS AND METHODS:** A comparative cross-sectional study was carried out from October to December 2019, and data were collected from adults aged 20 to 65 years. Logistic regression analysis was used to identify factors that contributed to the development of Type 2 Diabetes Mellitus (T2DM). Data was analyzed using SPSS Version 22. **RESULTS:** One-hundred seventy subjects were divided into two groups of 85 respondents in non-diabetic and diabetic groups, respectively. Educational level, vitD level and daily consumption of red meat, pizza, pastries, nut and bread were significantly higher in the non-diabetic than in the diabetic group ($p<0.05$). On the other hand, respondents with T2DM had higher family history of T2DM, waist-to-hip ratio (WHR), body fat percentage (BF%), fasting blood glucose (FBG) and daily consumption of brown bread ($p<0.05$). Multiple logistic regression showed that the only significant factors contributing to the status of diabetes were educational attainment and FBG ($p<0.05$). **CONCLUSION**: Higher educational level and decreasing one unit of FBS reduced the risk of T2DM by 10% and 67%, respectively. Future Interventions on fostering educational level, normal BMI, healthier diet and vitamin D intake are recommended for T2DM prevention and control in Iraqi adults.

Keywords
Type 2 DM, nutritional status, vitamin D, lifestyle.

Corresponding Author
Dr Hakimah Sallehuddin
Geriatric Unit, Department of Medicine, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia,
Serdang, Selangor, Malaysia
E-mail : drhakimah@upm.edu.my

Received: 24th March 2022; Accepted: 6th February 2023

Doi: https://doi.org/10.31436/imjm.v22i2

INTRODUCTION

Diabetes poses a significant global health burden[1,2], and it is expected to increase in the future. To be specific, T2DM is projected to reach 96.2% by 2035.[2] The prevalence of T2DM in the Middle East and North Africa has increased to 12.2%[3], specifically 10.2% in Iraq and 12% in Baghdad.[4]

There are several factors that affect T2DM such as obesity and sedentary lifestyle habits. Physical inactivity and unhealthy nutrition distort body composition and in turn, reorders the proportions of myocyte and adipocyte insulin receptors. Insulin that acts on adipocyte receptors produces less glucose uptake than comparable interactions with myocyte receptors. Accordingly, in individuals with disproportionate muscle/fat composition, any given glucose load requires greater-than-normal pancreatic insulin secretion for adequate disposal. Therefore, hyperinsulinemia becomes the leading cause of T2DM as insulin-sensitive tissues become desensitized. [5] In addition, a sedentary lifestyle, excessive energy intake and obesity are common among Iraqi adults with T2DM. [6]

Another factor is VitD, which plays an important role in glucose metabolism[7] by improving pancreatic β-cell function and regulation of insulin secretion. [8] VitD can be obtained via moderate sun exposure, from the diet or by consuming supplements. [9] Hence, greater sun exposure may reduce the risk of T2DM [10], and has a direct or indirect role in improving T2DM. In addition, smoking is one of the variables that affect T2DM. Smoking reduces insulin secretion and increases insulin resistance, which leads to impaired glucose metabolism that can cause diabetes. [11] In addition, handgrip-strength (HGS) reflects muscle mass, physical function, and health status. [12] Excessive central obesity accelerates the decline in muscle strength. [13] Individuals with diabetes usually have lower muscle strength than those without diabetes. [14]

Due to the high prevalence of poor glycemic control among Iraqis as well as the lack of comparative research on nutritional status factors such as HGS, VitD intake, and sun exposure between non-diabetic and diabetic adults in Baghdad, Iraq, there is a need for a comparative study to predict which variables affect the risk of T2DM. These variables can then be used to reduce the incidence of T2DM in Iraq. Furthermore, Iraq differs from the other countries in the region because of its culture, lifestyle, political factors, and economic situation. Therefore, this paper aims to fill the gap about the differences in socio-demographic factors, nutritional status, VitD levels, and lifestyles among non-diabetic and diabetic adults in Baghdad, Iraq.

METHODS

Study Population and Design

Convenience sampling was used to collect data from the Specialist Centre for Endocrinology and Diabetes (SCED), Baghdad, Iraq, between October and December 2019. A comparative cross-sectional study method was adopted to evaluate the factors between non-diabetes and diabetes groups. For the diabetic group, the respondents included having attended SCED with diagnosed T2DM for less than 10 years, and aged between 20-65 years. Those who took VitD supplements and insulin treatment, were pregnant or lactating, and had chronic liver or kidney disease were excluded from the diabetic group. For the non-diabetic group, the respondents included were aged between 20 to 65 years and had no known chronic diseases. This study matched age and sex between respondents with and without T2DM.

