

# Study of the Relationship between Dietary Pattern with Glycemic Control Among Type 2 Diabetic Patients in Damascus Hospital and Specialist Polyclinic Services in Syria

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## Systematic Review

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## Abstract

## Background

Dietary habits have an integral role in glycemic control. Where uncontrolled glucose levels can have an impact on almost every organ in the patients' bodies. In this study, the target fasting blood glucose is set to be 70–180 mg/dl in accordance with the American Diabetes Association which recommends keeping this value to more than 16 hours and 48 minutes a day.

## Objective

Intending to explore the food frequency consumption and its association with poor glycemic control among type 2 diabetic patients in Syria.

## Methods

In this cross-sectional study, data on the dietary pattern of 104 patients with type two diabetes were collected by trained interviewers in two diabetic clinics in Damascus, Syria. Dietary information was obtained by a quantitative food frequency questionnaire. Overall diet quality was evaluated. Glycemic control was assessed by fasting plasma glucose.

## Results

the general dietary habits demonstrate that 55.8% of the patients recorded fasting Blood Glucose of 70–180 mg/dl, 21.1% recorded 181–250 mg/dl, and 23.1% recorded above 250 mg/dl. None of the food items studied in this research recorded a statistical significance excepts for excess amounts of white sugar, and consuming fast food weekly which were associated with poor glycemic control.

## Conclusion

Consuming fast food weekly, and using 6–7 tablespoons or more of sugar a day could possibly serve as an independent predictor of poor glycemic control. Furthermore, distributing the total food intake in a day into multiple meals and eating less amounts of rice and creamed cheese were recognized to record better glycemic values, however, these results were not statistically significant.

## Introduction

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by hyperglycemia caused by insufficient insulin secretion or impaired insulin action <sup>(1)</sup>. Type 2 diabetes (T2D) is considered one of the most common diseases <sup>(2)</sup>. The usual symptoms are polyuria, polydipsia, polyphagia, weight loss, vision changes, and fatigue <sup>1</sup>. International Diabetes Federation has demonstrated the Middle East and North Africa (MENA) region has the uppermost regional spread of diabetes at (16.2%) and is estimated to have a rise of (86%) in the number of diabetic patients reaching 136 million by 2045 <sup>(3)</sup>. In Syria, statistical estimation showed that T2D is estimated to have doubled between 2003 and 2022 (from 10–21%), and by 2022 approximately one-fifth of the Syrian population, aged 25 years and older, will have T2D <sup>(4)</sup>. This global epidemic is due to multiple factors. One of them being the unhealthy dietary pattern which is reasoned by numerous circumstances surrounding the patients. Social, environmental, economic, and political conditions are all forming barriers against the healthy dietary pattern and good glycemic control <sup>(5)</sup>. Moreover, a study done on Syrian diabetic women stated; inadequate education, psychosocial issues, and poor patient-doctor relationship were all burdens against glycemic control <sup>(6)</sup>. American Diabetes Association (ADA) has set the target glucose range named Time in Range (TIR) to be 70–180 mg/dl, 70% of the day (16h 48min) <sup>(5)</sup>. Committing to the suggested glucose range is a necessity because uncontrolled glucose levels can take a toll on almost every organ in the patients' bodies <sup>(7)</sup>. Individuals with T2D are at a high risk of developing a range of debilitating complications such as microvascular complications (retinopathy, nephropathy, neuropathy) and macrovascular complications (ischemic heart disease, peripheral vascular disease, cerebrovascular disease); consequently, these complexities may trigger early death <sup>(8)</sup>. Studies proved that following healthy dietary patterns lowers the risk of developing diabetic complications <sup>(9)</sup>. ADA emphasized there isn't a specific diabetic dietary pattern, nevertheless, they recommended the Diabetes Plate Method (DPM) for a better and healthier diet <sup>(10)(11)</sup>. DPM includes boosting half of the plate with non-starchy vegetables which are high in fibers, minerals, and low in carbohydrates; portioning a quarter of the plate with lean protein foods which have less saturated fat; reducing the carbohydrate foods to one quarter; selecting a low-calorie drink <sup>(11)</sup>. Since studies done on T2D patients in Syria are exceptionally meager, we conducted this research to examine the relation between T2D patients' dietary pattern and their glycemic control.

