American Journal of Biomedicine and Pharmacy
https://biojournals.us/index.php/AJBP
ISSN: 2997-7177

Multifactorial Model of Glycemic Control: Socio-Demographic, Dietary, and Behavioral Determinants among Patients with Type 2 Diabetes – A Cross-Sectional Study

Hadeer Badin Rabie, Jabbar Taresh Ahmed, Wasen Abdul Ameer Ali
Southern Technical University/College of Health and Medical Techniques, Basrah, Iraq

Mahmood Thamer Altemimi
Thi Qar Specialized Diabetes Endocrine and Metabolism Center (TDEMC), Thi Qar Health Directorate, Thi Qar, Iraq

Received: 2024, 15, May
Accepted: 2025, 21, Jun
Published: 2025, 23, Jul

Annotation: Background: Type 2 diabetes mellitus (T2DM) is a major public health issue influenced by factors beyond medication. Dietary habits, lifestyle behaviors, and socio-demographic characteristics have shown significant impacts on glycemic control. However, integrated models examining these factors collectively remain limited. This study aims to evaluate the combined influence of these variables among T2DM patients.

Objective: This study aims to evaluate the combined influence of these variables among T2DM patients.

Methodology: This cross-sectional study included 250 patients with Type 2 Diabetes. The data was gathered through in-person interviews with patients through questionnaires distributed on the basis of axes.

Result: The mean of age 53.3±9.8 (with range; 32-75) years while the mean of BMI is 30.98±5.88 (with a range of 18.55-52.79).The results of the study reveal that for more than half of patients, their duration of disease with T2DM was 1-5 years (50.8%),The high percentage (76.8%) of the patients with T2DM have any first-degree relatives with diabetes. A very high

percentage (86.4%) of the patients with T2DM have high levels of HbA1c. The mean of HbA1c was 8.97±2.237 (with a range of 5.7-14.9).The study results of demonstrated that most patients suffering from diabetes (67.6%) practiced light physical activity, such as slow walking and light housework.A very high percentage (99.6%) of diabetics eat three meals a day. 54.8% of patients suffering from diabetes eat snacks and sugary pastries between meals.Also,the findings of this study indicate that 82.0% of patients follow unhealthy food patterns. Finally, the results found there were negative correlations between HbA1c and the overall food pattern scores (-0.713).

Conclusion: The study results show a statistically significant relationship between Socio-demographic, dietary habits and lifestyle behaviors variables and the incidence and control on the type 2 diabetes mellitus (T2DM).

Keywords: Type 2 diabetes mellitus, glycemic control, HbA1c, socio-demographic factors, dietary patterns, behavioral determinants, physical activity, obesity, cross-sectional study, Iraq, unhealthy food patterns, sedentary lifestyle, family history.

1. Introduction

Type 2 diabetes mellitus (T2DM) makes up about 90% of all cases of the disease and is known by high blood sugar brought on by several factors, including insufficient insulin secretion, excessive or inappropriate glucagon secretion, and resistance to the action of insulin (1).Unfortunately, type 2 diabetes is now spreading faster than measures to prevent it (2) .Type 2 diabetes is some of the main causes of suffering and death among people worldwide, and its prevalence and incidence are both rising , and there doesn't seem to be any indication that the rate of increase will slow down despite large spending in clinical care, research, and public health initiatives (3).

The development of T2DM is influenced by several factors, including metabolic, genetic, obesity, a sedentary lifestyle, and unhealthful food .Body fat ratio and inactivity are the primary causes of the global rise in diabetes. Therefore, controlling one's weight and food is essential for preventing, treating, and postponing the onset of T2DM. The cornerstone and one of the safest and most efficient ways to control blood sugar levels are still dietary interventions, sometimes called "Medical Nutrition Therapy." [(4),(5),(6)] . The Global Burden of Diseases (GBD) consortium found in a recent study the poor diet causes more deaths worldwide than any other risk factor, including tobacco use (7).

Patients with type 2 diabetes are difficult to treat because there is currently no cure; however, pharmaceutical therapy can be used to regulate blood sugar levels. Furthermore, keeping glucose

control is not the only goal of appropriate diabetes care; diet control, weight management, symptom relief, and avoiding micro- and macrovascular damage are also crucial goals to be followed [(8),(9)] .

People with diabetes should follow healthy and effective lifestyle changes, such as managing habits, getting regular exercise, and maintaining mental stability, in order to meet treatment goals (10) .

Weight, diet, and physical activity are all controllable variables that must be addressed immediately to halt or perhaps reverse this trend. Nutrition clearly shows a vital role in weight control and metabolism to prevent and manage of type II diabetes. Nonetheless, one of the toughest and most challenging aspects of managing type II diabetes is food (11) .

Modifiable elements like lifestyle choices (including nutrition) participate in the onset of type 2 diabetes, while unchangeable factors like age and family history also play a part in the disease's causative pathway. Modifications to these lifestyle choices may lower the chance of developing type 2 diabetes and affect how the condition develops when it comes to controlling and preventing type II diabetes [(12) , (13), (14)].

Dietary modifications can be made based on factors for example age, weight, occupation, gender, and health condition. Glycemic control, nutritional health, and avoiding the negative effects of diabetes are all reinforced by various dietary guidelines (15). Food choices made by diabetic patients are influenced by a variety of environmental and societal factors, with socioeconomic status being the most important (16) .

There is an enormous sum of study on the relationship concerning dietary variables and type 2 diabetes incidence. Evidence for a few dietary components in relation to type 2 diabetes prevention was summarized in recent papers. There is strong verification that consuming more whole grains and adhering to a healthy diet reduces the new cases occurrence of type 2 diabetes, while consuming more processed meat, total red meat, and sugar-sweetened beverages increases the incidence of the disease. In their summary of findings with probable or convincing evidence, Micha and colleagues noticed that a higher incidence of type 2 diabetes was related to a lower intake of dietary fiber, nuts or seeds, yogurt, and whole grains, as well as a higher intake of processed and unprocessed red meat, foods with a high glycemic load, and sugar-sweetened beverages [(17) , (18) , (19)] .