In Baghdad, there are two specialist centres for endocrinology and diabetes. However, only the Al-Khindi Hospital was chosen as it was the largest center. All respondents signed their consent before the respondents with kidney disease were excluded from the T2DM group. The diagnosis of T2DM were based on the American Diabetes Association (2017)[15] with FBG$\geq$7.0 mmol/l.

Sample Size

The sample size was determined by proportion formula based on knowledge of VitD status. [17] At least 163 respondents were required after accounting for 20% attrition rate. This study recruited 170 respondents, where 85 of them were T2DM patients, and 85 were non-T2DM.

Data Collection and Research Instruments

The data collection form consisted of four sections: 1) Socio-demographic characteristics, 2) Nutritional status, 3) Blood glucose and Vitamin D level, and 4) Dietary intake and lifestyle. The questionnaire answers and physical measurements were collected from the respondents via face-to-face interview and physical examination. The language used in the questionnaire was Arabic. Finally, the blood samples were withdrawn and sent to the laboratory for analysis.

Socio-Demographic Characteristics

The socio-demographic characteristics were collected directly from face-to-face interviews, and close-ended questions were used. The information required included age, sex, ethnicity, marital status, educational level and family history of diabetes mellitus (DM).

Nutritional Status

Waist-circumference (WC), body mass index (BMI), waist-to-hip-ratio (WHR), body fat percentage (BF%), and handgrip strength (HGS) were measured to examine the effects of variables on T2DM. The researcher took all measurements, which were measured two times and taken as the mean to reduce measurement errors, and used a metric system. Waist circumference and hip circumference were measured using a measuring tape (SECA,203.Vogel.and.Halke,.Germany). Obesity, which is defined by BMI $\geq$ 30 kg/m^2 is a major risk factor for Type 2 Diabetes. BMI was calculated using the equation "BMI (kg/m^2) =weight (kg)/ height (m^2)" and classified using World Health Organization (WHO) category to describe the body weight status of the respondents.[18] In this study, underweight and healthy weight were combined. WHR was used to measure the relationship between waist size and hip size.[19] Bioelectric impedance analysis using the Omron Karada scan body composition and scale (HBF-37545823015319.Japan.F/S) (BIA) was applied to measure BF%. The results of this study indicate that Omron's body composition estimates are reliable (rxx=0.933-0.993).[20] This study used the Camry-EH101 handheld electronic tester to measure HGS in kilograms. The Camry electronic hand test bench was reliable (r=0.98) for determining HGS. [21]

Blood Glucose Level and Vitamin D Status

Respondents were required to fast for 10-12 hours, and the blood samples were collected in two tubes. For FBG, a gold-top tube (serum separator) was used. FBG levels were classified as normal (4.4-5.5mmol/L), or high (5.6mmol/L and above)[4]. The cut-off of 5.6 mmol/L was taken because in non-diabetic respondents this level was considered pre-diabetic, and carried a risk of T2DM in the future. Additionally, FBG was analyzed using CobasC-311.[22]

The analyses were based on the enzymatic (GOD/PAP) method.[23] Serum 25(OH) Vitamin D was analyzed using theEnzyme Linked Fluorescent Assay (ELFA) method (Vidas®). VitD levels were classified according to the serum 25(OH) vitamin D (cholecalciferol) levels as VitD deficiency (<20ng/ml), insufficiency (21-29ng/ml), and normal (30–100ng/ml).[24]

Dietary Intake and Lifestyle

The dietary recall was obtained for one day during the weekend and two weekdays to determine mean daily total energy, total carbohydrate, total protein, total fat and total VitD intakes. The data was entered into a Nutritionist Pro software (version-2.4.1) to obtain comprehensive data on foods and drinks that were consumed on particular days. This study used the Goldberg cut-off methods to statistically determine whether the reported energy intake of a respondent was under-reported, normal/plausible reporting, or over-reported.[25] A semi-quantitative food frequency questionnaire (SFFQ) was utilized to provide data on VitD intake.[26] The reliability of SFFQ was (r=0.82, p<0.001) for VitD.[27]

Lifestyles factors included sun exposure, physical activity level and smoking. Sun exposure index was determined by calculating the number of hours of sun exposure per-day multiplied by the fraction of exposed body surface area (BSA).[28] An estimation of percentage of BSA was revealed. Next, a shortened version of the international physical activity questionnaire (IPAQ) was used to measure such physical activity including volume and the frequency of physical activity levels (number of sessions/ days). The reliability of IPAQ was found to be acceptable with scores from 0.7–0.8.[29] In addition, the questions regarding smoking included status as a smoker or non-smoker, number of cigarettes per-day, number of pack-years (average number of packs per-day×number of years as a smoker).