## Methods

### 2.1. Study design and materials:

This observational cross-sectional study included Syrian patients visiting the diabetic clinics both in Damascus hospital and Specialist Polyclinic Services in Damascus, Syria, from October 2021 until February 2022. The purpose and the nature of the research were explained to all participants and were assured of the confidentiality of the information. During the study period, no economic benefit or other incentives were offered.

## 2.2. Subjects:

This study was done on a number of 104 participants who met the inclusion criteria. Most of the patients were of low or median income, as most of the women were housewives and most of the men were farmers or retired employees. Eligible participants were men and women with T2D, aged 40 years and above. Patients were excluded if they are aged below 40 years old, and older than 75 years old; creatinine or BUN levels were above reference values; chronic diseases, autoimmune diseases, or malignancies existed; set on corticosteroids; reported being pregnant; missing data or incomplete lab results.

## 2.3. Data collection tool:

A one-on-one interview that lasted approximately 15 minutes was conducted with each participant. Studying the diet details was done using the Food frequency questionnaires (FFQ) tool which is an assessment method used widely in nutritional epidemiological researches to examine the correlation between food consumption and the different health outcomes including the glycemic blood levels<sup>(12)(13)</sup>. The previously constructed FFQ, which was validated by a panel composed of researchers and nutrition instructors in Lebanon, was adopted with a few adjustments which correspond to the local economic and social conditions. Data was filled by the researchers on an electronic form supervised by a specialist physician. Based on the study objective, the data collection questionnaire was divided into three parts. The first part included personal information, past medical history, diabetic history, self-glucose monitoring, and lab results. In the second part, we asked about the general diet habits, including the extent of diet regulation, the number and time of main meals and snacks, and the most eaten items. Lastly, we invested through 12 food groups.

## 2.4. Statistical analysis:

Data was evaluated using Statistical Package for the Social Sciences (SPSS) (version 25), descriptive analysis (frequencies and percentages) was done on the variables, Chi-square tests were executed in cross-tabulation where the relationship between FBG and multiple categorical variables were examined, and a p-value less than 0.05 was set to be statistically significant. The sample was divided into three groups according to the Fasting Blood Glucose (FBG) and TIR mentioned by ADA. Continuous Glucose Monitoring technique wasn't used with TIR, nevertheless depending on the patients fasting for more than 8 hours prior to the FBG result, patients with FBG range 70-180 mg/dl were set into a group; FBG range 181-250 mg/dl as the second group; FBG range 250 < as the third group.