According to data, one of the best diets for people with diabetes is the Mediterranean diet (MD). The idea behind the Mediterranean diet is to eat more seafood, wholegrain foods, nuts, fruits, vegetables, and legumes. Glycemic management, which, improved with the Mediterranean diet. By decreasing triglycerides, lowering HbA1c, and weight loss, while simultaneously increasing HDL. In people with type 2 diabetes, A healthy lifestyle is promoted by physical activity, which is important for managing type 2 diabetes mellitus. Despite the proven advantages of physical activity, many people with diabetes mellitus do not start or follow a regular program that the World Health Organization recommends: at least 150 minutes per week of moderate-intensity physical activity or 75 minutes of vigorous-intensity physical activity (20).

Numerous reasons, including social, emotional, environmental, and economic ones, affect people's failure to stick to a physical activity regimen. People with diabetes mellitus are less likely to be physically active because they feel exhausted and find it difficult to exercise. So patients with diabetes mellitus who exercise often stop doing so within three to six months . The main take away is that while any exercise is preferable to none at all, more exercise is more beneficial, particularly when paired with less sitting (21).

2. Methodology

Study design and setting:

The study is a descriptive and analytical research (cross- sectional design) done in Thi-Qar

governorate southern Iraq at the Specialized Diabetes Endocrine and Metabolism Center (TDEMC) by a non-random sampling procedure (convenience sampling method). Convenience sampling is a non-probability sampling approach that selects participants from a target group of people based on convenience of access. This center provides services to all patients who come from all districts, sub-districts, and the city center. As for the period of study, the data collection started in September and continued until November 2024.The time allocated for data gathering was five days in every week and five hours in every day from the hour of 9.00 A.M. to 2.00 P.M.

Sampling Size:

The smallest sample size for ill people with disease diabetes mellitus type 2 is 243, However, we have taken 250 to strengthen the research. Expected prevalence or proportion in Iraq, a research by Abusaib *et al.*, (22) indicated that the overall cases of diabetes mellitus type 2 was 19.7%.

Data collection methods

A quantitative research design was adopted, utilizing a designed questionnaire as the primary data collection tool. The data was gathered through in-person interviews with patients who came to the center after an explanation of the study's goals and obtaining consent to participate in this study. The questions were asked in plain Arabic. Every interview lasted between 15_20 min.

Content of questionnaire:

- **Sociodemographic characteristics of the patients:**

It includes eight variables relevant to the socio-demographic characteristics of participants, containing: age, gender, marital status, and residence area, level of education, occupational status, socioeconomic status and Body mass index (BMI) . The Socio-Economic Status was measured using World Health Organization (WHO) standards .

- **Disease characteristics:**

Disease characteristics were obtained and included (duration of DM, family history of disease (first-degree relatives with type 2 diabetes), and HbA1C results.As stated by the recommendation of the ADA (23), patients with HbA1c < 5.7% were categorized as normal, 5.7-6.4% as average (controlled), and ≥ 6.5% as high (uncontrolled) (24).

- **Behavioral Characteristics:**

It consists of (3) items associated with the behavioral characteristics of these participants, which include (physical activity, number of main meals in the day, and sugary snacks and pastries between meals).

- **The overall food assessment:**

The questions regarding overall food assessment" The rating and scoring of items are four points Likert scale applied for rating fiber, fat, and carbohydrates-contain food items. The fiber, fat, and carbohydrates -contain food items "With 19 food items, the lowest score was 19, and the highest score was 76. A score between >60% was deemed healthy consumption (>57 score), while a score of less than 60% was regarded unhealthy consumption (=<57) (25).

Statistical Analysis

The information for each item on the questionnaire was copied to code sheets, the data was input into a personal computer, and the statistical package from SPSS-27 was used to evaluate the data. Simple statistics like frequency, percent, average, standard deviation, and range displayed the data. A chi-square test (X^2-test) or Fisher exact test was utilized to identify the significance of qualitative data percentage variances. The P-value was measured as statistically significant when it was the same as or less than 0.05 (26)**.**

3- Reuslt

In Table (1), the findings of this study show that most patients with T2DM belong to the ages of 50-58 years (33.2%), followed by those aged 41-49 years (25.6%), 59-67 years (22.4%), and 32-40 years (9.6%), while the lowest percentage (9.2%) of patients are aged >67 years. The mean of age 53.3±9.8 (with range; 32-75) years. The gender ratio is 65.6% female to 34.4% male. While 84.8% of patients were married, followed by widowed (12.0%), single (1.6%), and divorced (1.6%). Most patients live in urban areas (80.4%) compared to rural areas (19.6%). As for the educational level of study participants , the highest percentages were for the illiterate (40.0%), followed by those who hold the primary school certificate(18.0%), then the intermediate certificate (13.6%), then those who read and write (13.6%), then those who hold the college and higher studies (11.2%), and finally the secondary school certificates (3.6%). Regarding occupational status, the highest percentage (61.2%) of the participants were housewives, 16.8% of participants were self-employed, 14.4% were government employees, and 7.6% were retired. Finally, 48.4% of participants have low socioeconomic status, followed by 34.4% with medium socioeconomic status and 17.2% with high socioeconomic status .Also,the present results found that most patients with T2DM were obese (50.8%), followed by those overweight (35.6%), while the lowest percentage (13.6%) of patients had normal weight.

