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Food Intake Patterns in Controlled vs. Uncontrolled Diabetic Patients in a sample of Egyptian population

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Abstract
***Background**: Type 2 diabetes mellitus (T2DM) has emerged as a major public health and economic burden of the 21st century.*
***Objective**: This observational study aimed to assess dietary carbohydrate intake and examine its association with glycemic control among Egyptian patients with T2DM.*
***Patients and methods**: This was a case-control study conducted at the outpatient clinic of a Family Health Care Center, El-Obour City, Qaliobia, Egypt in the period from the first of April 2022 to the end of June 2023. Data from 90 diabetic participants, consisting of 45 in the controlled group with HbA1c < 7gm/dl and 45 in the uncontrolled group with HbA1c ≥7 gm/dl, were analyzed. Anthropometric measurements and dietary intake including vegetables, fruits, whole grains, fried foods, sweetened beverages, sweets, and pastries along with physical activity levels, were collected through an interview survey..*
***Results**: The uncontrolled group consumed more frequent meals and higher amounts of bread, rice, and macaroni, showing significant differences in carbohydrate intake compared to the controlled group. While there were no significant differences in cooked vegetable, fruit, egg, or milk consumption, the controlled group ate more fresh vegetables and consumed significantly more daily salt. The uncontrolled group had higher fast food and soft drink consumption, but protein intake was similar between the groups*
***Conclusion**: This study's findings indicate that individuals with uncontrolled diabetes don't typically adhere to a healthy diet, and their levels of physical activity may not be sufficient.*
***Key words**: Carbohydrate; T2DM; dietary pattern; food intake.*

INTRODUCTION

Type 2 diabetes mellitus (T2DM) has emerged as a major public health and economic burden of the 21st century **(1)**. According to the International Diabetes Federation (IDF), more than half a billion people are living with diabetes worldwide, 90% of whom have T2DM **(2)**. By 2045, the IDF projects there will be an estimated 108 million diabetic patients in the Middle East and North Africa (MENA) region **(3).** Regarding the epidemiology of DM in Egypt, the IDF reports that Egypt has the tenth-highest prevalence of DM in the world **(2)**, with 10.930.700 adult diabetes patients in early 2021 and a prevalence of 18.4 %, which may be an underestimate **(2).**

Nutrition and lifestyle practices are acknowledged as integral components of successful T2DM management plans in improving patients' clinical outcomes and quality of life (4). In the past ten years, there has been a rise in various dietary strategies aimed at aiding individuals with T2DM. These alternative

approaches to national dietary guidelines encompass a range of dietary patterns, such as the Dietary Approaches to Stop Hypertension (DASH), intermittent fasting, low-carbohydrate, low-fat, lowglycemic index, Mediterranean, and plant-based options (5). Healthy dietary practices effectively reduce hemoglobin A1c (HbA1c) levels in T2DM patients and improve glucose tolerance, blood pressure, lipid profile, and the onset of diabetes complications, thus resulting in declining glucose-lowering medication doses. There are, shown to be vital in preventing the progression of prediabetes into T2DM (6).

This study aimed to describe diet pattern and behavior and physical activity from a representative sample of Egyptian adults with T2DM compared to control non-diabetic participants

PATIENTS AND METHODS

This was a case-control conducted at the outpatient clinic of a Family Health Care Center, El-Obour City, Qaliobia, Egypt in the period from the first of April 2022 to the end of June 2023, following approval from the Ethical Committee of Cairo University Hospitals, Cairo, Egypt. All patients provided informed written consent.

Sample size: The sample size was calculated using (open-epi) open-source sample size calculator. Setting type I error (α) at 0.05, and power (1-β) at 0.80 and from a previous study (4). Calculation according to this value produced a sample size of 45 participants in each arm.

Inclusion criteria: All participants were middle-aged adults between 35 and 64 years (5), diabetic patients in the controlled group with HbA1c (<7 mg/dl), and in the uncontrolled group with HbA1c ≥7 mg/dl, on oral hypoglycemic (metformin and/or sulfonylurea), has been diagnosed as diabetic for less than 10 years and BMI (25 to <35).

Exclusion criteria: Pregnant and lactating women, patients on the maximum dose of (metformin and sulfonylurea), decompensated cardiovascular disease, renal disease, and psychiatric problems and history of use of drugs affecting body weight as corticosteroids, those who participated in any special diet program during the previous 6 months and those with a history of bariatric surgery or marked weight changes.