## Results

Females constituted 63.4% of the participants, while males were only 36.5%. Regarding the age groups, the 51–60 group was the most prevalent with a rate of 40.4%, followed by 39.4% of the 61–70 group, whereas the 71–75 group was the least prevalent. The patient's Body Mass Index data was not complete. About two-thirds of the sample were smokers, and 52.8% of the total patients were exercising daily. We asked about hypertension, high blood cholesterol levels, and vascular disorders in reference to medical history; however, the data was incomplete. As for the diabetic history, questions included the onset of disease where 40.4% of the participants had the disease for 5–15 years, followed by 1–5 years with a rate of 26%, and 25 years or more with 2.9% as the less prevalent percentage. The medications were not questioned; self-glucose monitoring (SGM) data was not used in this study because more than half of the patients did not own the SGM device, and 89.4% of those of owned it were not using it daily. Data used in the lab results were only the FBG, where 55.8% of the patients recorded 70–180 mg/dl, 21.1% recorded 181–250 mg/dl, and 23.1% recorded 250 < mg/dl. HbA1c readings were not complete for all the individuals. As for the renal lab, results were checked before proceeding with the patients, as mentioned previously. In the general diet questions, 5.7% of the patients consume one meal per day; 67.3% consume two meals per day where 57.1% of that percentage recorded an FBG of 70–180 mg/dl; 25.9% of the patients consume three meals per day where 55.6% of the patients that consumed three meals per day recorded 70–180 mg/d, however these results were not statistically significant *Table 1 Table 2*. Moreover, 60% of the patients were punctual in their meals timings; nevertheless, their FBG was approximate to those who were not punctual, and the majority had an FBG of 70–180 mg/dl *Table 3*. Diving further into the meals and food ratio, for breakfast, 67.3% of the patients consume olives, 61.5% consume Labneh, 37.5% consume Makdous, and 6.7% consume beans and Falafel. As for the FBG, beans were associated with a lower sugar rate than the rest of the items, where 83.3% had an FBG of 180 – 70 mg/dl *Table 4*. As for lunch, cooking, especially vegetables, made up the majority with a percentage of 89.4%, followed by rice with a percentage of 16.3%. Concluding with dinner, vegetables were the most consumed item with a percentage of 15.4%, followed by Labneh with a 12.5%, and cheese with a 3.8% making it the least consumed. Moving onto the snacks, 86% of the sample confirmed to having daily snacks, where the category divides into fragments in the situation that 46% of them chose apple as their snack, 31% as orange, and 21% as biscuits. Regarding the food groups and starting with bread, 93.2% of the patients consumed traditional white bread daily, and subdivisions of that percentage document that 53.8% of them recorded FBG of 70–180 mg/dl. Only 8.6% and 5.7% of the sample had bran bread and brown bread, respectively, on a daily basis. Regarding the rice, pasta, and legumes, three-quarters of the participants ate rice weekly, and nearly half of the patients ate pasta monthly. As for Freekeh (green durum wheat), most of the sample did not eat it, and about 70% of the sample ate bulgur weekly; by moving to the FBG records, most of those who ate rice monthly, recorded greater rates at an FBG of 70–180 mg/dl. As for the Freekeh, individuals who ate it weekly recorded 100% FBG of 181–250 mg/dl. As for bulgur, 66.7% of the patients who ate it daily recorded FBG 250 < mg/dl. Regarding the number of rice servings, there was a tendency for higher FBG reading as the number of servings per meal increased (1 serving = 1 meal plate = 10–15 tablespoons) *Table 5*. Moving onto milk and dairy products, most of the participants, 54.8%, drank milk intermittently, and 36.5% did not consume it at all, where both recorded FBG of 70–180 mg/dl with a similar rate and it was 57.9%. As for white cheese, 26% of the sample ate it daily; regarding the FBG reading, 40.7% of patients that ate it daily, recorded 70–180 mg/dl. The majority of the participants did not consume creamed cheese and other types of cheese, and that consisted of 73.2%; nevertheless, individuals who consumed more than three tablespoons of creamed cheese recorded an FBG of 250 < mg/dl. 49.5% of the sample consumed yogurt daily and 56.9% of them recorded an FBG of 70–180. Most of the sample ate Labneh on a daily basis which resulted in a percentage of 58.7% where 55.7% of them recorded 70–180 mg/dl *Table 6*. Moving on to the fruits and juices, apples were the most consumed fruit accounting for 85.6%, followed by oranges with a 74%. 42.3% of the patients did not consume any type of juice, and most of the non-consumers recorded FBG of 70–180 mg/dl. Regarding vegetables, 86.5% consumed them daily, and the majority of the consumers recorded an FBG of 70–180 mg/dl *Table 7*. As for the types of vegetables eaten, tomatoes scored the highest percentage of

consumers with a 63.5%, followed by cucumbers with a 54.8%, and lettuce came third with a 42.3%. In regards to the meat, which was incorporated through cooking and the serving did not exceed 150 grams, 62.5% of the patients consumed meat weekly where 56.0% of the weekly consumers recorded an FBG of 70–180 mg/dl. Generally speaking, 76.8% of participants who ate meat consumed white meat, and 53.4% of this majority recorded an FBG of 70–180 mg/dl. Furthermore, 23.2% of the patients consumed red meat where most of the red meat consumers recorded an FBG of 70–180 mg/dl. Concerning fast food, individuals who never consume it recorded 62.5%, where the majority of the non-consumers recorded FBG of 70–180 mg/dl. Merely 6.7% of the patients consume fast food weekly which were more likely to record an FBG  $250 < \text{mg/dl}$  with a 71.4% and these results were statistically significant *Table 2*. Regarding the consumed fast food items, Shawarma recorded the highest percentage with 69.2% followed by broasted chicken with 33.3%. On the subject of nuts consumption, which are peanuts, sunflower and melon seeds, 56.7% eat nuts intermittently and more than half of the consumers recorded an FBG of 70–180 mg/dl. Only 7.7% of the individuals ate nuts daily, where the majority of the daily consumers recorded an FBG of 70–180 mg/dl *Table 8*. There was a tendency for high FBG rates as the number of servings of nuts increased (1 serving = 5–6 nuts). For those with an FBG of  $250 < \text{mg/dl}$ , 15.9% of them ate one serving, while 42.9% ate three servings. As for oils, the most used type is sunflower oil with a 88.3% of the participants confirming their usage, followed by olive oil with 9.7%. Moving on to the sugar, 71% of the patients used white sugar, where 55.4%, and 8.1% of the white sugar users, respectively consumed 1–2, and 6–7 teaspoons (1 teaspoon = 4 grams) of sugar per day. There was a tendency for high FBG records as the number of teaspoons of sugar increased, where most of patients who consume 1–2 teaspoons recorded an FBG of 70–180 mg/dl, and the majority of patients who consumed 6–7 teaspoons recorded  $250 < \text{mg/dl}$ , and these findings were statistically significant *Table 9 Table 2*. Furthermore, 84.6% did not use artificial sweeteners at all. Regarding salty snacks, an increased tendency was observed between FBG values and the frequency of consuming chips, where 59.6% of the patients never consumed chips and most of the non-consumers recorded an FBG of 70–180 mg/dl *Table 10*. As for popcorn 63.5% consumed it intermittently. There was no significant difference between the popcorn results.