Statistical Analysis

The chi-squared test was used to compare categorical variables between respondents without and with T2DM. Independent t-test and Mann-Whitney U-test were used to compare the mean differences in continuous variables between respondents with and without T2DM. To determine the contribution of variables to diabetes status, binary logistic regression was used to test the contribution towards the development of T2DM. In the first step, the researcher used univariate logistic regression to define all contributor variables to the development of T2DM. In the second step, the researcher used multivariate logistic regression by taking those factors with $p \leq 0.25$ from the univariate analysis and entering those simultaneously. Again, variances of all tests were viewed to be of significance when two-tailed p-values showed.<0.05.

Ethical Consideration

Ethical approval for this study was granted by the research ethics committee of the University Putra Malaysia (JKEUPM-2019-134) and the Iraqi Ministry of Health (1726-2).

RESULTS

Socio-Demographic Characteristics

From the total of 170 respondents in this study, 85 were in the non-diabetic group, and 85 were in the diabetic group. There was no significant difference between the two groups in terms of age, sex, marital status and ethnicity. However, the findings revealed a significant difference in the education levels and family history of T2DM between the groups (p<0.05). More non-diabetic respondents received tertiary education and had no family history of T2DM(Table-I).

Table I: Comparison of socio-demographic characteristics between groups.

	Total	Non-diabetic (n = 85)	Diabetic (n = 85)	p-value**
		N (%)	N (%(	
Age (years)				
20 – 40	36 (21.2)	18 (21.1)	18 (21.2)	
41 – 60	116 (68.2)	58 (68.2)	58 (68.2)	1.00
>60	18 (10.5)	9 (10.6)	9 (10.6)	
Sex				
Female	97 (57.1)	47 (55.3)	50 (58.8)	0.64
Male	73 (42.9)	38 (44.7)	35 (41.2)	
Ethnicity				
Arabic	153 (90.0)	73 (85.9)	80 (94.1)	0.07
Kurdish	17 (10.0)	12 (14.1)	5 (5.9)	
Marital status				
Single	7 (4.1)	4 (4.7)	3 (3.5)	
Married	151(88.8)	72 (84.7)	79 (92.9)	0.18
Other	12 (7.1)	9 (10.6)	3 (3.5)	
Educational level				
Primary	39 (22.9)	0 (0)	39)(45.9	
Secondary	42 (24.7)	16 (18.8)	26 (30.6)	**0.005**
Tertiary	89 (52.4)	69 (81.2)	20 (23.5)	
Family history of T2DM Variable				
No	62 (36.5)	43 (50.6)	19 (22.4)	**0.001**
Yes	108 (63.5)	42(49.4)	66(77.6)	
Diabetes duration				
0 month	85 (50.0)	85 (50)	0 (0)	
1 month – 5 years	55 (32.4)	0 (0)	55 (32.4)	**0.001**
6-10 years	30 (17.6)	0 (0)	30 (17.6)	

Chi-square test, N: number of respondents. The p value in **bold shows significant value.

Nutritional Status and Food Intake

Waist-to-Hip ratio, BF% and FBG were of significantly higher in diabetic respondents than in non-diabetics (p<0.05). Although the daily consumption of brown bread was higher in diabetic respondents (p<0.05), we found that the mean daily consumption of bread, meat, nuts, cakes and cheese pizza were higher in non-diabetic group compared to diabetic group (p<0.05) (Table II). WC, BMI, HGS, and Goldberg cut-off points did not show significant differences between the two groups. VitD intake, the consumption of labneh, yogurt, milk dessert, konafa, cheese, milk, waffle or crepe, fish, vegetables, leafy vegetables, eggs, chicken, and dates did not show significant differences between the two groups. Table II shows the comparison of nutritional status and the types of food with significant differences between the groups. The values of BMI(kg/m2), WHR, BF% and Handgrip strength(kg) were depicted in Supplement 1.

