

# Association between Dietary Intake and Glycemic Control among Adults with Type 2 Diabetes Attending a Public Hospital in Karachi, Pakistan

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## ABSTRACT

**Objective:** Dietary management is considered a crucial part of managing diabetes that helps patients achieve effective blood glucose management. This study aimed to identify frequency of food choices and determine its association with glycemic control among people with type 2 diabetes.

**Methodology:** This cross-sectional study was conducted among people with diabetes at the National Institute of Diabetes and Endocrinology, DUHS, in Karachi, Pakistan. Using convenience sampling, 300 people with diabetes were enrolled. Anthropometric measures, HbA1c, and a food frequency questionnaire were used to obtain the participants' dietary patterns.

**Results:** Participants were mostly females (54.5%), and the mean age was 51.66±10. Majority of the participants (78%) had HbA1c levels more than 7%, obesity was highly prevalent among the study participants, with 74% classified as obese according to Asian BMI cut-offs. An additional 14% were overweight, indicating that 88% of the population had excess body weight. Chapati was the most commonly consumed food item, with a mean intake frequency of 9.46 times per week. In the multivariable logistic regression analysis, higher fruit intake was independently associated with lower odds of having HbA1c >7% (OR = 0.865, 95% CI: 0.764-0.979). Similarly, greater consumption of raw fresh vegetable salads was associated with lower odds of having HbA1c >7% (OR = 0.763, 95% CI: 0.681-0.855). Among participants with HbA1c ≤7%, the mean frequency of fruit consumption was 4.61 ± 2.59 times per week, while the mean frequency of salad consumption was 3.27 ± 2.74 times per week.

**Conclusion:** Dietary intake patterns among individuals with type 2 diabetes showed variability across food groups. Higher consumption of fruits and salads was associated with better glycemic control, whereas no significant differences were observed for most other food items. These findings highlight the importance of incorporating nutrition education and ongoing dietary counselling into routine diabetes care to promote healthier dietary practices and support glycemic management.

**KEYWORDS:** Dietary patterns, glycosylated hemoglobin, glycemic control, HbA1c, Pakistan, Type 2 diabetes, food frequency.

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## INTRODUCTION

Diabetes remains a significant global health challenge, with its prevalence steadily rising. According to the International Diabetes Federation Diabetes Atlas (11th edition, 2025), approximately 589 million adults aged 20 to 79 years are living with diabetes, representing roughly 1 in 9 adults worldwide. Nearly 90% of these cases are type 2 diabetes (T2DM).<sup>1</sup>

About 80% of adults with diabetes reside in low and middle income countries, where health care systems are often already overburdened. In this context, the Middle East and North Africa (MENA) region faces a disproportionately high burden, with approximately 85 million people affected, projected to rise to 163 million by 2050. Pakistan, one of the 21 countries in the IDF MENA region, contributes significantly to this burden, highlighting the urgent need for effective diabetes prevention, detection and management strategies.

In Asian countries, the increasing prevalence of type 2 diabetes has been linked to over nutrition, reduced physical activity and rapid socioeconomic transitions.<sup>2</sup>

Strategies to prevent the onset of diabetes and delay its complications include improving glycaemic control, with a target HbA1c level of less than 7%.<sup>3</sup> Achieving this target also relies on lifestyle modifications, including healthy dietary habits, regular physical activity and adherence to prescribed medications. Environmental and genetic factors are the major contributor for the development of type 2 diabetes. Risk factors like age, ethnicity and genetic background are unlikely to be modified. However, lifestyle factors including eating habits, smoking habits and physical activity may be modified. Role of diet is crucial in the onset and progression of diabetes and there is a strong evidence that supports the link.<sup>4</sup>

The Food Frequency Questionnaire (FFQ) is an important and validated tool used in clinical and epidemiological studies to evaluate dietary intake. The FFQ offers a simple, low cost method to assess usual dietary intake over an extended time period.<sup>5</sup>

It allows evaluation of dietary patterns, food groups, and nutrient intake in relation to glycemic control and other metabolic outcomes. FFQs also help identify dietary factors associated with diabetes risk and complications, supporting the development of tailored dietary recommendations and management strategies.<sup>6</sup>

A varied diet based on the five main food groups is associated with reduced health risks. Therefore, nutritional epidemiology increasingly emphasizes the assessment of dietary intake in terms of quantity, proportion, variety, and nutrient composition. This approach provides a more comprehensive reflection of overall diet compared to single-nutrient analysis, as foods are not consumed in isolation. Improvements

in overall diet quality across food groups are linked to better disease prevention outcomes than single-nutrient approaches.<sup>7</sup>

Although the relationship between dietary patterns and glycemic control has been studied globally, evidence from Pakistan remains limited. This study aimed to assess the association between dietary frequency and HbA1c among patients with type 2 diabetes attending a public hospital in Pakistan, with the hypothesis that dietary patterns may influence glycemic control.