## Discussion

Dietary habits are considered a cornerstone both in the treatment and management of T2D <sup>(14)</sup>. Therefore, this study focused on assessing the association between dietary patterns and glycemic control among Syrian patients with T2D. This work has many strengths namely, it is the first study in Syria, to our knowledge, to look at the association between eating patterns and glycemic control in type 2 diabetic patients, all interviews were conducted by trained interviewers, which probably minimized the variability in estimating the portions and intakes. Moreover, the FFQ represents the best possible way for the dietary pattern assessment of the Syrian population because the food items list was adapted to the lifestyle of a typical Syrian citizen. The limitations of the study were that it only included patients who visited the diabetic clinic which means this sample does not represent the whole diabetic patients in the Syrian population, hence future studies could expand the sample to cover all of the Syrian society segments; also, the lack of validated nutritional tools in Syria was a major limitation of this study, thus, it is necessary to create culturally specific tools to evaluate food intake. Additionally, the data on different food incomes was fully dependent on what the sample informed us and was simply not monitored. However, this study gives an idea of the dietary preferences of the Syrian type 2 diabetes patients and may help in giving clinical practice recommendations and in designing possible future studies to assess the improvements. Glycemic control is the main strategy to prevent chronic diabetic complications. In this study, 55.8% of the participants were in the aimed FBG level of 70–180 mg/dl which is considered well in accordance with the small size of the sample. On the contrary, according to studies done in the neighbor Arabic countries, Palestine, Saudi Arabia, and Qatar, the percentages of the patients who recorded poor glycemic control were 56.1%, 75.9%, and 57.6% respectively <sup>(15) (16) (17)</sup>. This study found that a greater prevalence of diabetes was among females, which is opposite to other studies that indicated men were more prevalent to develop diabetes <sup>(18)</sup>; this could be owing to a bias in sampling or because of the higher prevalence of obesity among females in the Syrian society <sup>(19)</sup>. Though, the age group most likely to develop diabetes in this study corresponds with a national report by CDC which states ages 45–64 are the most likely to develop diabetes <sup>(20)</sup>. Regarding the number of meals, half of the patients who consumed one meal per day recorded higher FBG values, and more than half of the patients who consumed two or three meals per day recorded lower FBG values. These results are in accordance with a study done in the USA on healthy individuals. They found that individuals who consumed one meal a day recorded higher FBG values compared to those who consumed three meals per day <sup>(21)</sup>. Also in a study done in Czech Republic, found that dividing the food intake into two main meals (breakfast and lunch) had a positive effect on reducing FBG values among patients with T2D <sup>(22)</sup>. Although researchers suggest that T2D patients should strict their meals intake at regular times for better glycemic control, we did not find a significant difference in the FBG values among patients who were punctual to their meals timings and those who were not <sup>(23)</sup>. During the local crisis, there was no ability to purchase brown bread, hence the majority of the sample was consuming traditional white bread (bread that is similar to tortilla bread) which was expected because of the nature of the food in the Syrian population, nevertheless, we did not find a statistical significance between white bread servings and FBG values; however, those who consumed brown bread had a lower FBG and this coincides with the fact that brown bread has lower sugar content than white bread <sup>(24)</sup>. As for the rice, we found that individuals who did not consume it at all recorded higher FBG values than those who did. this might be reasoned by patients replacing the rice which is considered a basic dish in Syrian meals with different items that might have a higher glycemic index than rice. In addition, it is recommended for T2D patients to add bulgur to their diet as it is associated with lower FBG values and better insulin sensitivity <sup>(25)</sup>. However, this study showed that the majority of the patients who consumed bulgur daily recorded high FBG values. This might be owing to the number of bulgur servings that patients intake, the side dishes, or any different dietary habits throughout the day. Numerous studies proved that milk and dairy products consumption helps in T2D management by levels enhancing insulin response and lowering postprandial glucose <sup>(26)</sup>. This thought is to be reasoned by the nutrients contained in the dairy products especially proteins <sup>(26)</sup>. However, the number of the patients who consumed the milk and dairy products daily in our sample was too small because of the prices being high, hence we cannot rely on the results; nevertheless, there was a tendency among the patients who consumed milk intermittently and dairy products weekly to record lower FBG values. Furthermore, we noticed that individuals who consumed more than 3 tablespoons of creamed cheese (contains starch, lactose sugar, and other sugars) had a higher FBG in contrast to the other types of cheese; nevertheless, other research showed that increasing dairy consumption to more than 3 servings per day, irrespective of its fat content, has no effect on the glycemic control <sup>(27)</sup>. Corresponding to the fact that a plant-based diet is an excellent choice in managing glucose levels in T2D patients, we found a tendency for low FBG values among patients who depend more on fruits and vegetables in their regimen <sup>(28)</sup>. As for patients who consumed juices, approximately half of them