Vitamin D Status and Lifestyle

Majority of the respondents (91.2%) were VitD deficient. Lower mean serum VitD levels were found among diabetic than non-diabetic respondents (p<0.05). Diabetic respondents also had a lower vitD intake even though the value was insignificant. No differences were observed in sun exposure, VitD status, physical activity, and smoking habit between the groups (Table-III).

Factors Contributing to Diabetes Status

The regression analyses for factors contributing to diabetes status were shown in Table IV. For univariate logistic regression in the socio-demographic category, high educational level reduced T2DM risk by 7%. As for nutritional status parameters, higher WHR and FBG as well as a family history of T2DM increased T2DM risk. In terms of dietary intake, consumption of meat (lamb or beef), pizza, bread, and nuts were associated with reduced T2DM risk. In terms of VitD and lifestyle factors, reduced VitD status increased the risk of T2DM. All factors which had values of p<0.25 were included in the final model, including ethnicity, marital status, education, family history of T2DM, WHR, BF%, FBG, serum VitD level, total energy intake, carbohydrate intake, VitD intake, meat-per-

Table II: Comparison of nutritional status and food intake between groups.

Variable	Total N(%)	Non-diabetic (n = 85)	Diabetic (n = 85)	p-value**
		N (%)	N (%)	
Waist circumference (cm)				
Normal (<80cm in female and <94cm in male)	20 (11.8)	12 (14.1)	8 (9.4)	0.34
Increased risk (≥80cm in female and ≥94cm in male)	150 (88.2)	73 (85.9)	77 (90.6)	
Body mass index				
Underweight and Normal	23 (13.5)	12(14.1)	11 (12.9)	0.95
Overweight	53 (31.2)	27(31.8)	26 (30.6)	
Obese	94 (55.3)	46 (54.1)	48 (56.5)	
Waist-to-hip ratio				
Low risk	38 (22.4)	27 (31.8)	11 (12.9)	**0.004**
Moderate risk	43 (25.3)	23 (27.1)	20 (23.5)	
High risk	89 (52.4)	35 (41.2)	54 (63.5)	
Body fat percentage (%)				
Normal	13 (7.6)	10 (11.8)	3 (3.5)	**0.04**
High	157 (92.4)	75 (88.2)	82 (96.5)	
Handgrip strength				
Weak	41 (24.1)	22 (25.9)	19 (22.4)	0.77
Normal	122 (71.8)	59 (69.4)	63 (74.1)	
Strong	7 (4.1)	4 (4.7)	3 (3.5)	
Fasting blood glucose (mmol/L)				
<5.6 mmol/L(Normal)	85 (50.0)	85 (100)	6 (7.1)	**0.001**
≥5.6 mmol/L(High)	85 (50.0)	0 (0.0)	79 (92.9)	
Goldberg cut-off				
Under-reporters	42 (24.7)	20 (23.5)	22 (25.9)	0.576
Plausible-reporters	127 (74.7)	64 (75.3)	63 (74.1)	
Over-reporters	1 (0.5)	1 (1.2)	0 (0.0)	

Variable	Total (Mean±SD)	Non-diabetic (Mean±SD)	Diabetic (Mean±SD)	p-value^
Waist circumference (cm)	99.69±12.09	98.7±12.36	100.6±11.80	0.29
Body mass index (kg/m ²)	30.39±4.93	30.5±5.37	30.6±5.24	0.86
Waist-to-hip ratio	0.92±0.083	0.90±0.09	0.93±0.07	0.01
Body fat percentage (%)	37.95±10.31	37.9±10.6	37.9±10.03	0.97
Handgrip strength (kg)	29.34±11.14	30.0±12.0	28.6±10.18	0.62
Fasting blood glucose (mmol/L)	8.48 ± 4.33	5.4 ± 0.57	11.5 ± 4.3	**0.001***
EI-to-BMR ratio	1.07±0.36	1.09 ± 0.39	1.06 0.32 ±	0.54*
Total energy intake (kcal/day)	1710 ± 482.4	1770 ± 577	1676 ± 456	0.49*
Total carbohydrate (g/day)	260 ± 86.2	275±109	253±82.9	0.15
Total protein intake (g/day)	71 ± 28	70 ± 31	73 ± 27	0.49
Total fat intake (g/day)	43 ± 18	44 ± 22	44 ± 22	0.83*
Total Vitamin D intake (g/day)	39 ± 35	44 ± 22	44 ± 22	0.16*
Bread per day (serving/day)	8.7± 5.2	9.70 ± 4.73	6.54 ± 5.49	**0.02**
Brown bread (serving/day)	0.85 ± 2.61	0.03 ± 0.27	1.67 ± 3.5	**0.001**
Meat (lamb or beef) (serving/day)	0.32 ± 0.31	0.38 ± 0.32	0.26 ± 0.29	**0.002**
Nuts (serving/day)	0.18 ± 0.38	0.24 ± 0.32	0.12 ± 0.43	**0.001**
Cake (serving/day)	0.06 ± 0.12	0.06 ± 0.08	0.05 ± 0.15	**0.001**
Cheese pizza (serving/day)	0.03 ± 0.05	0.04 ± 0.05	0.02 ± 0.05	**0.03**