## METHODOLOGY

This cross-sectional study was conducted at the National Institute of Diabetes and Endocrinology (NIDE), Outpatient Department (OPD), Dow University of Health Sciences, Karachi, Pakistan, from November 2023 to May 2024. Convenience sampling was used to enroll study participants. A total of 300 patients with type 2 diabetes were recruited, with the sample size calculated using the OpenEpi calculator.

### *Inclusion criteria:*

- Patients diagnosed with type 2 diabetes for a minimum duration of six months.

### *Exclusion criteria:*

- Patients who declined or were unable to provide informed consent
- Patients with type 1 diabetes, gestational diabetes, or secondary diabetes (e.g., steroid-induced or pancreatic disease-related diabetes)
- Patients with serious complication in which dietary choices are restricted.

The study was conducted following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies.<sup>8</sup>

In order to minimize information bias, validated FFQ was used. Participants were encouraged to recall their usual dietary intake to reduce recall bias. To limit selection bias, only eligible type 2 diabetes patients were recruited.

The primary outcome was glycaemic control, assessed by HbA1c levels (<7% considered controlled). The main exposure was dietary intake measured using a validated Food Frequency Questionnaire (FFQ). Potential confounders included age, sex, BMI and diabetes.

Institutional Review Board (IRB) Dow University of Health Sciences approved the study. (Ref: IRB-3257/DUHS/Approval/2023/06). Written informed consent was obtained from all study participants before starting data collection. Information regarding the purpose of the study was provided to the participants and were informed that they could withdraw from the study at any time without penalty. The study was carried out in compliance with ethical guidelines, guaranteeing participant privacy and anonymity.

The sample size was calculated by OpenEpi calculator using a proportion of 17% of glycaemic control (HbA1c < 7%) among Pakistani diabetic patients, 5% margin of error and 95% confidence level.<sup>9</sup> The total sample size came out to be 217, which was extended to 300 patients.

A questionnaire was prepared to find the general characteristics of the study population including socio demographic and anthropometric measurements that includes height and weight to calculate BMI using standardized equipment. HbA1c levels were obtained from participants' recent laboratory reports recorded within the past three months. To assess dietary practices, a validated Food Frequency Questionnaire (FFQ) adapted from previous studies was used to assess participants' dietary patterns over the preceding three months. The FFQ included common food items grouped under cereals, fruits, vegetables, proteins, dairy products, and beverages.<sup>10</sup> This tool is used by researchers because of its cost effectiveness and its convenient use. All of the food items that were taken from earlier studies are included.<sup>11</sup> The purpose of selecting this tool is the feasibility for capturing dietary

intake in a hospital based setting. Although, FFQ is subject to recall bias, this limitation was minimized by using a culturally adapted questionnaire. FFQ frequency responses were converted into weekly intake frequencies according to a previously published and validated FFQ scoring system.<sup>12</sup>

**Data Analysis:** Statistical analyses were performed using Statistical Package for Social Sciences version (SPSS version 26.0). For continuous variables mean and standard deviation were calculated. For Categorical variable, frequency and percentage were calculated. HbA1c was categorized as good glycaemic control (<7%) and poor glycaemic control ( $\geq 7\%$ ) based on ADA guidelines for interpretation. Statistical significance was set at  $P < 0.05$ . Food consumption frequencies were converted into weekly frequencies as more than once per day-10 times per week, once per day-7 times per week, 4 to 5 times per week-4 times per week, 2 to 3 times per week-2 times per week, once per week-1 time per week, and never-0 times per week. Independent Samples t-test was used to determine the significance of mean differences in the frequency of food consumption between the participants considering potential