recorded low FBG, and the other half recorded high FBG. As stated in a study done in the UAE on healthy individuals, there was no important difference in glucose levels by consuming different types of juices (fresh and sweetened), nevertheless, they found a decline in insulin response <sup>(29)</sup>. Although studies proved that meat consumption results in high FBG values, we found that three-quarters of the patients who consumed meat daily recorded better FBG values <sup>(30)</sup>; however, there was no statistical significance. The study showed increased odds of poor glycemic control on the consumption of fast-food weekly, as  $p < 0.05$ . Similar results have been found in a study done in the UAE, suggesting that consumption of fast-food, once or more, daily was associated with poor glycemic control in T2D patients <sup>(31)</sup>. The observed association was expected, fast food is high in total fat, trans-fatty acids, and sodium, and portion size has increased two to five-fold over the last 50 years <sup>(32)</sup>. As for nuts consumption, the majority of the patients who consumed it daily recorded low FBG values. This result corresponds with a study done in Canada which stated that consuming more nuts than carbohydrates leads to better glycemic control <sup>(33)</sup>. In our study, there was a significant association between the amount of daily white sugar consumption and FBG values. The American Heart Association recommend limiting the amount of total added sugar to a maximum of 6 teaspoons for women and 9 teaspoons for men <sup>(34)</sup>. However, in this sample, individuals who consumed only 1–2 teaspoons of white sugar recorded low FBG values compared to those who consumed 6–7 teaspoons of white sugar who recorded high FBG values. Despite the association detected between the frequency of potato chips consumption and FBG values, there was no statistical significance; nevertheless, researches demonstrate diabetic patients should avoid potato chips and replace them with popcorn or snacks which are low in sugar and salt, and high in fiber and protein <sup>(35)</sup>.

## Conclusion

The current status of T2D patients in Syria demands prompt and sustainable educational conferences and activities to improve patients' education regarding glycemic control and healthy dietary habits. This cross-sectional study found that consuming more teaspoons of white sugar, and eating fast food weekly, possibly serve as an independent predictor for higher FBG values among T2D Syrian patients. In addition, the distributing of the total food intake in a day into more than one meal and consuming less creamed cheese could decrease the odds of high FBG readings. It would be of value to adapt the regional recommendations in light of the information provided in this study. Nevertheless, collected data of the study was self-reported, hence recall bias may be present. Moreover, the study design is a cross-sectional study, therefore, we cannot establish a temporal relationship between exposure and outcome and no inferences should be drawn regarding causality effects. Future studies could allocate efforts to executing controlled trials to prove the causality in this area.

## Declarations

**Disclosure:** The authors report no conflicts of interest in this work

**Ethics:** Our study was approved by the Institutional Review Board (IRB) at the Syrian Private University (SPU), however, we were not given a reference number. Also the study was approved by the Damascus Health Directorate. Written informed consent was obtained from all participants.

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## Tables 1-10

Tables 1-10 are available in the Supplementary Files section.

## Supplementary Files

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