Table (1): Socio-demographic characteristics of participants

Sociodemographic characteristics of patients with T2DM		No.	%
Age groups	32-40 years	24	9.6
	41-49 years	64	25.6
	50-58 years	83	33.2
	59-67 years	56	22.4
	>67 years	23	9.2
	Mean± SD (Range)	**53.3±9.8 (32-75)**	
Gender	Male	86	34.4
	Female	164	65.6
Marital status	Single	4	1.6
	Married	212	84.8
	Divorced	4	1.6
	Widow	30	12.0
Residential area	Urban	201	80.4
	Rural	49	19.6
Education level	Illiteracy	100	40.0
	Read & write	34	13.6
	Primary graduate	45	18.0
	Intermediate graduate	34	13.6
	Secondary graduate	9	3.6
	Collage and higher studies	28	11.2
Occupational Status	Government employed	36	14.4
	Self- employed	42	16.8
	Retired	19	7.6
	house wife	153	61.2
Socioeconomic status	Low	121	48.4
	Medium	86	34.4
	High	43	17.2
BMI categories	Underweight (<18.5)	-	-
	Normal weight (18.5-24.9)	34	13.6
	Overweight (25-29.9)	89	35.6
	Obesity (>=30)	127	50.8

3.2 The distribution of patients with T2DM according to the disease characteristics

In Table (2), the results of the study reveal that more than half of patients their duration of disease with T2DM was 1-5 years, followed by 6-10 years (26.0%),11-15 years (12.4%), 16-20 years (7.6%), and >20 years (3.2%). The high percentage (76.8%) of the patients with DM have any first-degree relatives with diabetes. The mean of HbA1c was 8.97±2.237 (with range; 5.7-14.9).

Table (2): The distribution of patients with T2DM according to the disease characteristics

The disease characteristics		No.	%
Duration of DM	1-5 years	127	50.8
	6-10 years	65	26.0
	11-15 years	31	12.4
	16-20 years	19	7.6
	>20 years	8	3.2
Do you have any first-degree relatives with diabetes?	Yes	192	76.8
	No	58	23.2
HbA1C categories	Average (5.7-6.4%)	34	13.6
	High (>6.4%)	216	86.4
	Mean± SD (Range)	**8.97±2.237 (5.7-14.9)**	

3.3 The distribution of patients with T2DM according to the behavioural Characteristics In Table (3), The results of the study revealed that most patients suffering from diabetes (67.6%) practiced light physical activity, such as slow walking and light housework. While 28% of patients suffered from physical inactivity. A very high percentage (99.6%) of diabetics eat three meals a day. While 54.8% of patients suffering from diabetes eat snacks and sugary pastries between meals.

Table (3): The distribution of patients with T2DM according to the behavioural Characteristics

Behavioural Characteristics		No.	%
Do you usually have exercise?	No	70	28.0
	Light physical activity (e.g., slow walking, light household chores)	169	67.6
	Moderate physical activity (e.g., brisk walking, moderate-speed cycling)	3	1.2
	Vigorous physical activity (e.g., running, high-speed cycling, intense exercises such as weightlifting)	8	3.2
Are you Cigarette Smoking?	Yes	12	4.8
	No	238	95.2
How many main meals do you eat in one day?	One meal	-	-
	Two meals	1	0.4
	Three meals	249	99.6
Do you have Sugary snacks and pastries between meals?	Yes	137	54.8
	No	113	45.2

3.4 Assessment overall score of food patterns

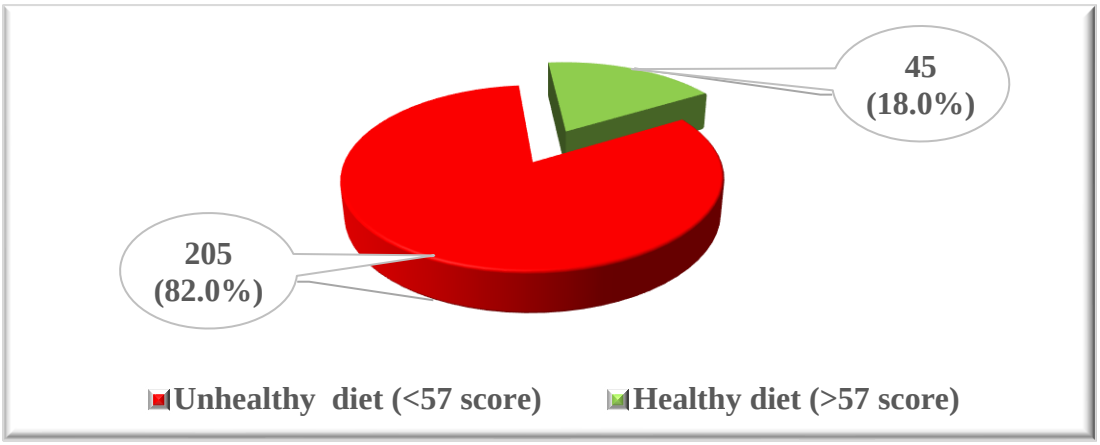

Figure (1): Pie chart illustrates the overall score of food patterns

In figure (1), the findings of this study indicate that 82.0% of patients follow unhealthy food patterns. While 18.0% of diabetic patients follow a healthy food pattern.

3.5 The relationship between the behavioural characteristics and disease characteristics of patients and HbA1C categories

In table (4), this study's findings show that there is a important correlation between behavioural characteristics (such as sugary snacks and pastries between meals, and exercise) and the HbA1C categories (P. value <0.05). These results explain that high physical activity, and those do not follow sugary snacks and pastries between meals have low levels for HbA1c compared to other categories.

Table (4): The relationship between the behavioural characteristics and disease characteristics of patients with HbA1C categories

		HbA1C categories				P-value
		Average (5.7-6.4%)		High (>6.4%)		
		No.	%	No.	%	
Do you have any first-degree relatives with diabetes?	Yes	27	14.1	165	85.9	0.698
	No	7	12.1	51	87.9	
Do you usually have exercise?	No	6	8.6	64	91.4	**<0.001**
	Light physical activity	22	13.0	147	87.0	
	Moderate physical activity	1	33.3	2	66.7	
	Vigorous physical activity	5	62.5	3	37.5	
Are you Cigarette Smoking?	Yes	1	8.3	11	91.7	0.585
	No	33	13.9	205	86.1	
How many main meals do you eat in one day?	One meal	0	.0	0	.0	0.691
	Two meals	0	.0	1	100.0	
	Three meals	34	13.7	215	86.3	
Do you have sugary snacks	Yes	8	5.8	129	94.2	**<0.001**
	No	26	23.0	87	77.0	

and pastries between meals ?						

3.6 Correlation between Duration of diabetic, HbA1c and BMI

In table (5), the results found there were positive correlation between duration of diabetic, and HbA1c (P=0.050; r=0.124). While there was no significant correlation between HbA1c and BMI.