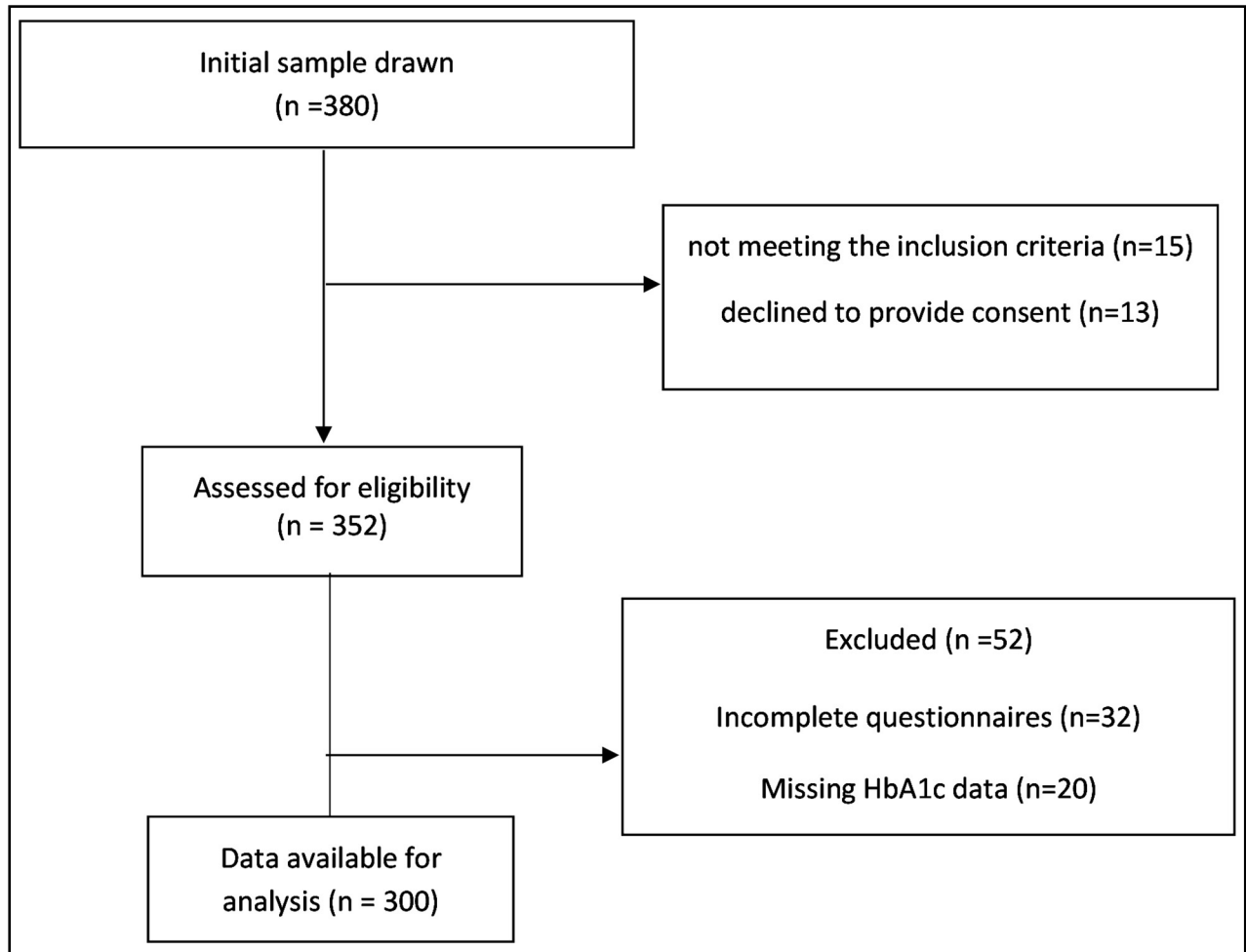


Fig.1. Study flow diagram showing participant recruitment and selection.

confounders such as age, sex, BMI, and duration of diabetes. Multivariate logistic regression analysis was used to determine the association between frequency of food consumption and glycemic control (HbA1c >7% vs ≤7%). Questionnaires with missing data were excluded. No sensitivity analyses were performed.

## RESULTS

A total of 380 individuals with type 2 diabetes were approached for participation. After screening for eligibility, those unwilling to provide consent, with incomplete questionnaires, or not meeting inclusion criteria were excluded. The final sample included 300 participants with complete data and HbA1c records, as illustrated in the study flow diagram. (Fig 1)

Table-I: General characteristics of study participants.