Patient preparation and data collection tools

Preparation of the patient was done in a separate room by explaining the study aims and benefits, obtaining consent, and starting the initial interview. The interview was composed of the following sections: An interview Arabic questionnaire, a detailed history of his/her diabetes, and behavioral and dietary information. BP and anthropometric measures: Weight, height, waist circumference, at one point.

There were 24 questions in all, divided into three major areas of the questionnaire. The questionnaire's first component contained data on demographics, health, and physical activity. Participants with type 2 diabetes had their health status evaluated for diabetes complications. Information about HbA1c was extracted from the patient's medical record.

Participants were asked about their consumption of specific food types and the typical frequency of food consumption throughout the previous week to collect data regarding dietary intake. The study focused on food groups including fruit, meat and alternatives, bread and grains, as well as information on the types of milk or dairy products consumed. Participants chose how frequently they consumed each food group. Additionally, individuals were asked to select the approximate serving size of a particular food type each time they ate.

The final component of the questionnaire evaluated the individuals' dietary habits, including their intake of fried meals, sweetened juices, soft drinks, sweets, pastries, and fat.

There are other queries on preparing lean meat, cooking chicken without the skin, eating whole wheat bread, using artificial sweeteners to replace sugar, and ingesting saturated or unsaturated fats like olive oil.

Anthropometric measures:

- Weight, height, and waist circumference measurement were measured at one point.
- Height and weight: were measured with subjects in light clothes and without shoes using standard apparatus.
- Weight was measured to the nearest 0.1 kg on a calibrated beam scale.
- Height was measured to the nearest 0.5 cm with a measuring tape.
- Body mass index (BMI) was calculated as weight (in kilograms) divided by height (in meters squared).
- Waist circumference (WC): was measured midway between the lower rib margin and the iliac crest at the end of a gentle expiration.
- WC was measured to the nearest 0.5 cm with a measuring tape.

Ethical consideration

The study protocol was approved by the scientific and ethical committee at the Faculty of Medicine – Cairo University. Written consent was obtained from the patients at the FHC center after an explanation of the study's aim and its benefits to them. In the illiterate patients, informed oral consent was taken after a full explanation of the nature of the study, benefits, and possible harm followed by a written signature from a witness relative that the patient agreed to be involved in this procedure was based on the WHO Research Ethics Review Committee report on obtaining informed consent (Research Ethics Review Committee WHO ERC., 2007)Participation was voluntary and the participant had the right to discontinue the study at any time.

Statistical analysis of data

The study used SPSS version 21 for data analysis, summarizing qualitative and quantitative variables using number and percentage. Comparisons were made using chi-square or Fisher exact tests for qualitative variables. Independent and dependent comparisons were made using t-tests, Mann-Whitney tests, and repeated measurement ANOVA for normally distributed variables. Correlations were conducted to test for relations between quantitative variables. Results were interpreted with P-values less than 0.05 for significance **(7).**

Results

Table (1): Basic Socio-demographic characteristics and lifestyle of the studied population

Socio-demographic character		Groups				p. value
		Controlled (total N =45)		Uncontrolled (total N =45)		
		No	%	No	%	
Gender	Male	17	37.8%	19	42.2%	0.667
	Female	28	62.2%	26	57.8%	
Smoking	yes	37	82.2%	35	77.8%	0.598
	No	8	17.8%	10	22.2%	
Physical activity	Yes	14	31.1%	18	40.0%	0.378
	No	31	68.9%	27	60.0%	
Age	Mean ±SD	53 ± 8		50.2 ± 7.8		0.080

*SES: Socioeconomic status

Both groups were age and sex-matched, where females represented 62 % & 57.8 % of the LCD and IOH groups respectively. The mean age of patients in the LCD group was 53 ± 8 years. No significant difference was noted between both groups as regards smoking percentage and physical activity as shown in Table (1).

Table 2: The number of main meals and snacks the studied population consumes.

Number & type of meals		Group				P. value
		Controlled (N =45)		Uncontrolled (N =45)		
		N	%	N	%	
Number of the main meals/day	one meal	1	2.2	1	2.2	0.566
	two meals	25	55.6%	20	44.5%	
	3 meals	19	42.2%	24	53.3%	
Number of the snacks /day	None	9	20.0%	20	44.4%	0.052
	one snack	19	42.2%	14	31.1%	
	two snacks	17	37.8%	10	22.2%	
	3 snacks	0	0.0%	1	2.2%	

Main meals: breakfast, lunch and dinner.

Table 2 reveals meal and snack consumption patterns between controlled and uncontrolled groups. The uncontrolled group consumed more frequent meals, with 53.3% eating three main meals, while 55.6% of the controlled group consumed two meals daily. The controlled group consumed more snacks, but these differences are not statistically significant.