Table (5): Correlation between Duration of diabetic, HbA1c and BMI

Correlations			
		Duration of diabetic per years	**BMI**
HbA1c	R	**0.124***	-0.120
	P-value	**0.050**	0.059
	N	250	250
Duration of diabetic per years	R	1	-0.115
	P-value		0.070
	N		250
*. Correlation is significant at the 0.05 level (2-tailed).			

3.7 Level of HbA1c according to food pattern

The results in table (6), showed that 86.6 % of individuals with an unhealthy diet had uncontrolled HbA1C (>6.4%), compared to 13.4 % among those with a healthy diet.

Table (6): Level of HbA1c according to food pattern

Food pattern of nutrients		**HbA1C categories**				**P-value**
		Controlled (5.7-6.4%)		**Uncontrolled (>6.4%)**		
		No.	**%**	**No.**	**%**	
The Overall Score of Food Patterns	Unhealthy diet	18	52.9	187	**86.6**	<0.001
	Healthy diet	16	47.1	29	13.4	

3.8 Correlation between HbA1c and food patterns

In table (7), the results found there were negative correlation between HbA1c with overall food patterns scores (r=-0.713) .

Table (7): Correlation between HbA1c and food patterns

		Overall scores
HbA1c	R	**-0.713****
	P-value	**<0.001**
	N	250

4- Discussion

The outcome of this study indicates that most patients with T2DM were older. These results agreed with the study findings conducted in Jazan, Saudi Arabia, by Elfaki *et al.*, (27) which found that most of the T2DM belonged to age groups of 51-60 years (30.5%), followed by those aged 41-49 years (28.6%). Also, another study in Baghdad, Iraq (28) showed the role of aging in the progress of the illness type 2 diabetes, which informed that 92 % of patients fall within age groups (50–60 years), followed by 8 % of patients who fall within age groups <50 years. The increase in the older age groups among the samples of this study may be because type 2 diabetes

is mostly associated with the elderly, which increases the frequency of these advanced age groups. This explanation is supported by Al Mansour (29) which reported that diabetes type 2 was more prevalent among the older respondents compared with the younger age groups.

In this study, the majority of the study sample comprises females, representing 164 (65.6%) of the total sample size. This result agreed with study findings done by Baral *et al.,* (30) which reveal that most of the study participants were females (56.9%). Other research conducted by Elfaki *et al.,* (27) reveals that half of participants were females (55.6%). A possible reason for this result could be that women are less active than men and follow a sedentary lifestyle and therefore may be overweight or obese. Women are also less aware than men of the risks of physical inactivity and the damage caused by obesity and its complications, so they are more likely to develop diabetes. This explanation is supported by Kautzky-Willer *et al.,* (31) which revealed that the most prominent risk factor for T2DM, which is obesity, is more common in women .

Regarding marital status, A high proportion of the patients with T2DM were married . These results are similar to the findings of a study done by Aladhab & Alabbood (32) which indicated that the majority (85.7%) of the study sample were married. Also, another recent study undertaken by Hamoodah *et al .,* (33) showed that the majority (72%) of the study sample were married. A possible explanation for this increase in married people in this study may be logical because most of the sick participants are from the older age groups.

In this study, the results reported that most patients with T2DM live in urban areas. This finding is supported by a study conducted by Nasir *et al.,* (34) **,** which found that most of the patients lived in urban areas. Also, other recent study conducted by Elenga-Bongo et al., (35) **,** which found the same results. The possible explanation for this increase in the number of residents in urban areas may be due to many factors, including the availability of health institutions equipped with the best technology and the most skilled doctors and easy access to them by residents of urban areas, which facilitates early diagnosis of many cases of diabetes and their increase in urban areas compared to rural areas that lack early detection programs and have difficulty in access to health facilities. Additionally, this high prevalence of diabetes in urban areas can also due to reflects the consequences of urbanization, the change in eating habits linked to it, and sedentary lifestyles.

Concerning the level of education of type 2 diabetic patients, it is demonstrated that the highest percentage of them are illiterate; they accounted for 40.0% of the study sample. This result agreed with results obtained from a study was completed by Baral *et al.,* (30)**,** who found that the educational level of most patients with type 2 diabetes was illiterate. Also, these results agreed with a recent study done by Al-Majidi *et al.,* (28) ,which found the same results. A possible explanation for this increase in the number of illiterate people visiting the hospital may be due to a lack of knowledge and poor blood sugar control, which lead to more frequent visits to the hospital compared to higher educational levels. This explanation is supported by Sharma *et al.*, (36) **,** which found that there was a high prevalence of poor-quality diet and suboptimal diabetes control among illiterate diabetes patients.

In regard to the participants' occupational status, it was found that the largest proportion of the study sample consisted of individuals who identified as housewives (61.2%). This result is similar to the result obtained from a study carried out by Mohamed *et al.,* (37) ,which indicated that the majority of the study sample were housewives. Also, these results were compatible with a study done by Nasir *et al.,* (34) **,** which found the same results. A possible explanation for this result may be that most housewives have sedentary routines due to household responsibilities that do not require much physical effort, which increases the risk of obesity and insulin resistance (38) **.**

About socioeconomic status, a majority of patients (48.4 %) have low socioeconomic status. This result agreed with study findings conducted by Nasir *et al.,* (34) **,** which reveal that most of

the patients have low socioeconomic status. Also, another study conducted by Adil & Ismail (39) reported that the majority of patients have insufficient income with low socioeconomic status. A possible explanation for this increase in the number of low socio-economic status people visiting the hospital may be due lack of knowledge in blood sugar control and a lack of healthy diet quality due to high cost, all of which are associated with uncontrolled levels of blood sugar that make people attend hospitals frequently. This explanation is supported by Sharma *et al.,* (36) **,** which found that there was a greater prevalence of uncontrolled levels of blood sugar in low socioeconomic status diabetes patients.