Characteristics	Fre- quency	Standard deviation	Percent- ages
<b>Age</b>			
20-35 years	19	10.413	6.3%
36-50 years	119		39.7%
51 and above	162		54.0%
<b>Gender</b>			
Male	137	0.498	45.7%
Female	163		54.3%
<b>Education</b>			
Uneducated	56	1.167	17.7%
Primary	25		8.3%
Secondary	104		34.7%
Higher	115		38.3%
<b>Employment</b>			
Seat bound worker (office workers, bankers)	42	1.382	14%
Unemployed/retired	65		21.6%
Housewife	136		45.3%
Labors	20		6.7%
Active workers	37		12.3%
<b>Family income (PKR)</b>			
10 - 30k	67	0.61	22.3%
31 - 50k	186		62%
> 50k	47		15.7%

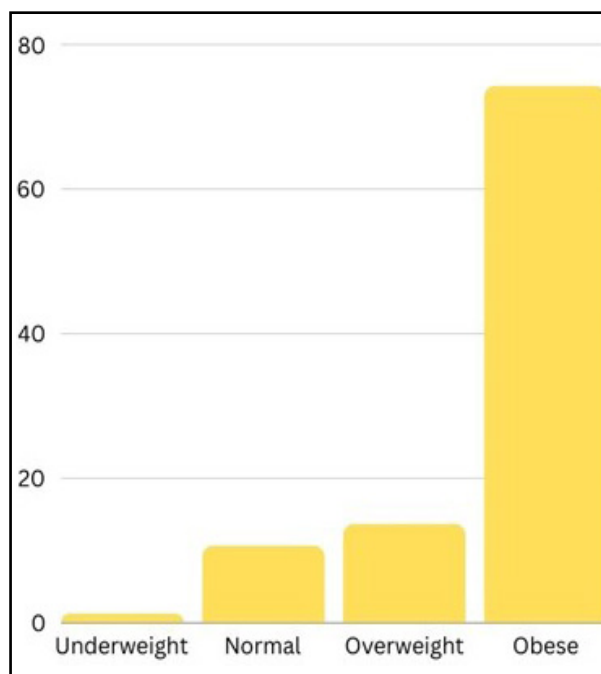


Fig.2: Body mass index distribution of study participants.

More than half were female (54.3%), whereas the mean age was  $51.7 \pm 10$  years. 38.3% of respondents have higher education, while 34.7% had secondary education, 8.3% had primary education and 17.7% were illiterate. 45.3% were housewives. 62% reported their monthly household income ranges from PKR 30,000 to 50,000. (Table-I)

Figure 2 shows a high prevalence of excess body weight among the study participants. Based on Asian BMI cut-offs, 74% of participants were classified as obese and a further 14% as overweight, indicating that nearly nine-tenths (88%) of the study population had excess body weight.

As shown in Fig.3, chapati was the most commonly consumed food item (9.46 times/week), followed by tea or coffee (4.56 times/week), vegetables (4.07 times/week), and fruits (3.98 times/week). The least frequently consumed items were noodles (1.08 times/week), soft drinks (1.15 times/week), and fish (1.20 times/week).

Table-II compares the mean weekly frequency of food consumption according to glycemic control status. Participants with HbA1c ≤7% reported significantly higher consumption of fruits ( $4.61 \pm 2.59$  vs.  $3.80 \pm 2.58$  times/week,  $p = 0.025$ ) and salads ( $3.27 \pm 2.74$  vs.  $2.41 \pm 2.20$  times/week,  $p = 0.008$ ) compared with those with HbA1c >7%. No significant differences were observed for the consumption of wheat chapati, milk tea, rice, biscuits, dairy products, lentils, red meat, bakery items, nuts, fried items, fruit juices, fish, soft drinks, or noodles (all  $p > 0.05$ ). Although participants with HbA1c ≤7% tended to consume vegetables and

Table-II: frequency of food consumption according to glycemic control.