Table 3: The frequency of carbohydrate intake by the studied population.

Carbohydrates		Group				P. value
		Controlled (N =45)		Uncontrolled (N =45)		
		N	%	N	%	
Bread/day	None	1	2.2%	0	0.0%	<0.001
	¼	1	2.2%	0	0.0%	
	one bread	37	82.2%	7	15.6%	
	more than one	6	13.3%	38	84.4%	
Rice/macaroni/day	None	14	31.1%	0	0.0%	0.021
	1/2 cup	24	53.3%	18	40.0%	
	Cup	7	15.6%	26	57.8%	
	2 cups	0	0.0%	1	2.2%	

Table 3 illustrates the carbohydrate intake of both the controlled and uncontrolled groups. The uncontrolled group demonstrates a higher daily consumption of bread, rice, and macaroni, with 84.4% consuming more than one piece of bread daily and 57.8% consuming at least one cup of rice or macaroni. There is a highly significant difference between the two groups, indicating varying levels of dietary carbohydrate intake.

Table 4: The frequency of fruit and vegetable intake by the studied population.

Frequency of fruit and vegetable intake		Group				P. value
		Controlled (N =45)		Uncontrolled (N =45)		
		N	%	N	%	
Fresh veg/day	None	4	8.9%	28	62.2%	<0.001
	one serving	19	42.2%	6	13.3%	
	2 servings	20	44.4%	10	22.2%	
	3 servings	2	4.4%	1	2.2%	
Cooked veg/day	None	0	0.0%	4	8.9%	0.135
	one serving	39	86.7%	38	84.4%	
	2 servings	5	11.1%	3	6.7%	
	3 servings	1	2.2%	0	0.0%	
Fresh fruit/day	None	3	6.7%	7	15.6%	0.324
	one serving	23	51.1%	26	57.8%	
	2 servings	18	40.0%	11	24.4%	
	3 servings	1	2.2%	1	2.2%	

Table (4) shows that there was an insignificant difference between the controlled and uncontrolled groups as regards the daily consumption of cooked vegetables as well as the daily consumption of fruits. However, the controlled group consumes more fresh vegetables with significant difference between both groups.

Table 5: The frequency of beans, milk, and egg intake by the studied population.

beans, milk, and egg intake		Group				P. value
		Controlled (N =45)		Uncontrolled (N =45)		
		N	%	N	%	
Beans /wk	None	2	4.4%	4	8.9%	0.134
	1-3	18	40.0%	27	60.0%	
	4-7	18	40.0%	10	22.2%	
	> 7	7	15.6%	4	8.9%	
Cups of milk or yogurt/wk	None	12	26.7%	10	22.2%	0.060
	1-3	15	33.3%	24	53.3%	
	4-7	13	28.9%	11	24.4%	
	> 7	5	11.1%	0	0.0%	
Egg/wk	None	9	20.0%	9	20.0%	0.744
	1-3	23	51.1%	26	57.8%	
	4-7	10	22.2 %	9	20.0%	
	> 7	3	6.7%	1	2.2 %	

Table 5 compares bean, milk, and egg intake between the controlled and uncontrolled group. Both groups have similar egg consumption patterns, but no significant differences were found. The uncontrolled group had a higher milk/yogurt intake but no more than seven cups, and controlled group had a higher bean consumption.

Table 6: The frequency of fast food, soft drinks intake, and added salt by the studied population.

fast food, soft drinks, and salt intake		Group				P. value
		Controlled (N =45)		Uncontrolled (N =45)		
		N	%	N	%	
Fast food /week	None	38	84.4%	11	24.4%	<0.001
	1-3	7	15.6%	34	75.6%	
Soft drinks /week	None	28	62.2%	15	33.3%	<0.001
	1-3	14	31.1%	30	66.7%	
	4-7	3	6.7%	0	0.0%	
Salt	None	0	0.0%	2	4.4%	0.033
	Seldom	22	48.9%	23	51.1%	
	Sometimes	14	31.1%	19	42.2%	
	Usually	8	17.8%	1	2.2%	
	Always	1	2.2%	0	0.0%	

Table 6 shows that the uncontrolled group consumes more fast food and soft drinks than the controlled group. However, the controlled group consumes more daily salt with significant difference between both groups.

Table 7: The frequency of chicken, meat, and fish intake by the studied population.