The present results found that more than half of patients (50.8%) with T2DM were obese. These results were similar to the results obtained from a research done by Shiriyedeve *et al.,* (40) which revealed that most of the participants were obese. Another study conducted by Sabea *et al.,* (1) also supported these results. This may be due to the direct correlation between obesity and T2DM. According to a study by Parmar (41) **,** the relationship between obesity and diabetes is of such interdependence that the term 'disability' has been developed. Chronic overconsumption of high-energy foods, lifestyle, genetic composition, and environment all play important roles in adipose tissue function or malfunction. T2DM is characterized by poor fat metabolism, which leads to glucotoxicity. Overconsumption of energy-dense meals causes extra fat deposition and increased insulin resistance.

The results of the study reveal that more than half of patients their duration of disease with T2DM was 1-5 years. These results aligned with the study done in Basra, Southern Iraq Aladhab & Alabbood (32) which revealed that most of patients their duration of disease was less than 5 years. Also, these results were compatible with study done by Lee & Li (42) that found the same results. The samples in this study predominantly included diabetic patients in the early stages of the disease, this may be attributed to the recent advancements in early diabetes detection and increasing health awareness about the need for early detection of chronic diseases, especially among the elderly because older age is associated with chronic diseases and more frequent visits to health care facilities.

In this study, the majority of the patients (76.8 %) with T2DM have first-degree relatives with diabetes. These results agreed with the study findings done by Cederberg *et al.,* (43) which reported that a family history of type 2 diabetes mellitus (T2DM) predisposes individuals to developing the diabetes 30–70% . Another study done by Al-Majidi *et al.,* (28) reported that most patients (79.4 %) have family history of type 2 diabetes mellitus (T2DM) .

In this study, the majority of the patients (86.4 %) with T2DM have high levels of HbA1c (>6.4%).These results are compatible with the study done by Elfaki *et al.,* (27) reported that the most of patients (90.8%) suffer from high levels and uncontrolled of HbA1c .Also, study carried out by Al-Majidi *et al.,* (28) supported this result. There are many reasons for increased HbA1c levels, which may result from bad behaviors such as light physical activity, as shown in this study, or lack of awareness of following nutritional programs and a healthy lifestyle. This explanation is supported by Ofori & Angmorterh (44)**,** which found that there was some behaviors that increase the risk of HbA1c changes, including poor eating habits, being overweight, and physical inactivity .

The results of this research displayed that the level of physical activity in the majority of patients was low. These results aligned with the study done by Shiriyedeve *et al.,* (40) which revealed that most patients practiced light physical activity . Also, other study conducted by Kang *et al.,* (45) found the same result . This may be due to that the majority of subject are housewives, resulting in frequent light physical activity. Another explanation, most diabetics feel weariness, joint discomfort, or neuropathy, restricting moderate or strenuous activity. This explanation supported by Kluding *et al.,* (46) which reported that diabetic peripheral neuropathy (DPN) occurs in more than 50% of people with diabetes and is an important risk factor for reduced physical mobility.

In this study, most patients with T2DM were non-smokers. These results are congruent with the study findings done by Alfaqeeh *et al.,* (47) which found that most the participants with DM were non-smokers. Also, a study by Foster *et al.,* (48) which found that 96.0% of patients with DM were non-smokers. A possible explanation for the increased frequency of non-smokers in diabetics may be due to the loss of the effect of smoking on diabetics, which may reflect the influence of other variables such as physical activity and diet

A very high percentage (99.6%) of diabetics eat three meals a day. These results agreed with the study findings done by Ruhee & Mahomoodally (49) which revealed that most of the diabetic patients actually consumed three meals per day. Furthermore, a study by Aljahdali & Bawazeer (50) which reported that most patients ate their regular three meals per day. A possible explanation for the increased frequency of meals, as three times a day, may be due to the food culture in our societies, which mainly stipulates three meals: breakfast, lunch, and dinner.

More than half of patients suffering from diabetes eat snacks and sugary pastries between meals. This result is in agreement with the study findings done by Heller *et al.,* (51) who informed that most patients with diabetes eat snacks between meals .Another study done by Anguah *et al.,* (52) supported this result .This can explain that diabetes often causes blood sugar variations, which cause hunger and desire for sweet meals (52)**.** Additionally, cultural and lifestyle practices, as well as simple availability to processed foods, encourage frequent intake.

In figure (1), the findings of this study indicate that most patients have inadequate assessment score regarding consumption of healthy food patterns.The results are line with a study in Shiraz, Iran (53) which found the Levels of adherence diet amongst patients with T2DM are not within the not good range. Another study conducted in Riyadh by Aljahdali & Bawazeer (50)**,** this finding confirms the low compliance with the dietary recommendations among T2DM . Explanation for this result may be due to the high consumption of unhealthy carbohydrates especially processed or refined carbohydrate foods (white bread and white rice), with unhealthy consumption of fats.

These results explain that patients with high physical activity have low levels for HbA1c at significantly level <0.001. These results agreed with Gay *et al.,* (54) which found that higher level of physical activity were associated with lower HbA1c. Another recent study by Garcia *et al.,* (55) which reported that High-intensity interval training led to the most significant reduction in HbA1c. This can explain that exercise improves blood glucose levels and reduces glycosylated hemoglobin (HbA1c). Physical aerobic exercise utilizes energy stored in the form of Adenosine Triphosphate (ATP) and helps to burn stored fat in liver and muscles, helping to reduce insulin resistant .Additionally, the process of muscular contraction during a physical workout controls the mechanisms responsible for improving blood glucose levels and increased cell sensitivity to insulin (56)**.**

In this study, patients with T2DM who eat sugary snacks and pastries between meals have high levels for HbA1c. These results are consistent with the study findings done by Yan *et al.,* (57) that revealed on high levels for HbA1c among T2DM patients who eat sugary snacks and pastries between meals .Another study by Maguolo *et al.,* (58) found the same results. This can discuss that these foods induce fast blood glucose rises, overwhelming insulin response and affecting glycaemic control. Snacking also inhibits blood sugar from settling between meals, increasing glycaemic load. Chronic post-meal hyperglycaemia from unhealthy snacking directly corresponds with higher HbA1c, which measures average blood glucose levels over the last two to three months (59)**.**

This study shows a direct positive association between duration of diabetic, and HbA1c. This result is consistent with the study conducted by Wang *et al.,* (60) **,** who showed that disease duration had significant effects on HbA1c management . A similar finding was observed by Lee & Li (42) who reported less optimal glycemic management with increasing disease duration.