Food Item	HbA1c ≤ 7% (n = 66)	HbA1c > 7% (n = 234)	p-value
Wheat Chapati	9.61 ± 1.66	9.42 ± 1.64	0.426
Milk tea	4.75 ± 2.87	4.52 ± 2.44	0.95
Cooked Vegetables	4.52 ± 2.16	3.94 ± 2.24	0.061
Fruits	4.61 ± 2.59	3.80 ± 2.58	0.025*
Rice	2.88 ± 2.25	2.91 ± 2.26	0.92
Biscuits	2.30 ± 2.05	2.76 ± 2.35	0.157
Salads	3.27 ± 2.74	2.41 ± 2.20	0.008*
Bread	2.95 ± 2.57	2.35 ± 2.33	0.07
Dairy Products	2.20 ± 1.26	2.23 ± 1.32	0.845
Lentils	2.33 ± 1.60	2.13 ± 1.37	0.23
Chicken	1.86 ± 1.23	2.22 ± 1.56	0.061
Red Meat	1.52 ± 0.79	1.70 ± 1.20	0.139
Bakery Items	1.47 ± 1.35	1.71 ± 1.74	0.236
Nuts	1.91 ± 2.08	1.58 ± 1.59	0.17
Fried Items	1.45 ± 1.35	1.43 ± 1.17	0.892
Desserts	1.15 ± 0.77	1.38 ± 1.18	0.063
Fruit Juices	1.17 ± 0.83	1.30 ± 1.16	0.286
Fish	1.18 ± 0.78	1.20 ± 0.79	0.86
Soft Drinks	1.14 ± 0.76	1.16 ± 0.76	0.837
Noodles	1.08 ± 0.40	1.08 ± 0.50	0.928

Values are presented as mean ± SD frequency of consumption (times/week). Group differences between participants with HbA1c ≤7% and HbA1c >7% were assessed using the independent-samples t-test. A p-value <0.05 was considered statistically significant. Statistically significant results are indicated by an asterisk (\*).

bread more frequently and chicken and desserts less frequently, these differences did not reach statistical significance.

Table-III presents the multivariable logistic regression analysis of factors associated with glycemic control. Higher fruit intake (OR = 0.865, 95% CI: 0.764–0.979, p = 0.024) and salad consumption (OR = 0.763, 95% CI: 0.681–0.855, p < 0.001) were independently associated with lower odds of poor glycemic control. Age, gender, BMI, duration of diabetes, and socioeconomic status were not significantly associated with the outcome (all p > 0.05).

## DISCUSSION

This study was conducted to assess the frequency of consumption of different food items over a specified period, as dietary modification that improves glycemic control plays a crucial role in the management of type 2 diabetes.

An HbA1c level of around 7% or lower is commonly recommended by major guidelines, including the American Heart Association, the American Diabetes Association, and the European Society of Cardiology/ European Association for the Study of Diabetes.<sup>13</sup>

Our study found that only 22% of participants achieved good glycemic control (HbA1c < 7%). Poor glycemic control was associated with lower intake of fruits and vegetables, highlighting the potential impact of dietary patterns on glycemic control. Similar patterns have been reported by Elfaki et al. (2023) and Priya et al. (2022), who observed that high consumption of staple foods and low intake of fruits and vegetables are associated with poorer glycemic control, emphasizing the need for culturally tailored dietary interventions.<sup>12,14</sup>

Further more fruits and vegetables optimum intake is important as evidence shows that healthy diet that is low in processed sugars and saturated fats, and rich in fruits,

Table-III: Multivariable logistic regression analysis of the association between weekly Food Consumption and Glycemic Control.

Variable	B	S.E.	Wald	df	Sig.	Exp(B)	95% CI for Exp(B)
Fruits (times/week)	-0.145	0.064	5.09	1	0.024	0.865	0.764 - 0.979
Salads (times/week)	-0.271	0.058	21.83	1	<0.001	0.763	0.681 - 0.855
Age (years)	0.012	0.014	0.74	1	0.39	1.012	0.985 - 1.041
Gender (female vs male)	-0.119	0.298	0.16	1	0.689	0.888	0.495 - 1.592
BMI (kg/m <sup>2</sup> )	0.018	0.019	0.87	1	0.352	1.018	0.981 - 1.057
Duration of diabetes (years)	0.043	0.026	2.72	1	0.099	1.044	0.992 - 1.099
Socio economic status (>50k vs =50k)	-0.162	0.382	0.18	1	0.672	0.851	0.401 - 1.804
Constant	2.897	0.397	53.27	1	<0.001	18.112	-

Multivariable binary logistic regression was used; AOR = adjusted odds ratio, CI = confidence interval.