*Independent t-test, SD: standard deviation, ^Mann-Whitney U test. The p value in **bold** shows significant value.

day, pizza cheese-per-day, konafa-per-day, nuts-per-day, dates-per-day, bread-per-day, brown bread-per-day, and sun exposure.

After adjusting for the above factors, we found that only the level of education and FBG had statistically significant contributions to the development of T2DM among our respondents. A high educational level reduced T2DM risk by 10%, while increasing one unit of FBG contributed to T2DM risk by 22 times.

Table III: Comparison of VitD and lifestyle variables between groups.

Variable	Total	Non-diabetic (n = 85)	Diabetic (n = 85)	P-value
		N (%)	N (%)	
Vitamin D status				
Deficiency (<20 ng/ ml)	155 (91.2)	77 (90.6)	78 (94.8)	0.844**
Insufficiency (21 – 29 ng/ ml)	12 (7.1)	6 (7.1)	6 (7.1)	
Normal (30 – 100 ng/ ml)	3 (1.8)	2 (2.4)	1 (1.2)	
Physical activity level				
Inactive	96 (56.5)	49 (57.6)	47 (55.3)	0.88**
Sufficiently active	69 (40.6)	34 (40.0)	35 (41.2)	
Active	5 (2.9)	2 (2.4)	3 (3.5)	
Do you smoke?				
No	141 (82.9)	71 (83.5)	70 (82.4)	0.84**
Yes	29 (17.1)	14 (16.5)	15 (17.6)	
Number of cigarettes per day				
1 - 10	5 (2.9)	1 (1.2)	4 (4.7)	0.41**
11 - 20	9 (5.3)	6 (7.1)	3 (3.5)	
More 20	15 (8.8)	7 (8.2)	8 (9.4)	
Number of years smoking				
1 - 20 years	14 (8.2)	7 (8.2)	7 (8.2)	0.964**
More than 20 years	15 (8.8)	7 (8.2)	8 (9.4)	
Mean± SD				
Vitamin D level (ng/ml)	12.08± 6.64	13.5 ± 6.8	11.7 ± 5.4	**0.004***
Sun exposure	1.25 ± 2.00	1.07 ± 1.66	1.44 ±2.28	0.152*
Smoking (number of pack/ year)	84.59 ± 233	82.41±220	86.7± 247	0.904*

*Independent t-test, **Chi-square test, N: number of respondents, SD:standard deviation. The p-value in **bold** shows significant value.

DISCUSSION

More than half of the respondents in this study had at least a diploma degree, which can be attributed to the fact that the non-diabetic respondents were chosen from hospital workers, who usually have high education degrees. However, this result aligned with previous studies conducted in Basra, Iraq.[6,] To understand the relationship between education and incidence of T2DM, mediating factors between education and incidence of T2DM needed to be investigated. These factors include body mass index, alcohol consumption, hypertension, fasting triglycerides, high-density lipoprotein cholesterol, physical activity, and smoking status.[30]

Iraq has suffered from wars and political challenges, which has made maintaining health and an active lifestyle a difficult task to achieve. [3] In combination with a lack of awareness about diets and physical activity [32], it has led to overall low physical activity levels. This was reflected in our study, where 56.5% of the respondents were physically inactive. All these challenges could explain the high rates of obesity and overweight in Iraq.

Table IV Factors contributing to diabetes status.