The possible explanation of this result is supported by Rorsman & Ashcroft (61) which reported that over time, pancreatic beta-cell activity diminishes, decreasing insulin production and increasing insulin resistance, making blood glucose management harder.

Regarding to BMI and HbA1c , the study showed there was no significant correlation between HbA1c and BMI (P > 0.05).This findings supported by cross-sectional study conducted in Babil, Iraq (62), results shown that glycemic control was not substantially related to BMI.. Also these results compatible with study conducted by Bag *et al.,* (63) (that showed there is no association between BMI and HbA1c in any age-group. The explanation of this result may be due to various factors such as lifestyle, nutrition, exercise, and genetics affect HbA1c levels regardless of BMI. Complexities may explain the absence of a direct link between HbA1c and BMI. This explanation supported by Lin (64) which reported that the relationship between BMI and HbA1c may be complex and multifaceted, particularly in the context of diabetes, where various physiological and lifestyle factors interact to influence blood-sugar control .

The results found there was a negative correlation between HbA1c and the overall food pattern scores. A highly statistically significant relationship between HbA1c and overall food pattern scores suggests that higher healthy food intake is associated with lower HbA1c levels, highlighting the potential role of diet quality in glycemic control. This findings are supported by Micha *et al.,* (65) who found that a higher new cases of type 2 diabetes was associated with a lower eating of dietary fiber, nuts or seeds, yogurt, and whole grains, as well as a higher intake of processed and unprocessed red meat, the foods in height glycemic load, and sugar-sweetened beverages .Moreover , these result are in line with a study conducted by Becerra-Tomás *et al.***,** (66) on Mediterranean diet, which showed that the idea behind the Mediterranean diet is to eat more seafood, wholegrain foods, nuts, fruits, vegetables, and legumes. In people with type 2 diabetes, a Mediterranean diet plays a significant impact in glycemic management and preventing cardiovascular disease by decreasing triglycerides, lowering HbA1c. This explanation is supported by Al-Mssallem & Al-Arifi (27) **,**which reported that following healthy dietary pattern is associated with hemoglobin A1c <7% .

5- Conclusion

1. Type 2 diabetes is increasing among patients in the age group of 40-60 years, females, urban residents, married persons, housewives, illiteracy, and low socioeconomic status.
2. In this study, most of the diabetic patients were obese, overweight, had a family history of diabetes, and had a short duration of the disease.
3. The majority of diabetics suffer from poor blood sugar control with unhealthy behaviors such as physical inactivity and eating sugary snacks and pastries between meals.
4. In general, the concluded that the overall assessment of the dietary patterns was unhealthy among many patients with diabetes mellitus.
5. In this study high HbA1c level is associated with unhealthy behaviors and unhealthy dietary patterns consumption.

References

1. Sabea WS, Hassoun SM, Hussein AA. ASSOCIATION BETWEEN SOCIO-DEMOGRAPHIC, HEALTH CHARACTERISTICS AND TYPE 1, TYPE 2 DIABETIC CASES IN GOVERNORATE OF BABYLON, IRAQ. Glob J Public Heal Med. 2022;4(1):608–17.
2. Noshad S, Afarideh M, Heidari B, Mechanick JI, Esteghamati A. Diabetes care in Iran: where we stand and where we are headed. Ann Glob Heal. 2015;81(6):839–50.

3. Abdul Basith Khan M, Hashim MJ, King JK, Govender RD, Mustafa H, Al Kaabi J. Epidemiology of type 2 diabetes—global burden of disease and forecasted trends. J Epidemiol Glob Health. 2020;10(1):107–11.

4. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care. 2004;27(5):1047–53.

5. Davies MJ, D'Alessio DA, Fradkin J, Kernan WN, Mathieu C, Mingrone G, et al. Management of hyperglycemia in type 2 diabetes, 2018. A consensus report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). Diabetes Care. 2018;41(12):2669–701.

6. Galicia-Garcia U, Benito-Vicente A, Jebari S, Larrea-Sebal A, Siddiqi H, Uribe KB, et al. Pathophysiology of type 2 diabetes mellitus. Int J Mol Sci. 2020;21(17):6275.

7. Afshin A, Sur PJ, Fay KA, Cornaby L, Ferrara G, Salama JS, et al. Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. Lancet. 2019;393(10184):1958–72.

8. McGovern A, Tippu Z, Hinton W, Munro N, Whyte M, de Lusignan S. Comparison of medication adherence and persistence in type 2 diabetes: A systematic review and meta-analysis. Diabetes, Obes Metab. 2018;20(4):1040–3.

9. Standl E, Khunti K, Hansen TB, Schnell O. The global epidemics of diabetes in the 21st century: Current situation and perspectives. Eur J Prev Cardiol. 2019;26(2_suppl):7–14.

10. Young-Hyman D, de Groot M, Hill-Briggs F, Gonzalez JS, Hood K, Peyrot M. Erratum. Psychosocial Care for People With Diabetes: A Position Statement of the American Diabetes Association. Diabetes Care 2016; 39: 2126–2140. Diabetes Care. 2017;40(2):287.

11. Forouhi NG, Misra A, Mohan V, Taylor R, Yancy W. Dietary and nutritional approaches for prevention and management of type 2 diabetes. Bmj. 2018;361.

12. Zaccardi F, Webb DR, Yates T, Davies MJ. Pathophysiology of type 1 and type 2 diabetes mellitus: a 90-year perspective. Postgrad Med J. 2016;92(1084):63–9.

13. Kahan S, Manson JE. Nutrition counseling in clinical practice: how clinicians can do better. Jama. 2017;318(12):1101–2.

14. Dyson PA, Twenefour D, Breen C, Duncan A, Elvin E, Goff L, et al. Diabetes UK evidence-based nutrition guidelines for the prevention and management of diabetes. Diabet Med. 2018;35(5):541–7.

15. Asif M. The prevention and control the type-2 diabetes by changing lifestyle and dietary pattern. J Educ Health Promot. 2014;3(1):1.