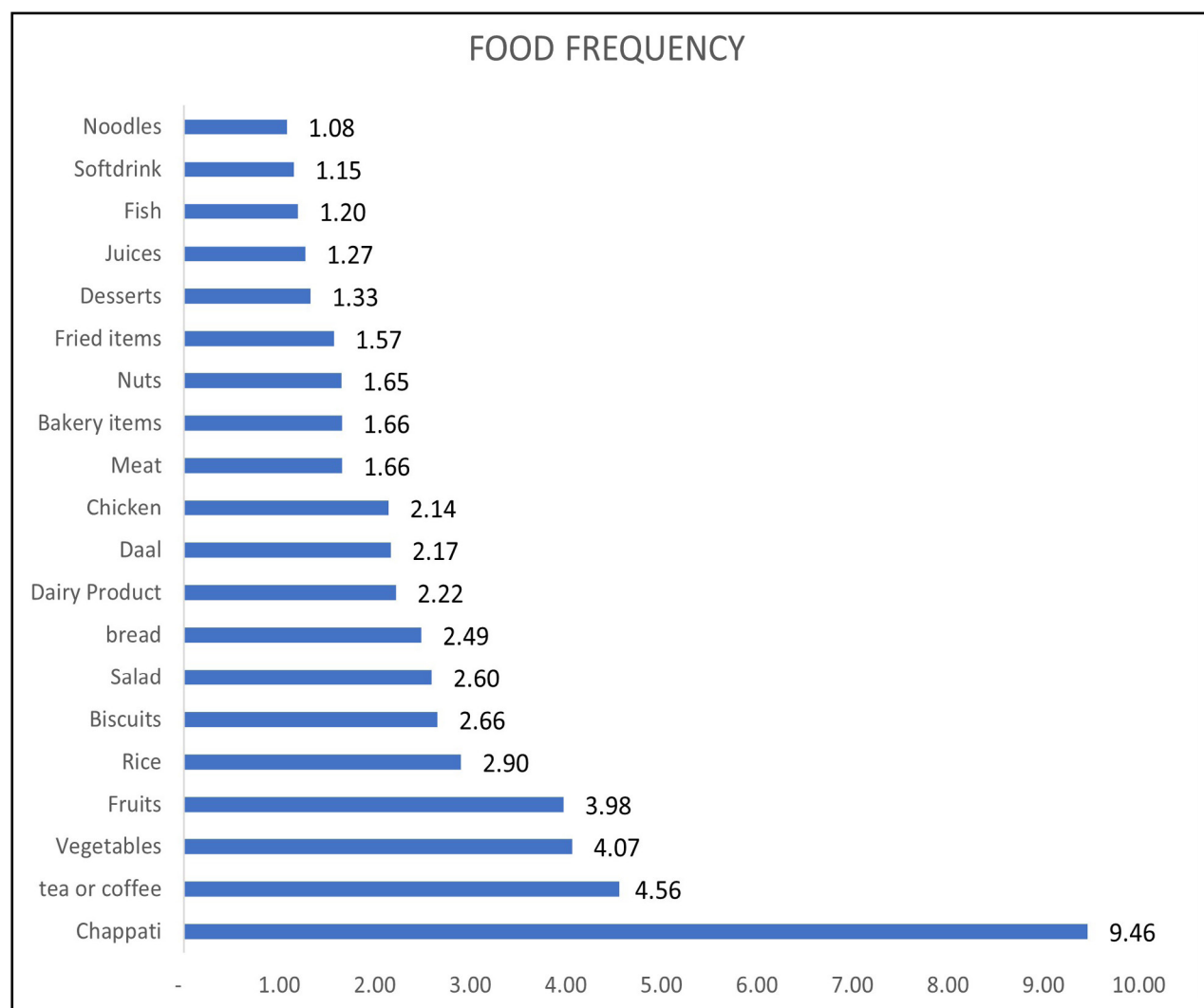


Fig.3: Food Frequency chart of Participants on weekly basis.

non-starchy vegetables, whole grains, and lean proteins, can help regulate blood sugar levels and promote overall health.<sup>15</sup>

The mean weekly intake of fruits and vegetables was 3.98 and 4.07 times per week, respectively. Our findings further demonstrated that higher consumption of fruits on weekly basis was significantly associated with improved glycemic control which is consistent with studies from Korea and Saudi Arabia.<sup>16,17</sup> This trend highlights the gap between nutritional awareness and actual practice emphasizing need for targeted intervention to promote adequate consumption.