	Univariate logistic regression			Multivariate logistic regression		
	β	OR (95% Cl)	p-value	β	OR (95% Cl)	p-value
Ethnicity						
Arabic						
Kurdish	-0.96	-0.38 (0.13, 1.13)	0.082	-0.0513	0.62 (0.09,4.12)	0.624
Marital status						
Non married						
Married	-0.86	-2.38 (0.86, 6.58)	0.096	0.755	2.21 (0.47,10.45)	0.316
Educational level						
Without diploma						
Diploma and above	-2.64	- 0.07 (0.03, 0.15)	**0.001**	-2.278	0.10 (0.04,0.28)	**0.001**
Waist-to-hip ratio						
Low health risk						
Moderate risk and high risk	-1.14	-3.132 (1.43, 6.84)	**0.004**	-0.175	1.11 (0.58,2.15)	0.753
Body Fat Percentage %						
Normal						
High and very high	-1.29	-3.64 (0.97, 13.7)	0.056	0.154	1.01 (0.15,6.74)	0.995
Fasting blood glucose (FBG)						
Normal						
High	-2.79	-16.29 (6.40, 41.43)	**0.00**	3.212	22.67 (5.25,97.86)	**0.001**
Family history of DM						
No						
Yes	-1.26	-3.66 (1.83, 7.0)	**0.000**	1.080	3.05 (0.98,9.48)	0.054
Serum vitamin D (ng/ ml)	-0.07	0.93 (0.89, 0.98)	**0.005**	-0.072	0.93 (0.84, 1.03)	0.149
Total energy intake (kcal/day)	0.00	1.00 (0.99, 1.00)	0.240	0.001	1.00 (0.99, 1.00)	0.145
Carbohydrate intake (g/day)	-0.01	1.00 (0.99, 1.00)	0.156	-0.007	0.99 (0.98, 1.00)	0.205
Vitamin D intake (g/day)	-0.01	0.99(0.99, 1.00)	0.100	-0.006	0.99 (0.98, 1.01)	0.328
Bread (serving/day)	-0.01	0.99 (0.98, 0.998)	**0.021**	-0.012	0.99 (0.97, 1.01)	0.212
Brown bread (serving/day)	0.127	1.14 (1.0, 1.29)	0.056	0.138	1.14 (0.96, 1.37)	0.136
Dates (serving/day)	-0.05	0.95 (0.91, 1.01)	0.054	-0.001	1.00 (0.92, 1.09)	0.942
Meat (lamb or beef) (serving/day)	-0.19	0.83 (0.70, 0.97)	**0.022**	-0.145	0.86 (0.69, 1.08)	0.207
Nuts (serving/day)	-0.16	0.85 (0.73, 1.00)	**0.048**	0.060	1.06 (0.89, 1.27)	0.493
Pizza cheese (serving/day)	-1.19	0.74 (0.57, 0.97)	**0.026**	-0.658	0.50 (0.09, 2.72)	0.426
Konafa (serving/day)	-4.64	0.01(0.00, 4.31)	0.136	-2.687	0.09 (0.00, 407.2)	0.571
Sun exposure	0.096	1.10 (0.94, 1.29)	0.228	0.060	1.03 (0.80, 1.33)	0.807

β: beta. The p-value in **bold** shows significant value.

In this study, WHR and BF% were found to be significantly higher in the diabetic than non-diabetic group, and this is in line with other research studies.[33,34] Waist-to-hip ratio measures central adiposity, which has a greater predictive ability in diabetes development.[35] Furthermore, central obesity has been found to be predictive of other disorders important in the clinical development of insulin resistance and diabetes, such as lipid profile, blood pressure, and glycemic indices.[36]

Next, BF% was significantly higher in diabetic group. Similar results were found in studies conducted in Pakistan and Czech. [37] While both BF% and BMI measure obesity, our result showed a significant difference in BF%, but not BMI between the two groups. This could be due to BMI's dependence on weight and height, whereby weight comprises of fat as well as various body compositions such as muscle, organs, and body water. [46]

The mean FBG level was higher in diabetic than non-diabetic respondents. Other studies have also reported high mean FBG levels in respondents with diabetic compared to non-diabetic.[33,36,38] The mean FBG level among diabetic was 11.5 mmol/l, which is very high (WHO-2016). It is similar to previous studies where only 14 to 27% of T2DM patients in Iraq met the glycemic target.[39] Lack of physical activity, overweight, and obesity were associated with poor glycemic control among T2DM Iraqis.[39] Our study showed a high percentage of respondents with physical inactivity, obesity and overweight in the diabetic group (56.5%, 55.3%, and 31.2%, respectively). The results of this study agree with previous studies.[39]