16. Miller V, Yusuf S, Chow CK, Dehghan M, Corsi DJ, Lock K, et al. 28. Miller, V.; Yusuf, S.; Chow, C.K.; Dehghan, M.; Corsi, D.J.; Lock, K.; Popkin, B.; Rangarajan, S.; Khatib, R.; Lear, S.A.; et al. Availability, affordability, and consumption of fruits and vegetables in 18 countries across income levels: Findings from. lancet Glob Heal. 2016;4(10):e695–703.

17. Micha R, Shulkin ML, Penalvo JL, Khatibzadeh S, Singh GM, Rao M, et al. Etiologic effects and optimal intakes of foods and nutrients for risk of cardiovascular diseases and diabetes: systematic reviews and meta-analyses from the Nutrition and Chronic Diseases Expert Group (NutriCoDE). PLoS One. 2017;12(4):e0175149.

18. Schwingshackl L, Hoffmann G, Lampousi AM, Knüppel S, Iqbal K, Schwedhelm C, et al. Food groups and risk of type 2 diabetes mellitus: a systematic review and meta-analysis of prospective studies. Eur J Epidemiol. 2017;32:363–75.

19. Bellou V, Belbasis L, Tzoulaki I, Evangelou E. Risk factors for type 2 diabetes mellitus: an exposure-wide umbrella review of meta-analyses. PLoS One. 2018;13(3):e0194127.

20. Putri RT, Wahyuni Y, Jus' at I. Glycemic load, fiber, magnesium, zinc, physical activity, stress factor and fasting blood glucose level. Darussalam Nutr J. 2021;5(1):1–13.

21. Harrington D, Henson J. Physical activity and exercise in the management of type 2 diabetes: where to start? Pract Diabetes. 2021;38(5):35-40b.

22. Abusaib M, Ahmed M, Nwayyir HA, Alidrisi HA, Al-Abbood M, Al-Bayati A, et al. Iraqi experts consensus on the management of type 2 diabetes/prediabetes in adults. Clin Med Insights Endocrinol Diabetes. 2020;13:1179551420942232.

23. American Diabetes Association. Diagnosis and classification of diabetes mellitus. Diabetes Care. 2011;33(Supplement_1):S62–9.

24. Eyth E, Naik R. Hemoglobin A1c. In: StatPearls [Internet]. StatPearls Publishing; 2023.

25. Kwon YJ, Lee HS, Park JY, Lee JW. Associating intake proportion of carbohydrate, fat, and protein with all-cause mortality in Korean adults. Nutrients. 2020;12(10):3208.

26. Benjamin DJ, Berger JO, Johannesson M, Nosek BA, Wagenmakers EJ, Berk R, et al. Redefine statistical significance. Nat Hum Behav. 2018;2(1):6–10.

27. Al-Mssallem, M., & Al-Arifi S. Dietary Intake and Health Status in Patients with Type 2 Diabetes Mellitus: A Cross-Sectional Study. Appl Sci. 2022;23(1):116–9.

28. Al-Majidi ZAZ, Lami FH, Hakimi S. Proportion and Potential Risk Factors of Poor Glycemic Control among Patients with Type 2 Diabetes Mellitus: Experience of a Tertiary Center in Baghdad, Iraq, 2020. J Fac Med Baghdad. 2024;66(2):209–15.

29. Al Mansour MA. The prevalence and risk factors of type 2 diabetes mellitus (DMT2) in a semi-urban Saudi population. Int J Environ Res Public Health. 2020;17(1):7.

30. Baral J, Karki KB, Thapa P, Timalsina A, Bhandari R, Bhandari R, et al. Adherence to Dietary Recommendation and Its Associated Factors among People with Type 2 Diabetes: A Cross-Sectional Study in Nepal. J Diabetes Res. 2022;2022(1):6136059.

31. Kautzky-Willer A, Harreiter J, Pacini G. however, the most prominent risk factor, which is obesity, is more common in women. Generally, large sex-ratio differences across countries are observed. Diversities in biology, culture, lifestyle, environment, and socioeconomic status impact differences . Endocr Rev. 2016;37(3):278–316.

32. Aladhab RA, Alabbood MH. Adherence of patients with diabetes to a lifestyle advice and management plan in Basra, Southern Iraq. Int J Diabetes Metab. 2019;25(3–4):100–5.

33. Hamoodah ZJ, Hasan IR, Mejbel SA, Ali AT. Hyperlipidemia among Patients with type 2 Diabetes Mellitus in Al-Nasiriya City. J Pharm Negat Results. 2022;993–8.

34. Nasir AM, kamil Ouda M, kamil Ouda M. Study Investigate Covid 19 Complications among Type 2 Diabetes Mellitus Patients. 2023;

35. Elenga-Bongo CL, Bouenizabila E, Mayanda RL, Sida GRB, Ongoth FE, Bugova LA, et al. Diabetes Mellitus and Associated Risk Factors in Urban and Rural Congolese Areas. EAS J Med Surg. 2024;6(12):388–97.

36. Sharma N, Sharma SK, Maheshwari VD, Sharma KK, Gupta R. Association of low educational status with microvascular complications in type 2 diabetes: Jaipur diabetes registry-1. Indian J Endocrinol Metab. 2015;19(5):667–72.

37. Mohamed HA, Makhlouf MM, Zainel AA, Osman SO, Selim N. Association of sociodemographic characteristics and lifestyle with type 2 diabetes mellitus and glycemic control: A cross-sectional study. J Community Med Public Heal. 2021;2:2–10.

38. Ali MY, Begum M, Dipu SS. Prevalence of T2 Diabetes Mellitus (DM) Among the Rural People of Selected villages Of Bangladesh. Community Based Med J. 2015;4(1):22–9.

39. Adil Y, Ismail KH. The Effect of Lifestyle Intervention on Glycemic Control in Type 2 Diabetic Patients. Bahrain Med Bull. 2024;46(1).

40. Shiriyedeve S, Dlungwane TP, Tlou B. Factors associated with physical activity in type 2 diabetes mellitus patients at a public clinic in Gaborone, Botswana, in 2017. African J Prim Heal care Fam Med. 2019;11(1):1–7.