Furthermore, fruit intake has been associated with improved blood glucose levels, which may be related to their diverse phytochemical profile. In addition, bioactive compounds present in fruits, such as polysaccharides, phenolic compounds, vitamin C, and antioxidants, have been associated with better glycemic outcomes and may play a role in diabetes management.<sup>18</sup>

Similarly, a significant association with target of <7 HbA1c was also found with salad or fresh vegetable consumption (p value 0.008). In the previous researches it was mentioned that salads (raw vegetables) are good for glycemic control as compare to cooked vegetables due to availability of phytochemicals that are destroyed while cooking and long steaming. According to the authors, salads should be eaten in large quantities at the beginning of each meal.<sup>19</sup> Salads have been identified as a component of many favorable dietary patterns and proved to be associated with reduced risk of metabolic syndrome.<sup>20</sup>

Our findings indicated the mean weekly consumption of various food items, with chapati being the most frequently consumed (9.46 times/week). Previous research conducted in Pakistan suggests that excessive chapatti consumption may be associated with higher HbA1c levels.<sup>4</sup>

Our study findings suggest suboptimal protein consumption among participants with diabetes. The mean frequency of intake was 2.14 times per week for chicken, 1.66 times per week for red meat, 1.20 times per week for fish, 2.17 times per week for lentils, and 1.65 times per week for nuts. Adequate protein intake is particularly important in individuals with diabetes, as chronic hyperglycemia, insulin resistance, and associated endocrine alterations contribute to accelerated loss of muscle mass and strength.<sup>21</sup>

The American Diabetes Association (ADA) Standards of Care 2023 emphasize the importance of adequate protein intake and protein intake below the recommended dietary allowance of 0.8 g/kg/day is discouraged, as it has not been shown to improve glycemic control or cardiovascular outcomes and may increase the risk of malnutrition.<sup>22</sup>

Current dietary guidelines also advocate healthy eating patterns that include adequate amounts of high-quality protein, dietary fiber, fruits, and vegetables, which have been associated with improved glycemic control and a lower risk of diabetes-related complications.<sup>23</sup>

In the present study, dairy products were consumed at a mean frequency of 2.22 times per week. Previous studies have suggested that dairy products, particularly milk and yogurt, may be associated with improved glycemic control and favorable metabolic outcomes among individuals with diabetes.<sup>24</sup>

In addition, participants reported regular consumption of unhealthy food items, including fried foods, desserts, bakery products, biscuits, fruit juices, and soft drinks. Such dietary choices are often rich in refined carbohydrates, added sugars, and saturated fats, which have been associated with poorer glycemic control. Previous studies have reported a significant association between the consumption of these foods and higher HbA1c levels in individuals with diabetes.<sup>25</sup> These findings highlight the importance of dietary counseling strategies focused on limiting the intake of processed and sugar-rich foods as part of comprehensive diabetes management.

## LIMITATIONS

A cross-sectional design with a convenience sampling method was employed due to its feasibility in a hospital setting. Although this design limits causal inference and the sampling method may introduce selection bias, thereby restricting the generalizability of findings to other populations. In addition, information on diabetes medications and insulin use was not collected, as these factors were beyond the scope of the study; therefore, their potential impact on glycemic control could not be assessed. Furthermore, the lack of longitudinal follow-up limited the ability to evaluate changes in dietary habits and glycemic control over time. However, the study provides valuable baseline data on dietary patterns and glycemic control among patients in a real-world clinical context. These findings can offer insights to guide future longitudinal research.

## CONCLUSION

This study demonstrates a high prevalence of suboptimal dietary patterns in people with type 2 diabetes that may contribute to poor glycemic control. The findings highlight inadequate consumption of fruits and vegetables and excessive intake of refined carbohydrates and sugary foods. These results underscore the need for targeted, culturally appropriate, and individualized nutritional interventions aimed at improving dietary behaviors. Strengthening dietary counseling and nutrition education may help optimize glycemic control and reduce the risk of diabetes-related complications in this population.

## DECLARATION SECTION

**Ethics Approval:** The study was approved by the Institutional Review Board (IRB) Dow University of Health Sciences, (Ref: IRB-3257/DUHS/Approval/2023/06). Written informed consent was obtained from all participants.

**Consent for Publication:** Not applicable; the Ethics Committee confirmed that individual consent for publication was not required.

**Data Availability Statement:** Data supporting the findings are available from the corresponding author on reasonable request.

**Competing Interests:** The authors declare no competing interests.

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### Authors' Contributions:

**TR:** Concept, design, Literature search, collection and assembling of data, interpretation of data, drafting the article, writing the manuscript.

**SZ:** Literature search, Data collection and assembling of data, writing the manuscript, interpretation of data, drafting the article.

**TM:** Analysis & interpretation of data.