Frequency of chicken, meat, and fish intake		Group				P. value
		LCD (N =45)		IOH (N =45)		
		N	%	N	%	
chicken, meat/ week	None	2	4.5%	2	4.5%	0.912
	1-3	35	79.5%	37	82.2%	
	4-7	7	15.9%	6	13.3%	
Fish/ month	None	16	35.6%	18	40.0%	0.272
	1-3	19	42.2%	22	48.9%	
	4-7	10	22.2%	4	8.9%	
	> 7	0	0.0%	1	2.2%	

As shown in Table 7, there is no difference between both groups as regards protein consumption

Discussion

Many health problems are caused by dietary changes in the type of carbohydrates consumed. This study's primary goal was to find out how carbohydrates relate to HbA1c in T2DM. We obtained data from 90 patients with T2DM who were classified into two equal groups (controlled and uncontrolled) as regards their HbA1c. The HbA1c was found to be positively connected with dietary intake of carbohydrates.

In our study, the mean age of the study population was 53±8 years. In a cross-sectional study by Sarmento et al. that was conducted on 197 adults with T2DM, the mean age was 62.5 ± 9.1 years **(8)**. In another study by Al-Mssallem et al. conducted on 404 patients, the mean age was 55.27 ± 9.66 years **(9)**. The mean age of participants in studies related to T2DM tends to be similar due to the high prevalence of T2DM in older individuals **(10).**

In this study, it was found that 62% of the participants were female. Similarly, a study conducted by Sarmento et al. in Brazil reported that 63.5% of its participants were female **(8)**. The high proportion of females in our study, which is comparable to relatively high percentages in other studies **(8,9)**, may be attributed to the fact that females are more likely to utilize primary health care facilities and attend follow-up appointments.

Carbohydrates are considered to have the biggest impact on blood glucose levels. Nevertheless, there is currently no universally accepted data regarding the optimal carbohydrate consumption for diabetics **(10)**. In fact, in the present study, the carbohydrate consumption was different between the controlled and uncontrolled group. The association between healthy eating pattern and glycemic control could be better explained by the quality of carbohydrate intake than the amount of this macronutrient. In agreement with this, we demonstrated a higher consumption of whole carbohydrates, fruits, and vegetables in the controlled patients. As a consequence, these patients consumed diets with a lower glycemic index and glycemic load values as compared with patients in the uncontrolled group. Currently, diets with a low glycemic index have been associated with improved glycemic control **(4).**

In this study, there were no differences between both groups regarding the physical activity level and smoking. The epidemiological study with Japanese individuals, which also found an association between the adherence to a 'healthy' pattern and lower incidence of diabetes, emphasized that the diet significantly improves glucose metabolism when combined with a healthy lifestyle, such as the practice of physical activities, and the regular consumption of the dietary pattern **(11)**.

The lower consumption of salt by the uncontrolled group can explain the lower number of patients maintained on antihypertensive medications in this group. Although it is recommended to adhere to a diet rich in vegetables and other protective foods for diabetes, the greater adherence to the traditional Egyptian pattern may have been influenced by the socioeconomic status of the individuals, since this food contain an excess of carbohydrates and fats, and it is less expensive when compared to the so-called healthy pattern.

A study in an Eastern Chinese cohort with a sample of type 2 diabetic individuals or those who presented altered fasting glycemia found an association only between the so-called pattern 'rich in vegetables' with diabetes and glycemic control. Thus, those who adhered to this dietary pattern presented improved fasting glucose control and lower risk of diabetes **(12)**

Limitations

Using the 24-hour food recall approach to study consumption may cause patients to overestimate or underestimate their intake, as well as be biased memory. The lack of a precise estimation of sodium intake was one potential limitation of our research. Rather of using 24-hour urine sodium measurements, which provide a more reliable assessment of salt intake **(13)**, we used the intrinsic sodium of foods obtained from a table **(14)**.

Conclusion

Patients with type 2 diabetes who follow a healthy eating pattern which includes consuming whole carbs, dairy products, white meat, fish, fruits, and vegetables frequently—have lower HbA1c.

Recommendation

Patients should be advised to reduce their daily intake of carbohydrates to maintain their consumption within the recommended daily intake range.

Acknowledgment

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Statements and declarations

Ethical considerations: This study was approved by the research ethical committee at the Faculty of Medicine – Cairo University. (Approval no. 40-2022) on 03-27- 2022.

Consent to participate: the participants provided written informed consent. In the illiterate participants, informed oral consent was taken after a full explanation of the nature of the study, benefits, and possible harm followed by a written signature from a witness relative that the patient agreed to be involved in this study.
Consent for publication: informed consent for publication was provided by the participants

Declaration of conflicting interest: The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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Availability of data and material: available upon request

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