41. Parmar MY. Obesity and Type 2 diabetes mellitus. Integr Obes Diabetes. 2018;4(4):1–2.

42. Lee SF, Li CP. Personality as a predictor of HbA1c level in patients with type 2 diabetes mellitus. Medicine (Baltimore). 2021;100(27):e26590.

43. Cederberg H, Stančáková A, Kuusisto J, Laakso M, Smith U. Family history of type 2 diabetes increases the risk of both obesity and its complications: is type 2 diabetes a disease of inappropriate lipid storage? J Intern Med. 2015;277(5):540–51.

44. Ofori EK, Angmorterh SK. Relationship between physical activity, body mass index (BMI) and lipid profile of students in Ghana. Pan Afr Med J. 2019;33(1).

45. Kang N, Liu X, Liao W, Tu R, Sang S, Zhai Z, et al. Health-related quality of life among rural adults with type 2 diabetes mellitus: A cross-sectional study. Eur J Public Health. 2021;31(3):547–53.

46. Kluding PM, Bareiss SK, Hastings M, Marcus RL, Sinacore DR, Mueller MJ. Physical training and activity in people with diabetic peripheral neuropathy: paradigm shift. Phys Ther. 2017;97(1):31–43.

47. Alfaqeeh M, Alfian SD, Abdulah R. Factors associated with diabetes mellitus among adults: Findings from the Indonesian Family Life Survey-5. Endocr Metab Sci. 2024;14:100161.

48. Foster T, Mowatt L, Mullings J. Knowledge, beliefs and practices of patients with diabetic retinopathy at the University Hospital of the West Indies, Jamaica. J Community Health. 2016;41:584–92.

49. Ruhee D, Mahomoodally F. Relationship between family meal frequency and individual dietary intake among diabetic patients. J Diabetes Metab Disord. 2015;14:1–13.

50. Aljahdali AA, Bawazeer NM. Dietary patterns among Saudis with type 2 diabetes mellitus in Riyadh: A cross-sectional study. PLoS One. 2022;17(5):e0267977.

51. Heller T, Kloos C, Keßler D, Müller N, Thierbach R, Wolf G, et al. Use of snacks in insulin-treated people with diabetes mellitus and association with HbA1c, weight and quality of life: a cross sectional study. Diabet Med. 2015;32(3):353–8.

52. Anguah KOB, Syed-Abdul MM, Hu Q, Jacome-Sosa M, Heimowitz C, Cox V, et al. Changes in food cravings and eating behavior after a dietary carbohydrate restriction intervention trial. Nutrients. 2019;12(1):52.

53. Mirahmadizadeh A, Khorshidsavar H, Seif M, Sharifi MH. Adherence to medication, diet and physical activity and the associated factors amongst patients with type 2 diabetes. Diabetes Ther. 2020;11:479–94.

54. Gay JL, Buchner DM, Schmidt MD. Dose–response association of physical activity with HbA1c: Intensity and bout length. Prev Med (Baltim). 2016;86:58–63.

55. Garcia SP, Cureau FV, de Quadros Iorra F, Bottino LG, Monteiro LERC, Leivas G, et al. Effects of exercise training and physical activity advice on HbA1c in people with type 2 diabetes: A network meta-analysis of randomized controlled trials. Diabetes Res Clin Pract. 2025;112027.

56. Singh B, Koneru YC, Zimmerman H, Kanagala SG, Milne I, Sethi A, et al. A step in the right direction: exploring the effects of aerobic exercise on HbA1c reduction. Egypt J Intern Med. 2023;35(1):58.

57. Yan MR, Parsons A, Whalley GA, Rush EC. Effects of a healthier snack on snacking habits and glycated Hb (HbA1c): a 6-week intervention study. Br J Nutr. 2016;116(12):2169–74.

58. Maguolo A, Mazzuca G, Smart CE, Maffeis C. Postprandial glucose metabolism in children and adolescents with type 1 diabetes mellitus: potential targets for improvement. Eur J Clin Nutr. 2024;78(2):79–86.

59. Vlachos D, Malisova S, Lindberg FA, Karaniki G. Glycemic index (GI) or glycemic load (GL) and dietary interventions for optimizing postprandial hyperglycemia in patients with T2 diabetes: A review. Nutrients. 2020;12(6):1561.

60. Wang YC, Wang C, Shih PW, Tang PL. Analysis of the relationship between lifestyle habits and glycosylated hemoglobin control based on data from a health management plan. Nutr Res Pract. 2020;14(3):218–29.

61. Rorsman P, Ashcroft FM. Pancreatic β-cell electrical activity and insulin secretion: of mice and men. Physiol Rev. 2018;98(1):117–214.

62. Al-Bayati HF, Al-Diwan JK. Dietary pattern assessment and body composition analysis of adult patients with type 2 diabetes mellitus attending diabetes and endocrine center in Mirjan Teaching Hospital, Babil/2021. Med J Babylon. 2022;19(2):250–7.

63. Bag N, Das I, Waliullah M, Manna D, Chatterjee S. Study of Association between BMI and HbA1c Level in Newly-Diagnosed Type-2-Diabetes-Mellitus Patients. SVU-InteStudy Assoc between BMI HbA1c Lev Newly-Diagnosed Type-2-Diabetes-Mellitus Patientsrnational J Med Sci. 2023;6(2):1–9.

64. Lin W. The Association between Body Mass Index and Glycohemoglobin (HbA1c) in the US Population's Diabetes Status. Int J Environ Res Public Health. 2024;21(5):517.

65. Micha R, Peñalvo JL, Cudhea F, Imamura F, Rehm CD, Mozaffarian D. Association between dietary factors and mortality from heart disease, stroke, and type 2 diabetes in the United States. Jama. 2017;317(9):912–24.

66. Becerra-Tomás N, Blanco Mejía S, Viguiliouk E, Khan T, Kendall CWC, Kahleova H, et al. Mediterranean diet, cardiovascular disease and mortality in diabetes: A systematic review and meta-analysis of prospective cohort studies and randomized clinical trials. Crit Rev Food Sci Nutr. 2020;60(7):1207–27.