Family history of DM led to a significant difference between non-diabetic and diabetic groups. Other studies reported similar results.[38,40,41] There are two possible reasons for this finding. The first is the genetic factors contributing to T2DM among relatives, and the second is the likelihood of similar environment and lifestyles, including diet and other habits.[42] Likewise, a study mentioned that the risk of T2DM increases by 2-to-4 times if the father, mother, or both have T2DM.[42]

The nutritional intake analysis showed that the average VitD intake was 39.22-IU/day. However, the consumption of VitD was less than recommended. Likewise, only 2 participants have visited a nutritionist, indicating low awareness among Iraqis. In addition, medical nutrition therapy and registered dietitian nutritionists have been proven to play a significant role in the treatment and prevention of diabetes.[43]

As mentioned before, VitD intake is lower than the recommended 600-IU/d.[42,43] Likewise, the average sun exposure index was 1.25, lower than previous studies in Brazil, 4.21.[44] That said, it was expected to see a high prevalence of VDD in Iraq as a high prevalence of VDD has been noted in the Middle East region, including Jordan and Saudi Arabia.[45] VitD levels were higher in non-diabetic respondents. Therefore, the results agreed with other studies.[38] Although VitD intake and sun exposure were not significantly different between the two groups, VitD levels were higher in non-diabetic group. This suggests that other factors control VitD levels in the diabetic group. Therefore, this highlights the need to study other factors contributing to VDD among individuals with T2DM.

Results for univariate logistic regression revealed that high educational level reduced T2DM risk by 7%. As for nutritional status parameters, higher WHR, FBG, and family history of T2DM had increased T2DM risk. In terms of dietary intake data, consumption of meat, pizza, bread, and nuts were associated with reduced diabetic risk. In terms of VitD and lifestyle factors, reduced VitD status increased the risk of diabetic .The association between low vitD status and the risk of developing impaired glucose tolerance, T2DM and metabolic syndrome are clear as role of vitD in pancreatic β-cell function and regulation of insulin secretion.

For the multivariate logistic regression test, a high level of education reduced the risk of T2DM by 10.0%, while a low level of education contributes to high T2DM status. These results are similar to previous studies.[40,41] The risk of T2DM decreased with increasing education.[30] They also found that people with the lowest education categories were more likely to be overweight and have high blood pressure.[30] Respondents with the highest levels of education were more likely to engage in intense physical activity as well as consume multivitamin supplements, vegetables, and fruit every day.[30]

One FBG unit contributed 22 times to the risk of T2DM. Thus, high FBG contributes to a higher risk of T2DM. High FBG increased the risk of T2DM in the uncorrected model by 16 times and in the corrected model by 22 times. In addition, the pathophysiology of T2DM changes is characterized by β-cell dysfunction, insulin resistance, and chronic inflammation, which progressively hamper the control of blood glucose levels and lead to micro-and macrovascular complications.[46]

CONCLUSION AND FUTURE RECOMMENDATIONS

In general, there are high rates of obesity and overweight, increased BF%, and low VitD intake among Iraqis. Likewise, Iraqi adults have high prevalence of vitamin D deficiency (VDD) and low physical activity. WHR, BF%, FBG, family history of T2DM, and VDD were higher in diabetic respondents. In non-diabetic respondents, educational level as well as daily consumption of bread, red meat, nuts, cake, and cheese pizza were significantly high. However, only education level and FBG had significantly contributed to the model. The final model found that high education level reduced T2DM risk by 10.0%, and increasing one unit of FBG contributed to increased T2DM risk by 22 times.

An intervention study could promote weight loss, changes to a healthier diet, improve VitD intake, and increase physical activity levels to prevent or control T2DM. Additionally, further studies about other factors contributing to VDD among T2DM can be done to investigate the relationship between VitD levels and T2DM.

LIMITATIONS OF THIS STUDY

In this study, the without-T2DM respondents were hospital workers with tertiary educational levels, while the T2DM respondents were hospital visitors, which suggests more diversity among the educational levels of respondents with T2DM. As this research was a cross-sectional study, it could not evaluate for cause-and-effect relationships. Furthermore, convenience sampling was used due to the lack of data about the respondents, which can sometimes be biased.

CONFLICT OF INTEREST

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

FUNDING

The author(s) received no specific funding for this work.

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