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FOOD INTAKE, PHYSICAL ACTIVITY, AND FASTING BLOOD GLUCOSE AMONG TYPE 2 DIABETES MELLITUS PATIENTS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Poor dietary control and low physical activity in patient with diabetes mellitus type 2 commonly worsen glycemic regulation. This study aimed to analyze the relationship between dietary intake, physical activity, and fasting blood glucose levels. This quantitative cross-sectional study was conducted at Blooto Public Health Center in September 2025 and involved 80 respondents selected through convenience sampling. This study used Food Recall Questionare, IPAQ, and fasting blood glucose using a glucometer. Data were analyzed using Chi-square. The results showed that 60% of respondents consumed more than 50 grams of sugar per day, 60% engaged in light to moderate physical activity, and 62.5% had elevated fasting blood glucose levels (>100 mg/dL). Significant associations were found between dietary intake and fasting blood glucose (p = 0.000) and between physical activity and fasting blood glucose (p = 0.000) p value < 0,05. These results indicate that dietary intake and physical activity were significantly associated with fasting blood glucose levels. Dietary intake and physical activity are independently associated with fasting blood glucose levels, emphasizing the need for focused nutritional guidance and sustained physical activity interventions to improve glycemic control in T2DM patients.

Keywords

Type 2 Diabetes Mellitus; Food Recall; Physical Activity; Fasting Blood Glucose; Glycemic Control

INTRODUCTION

Diabetes mellitus is a disease considered dangerous due to elevated blood glucose levels resulting from impaired insulin hormone function, which normally maintains body homeostasis by lowering blood sugar levels (Aillsa Zulkarnain & Farapti, 2024). Type 2 diabetes mellitus is caused by genetic factors related to impaired insulin secretion and insulin resistance, as well as other factors such as obesity, poor dietary patterns, exercise habits, and stress regulation (Aillsa Zulkarnain & Farapti, 2024). Type 2 diabetes, previously referred to as non–insulin-dependent diabetes, accounts for 90–95% of all diabetes cases. This form includes individuals with relative (not absolute) insulin deficiency and peripheral insulin resistance. At least initially, and often throughout their lives, these individuals may not require insulin therapy to survive (Care & Suppl, 2022).

A common problem observed is the lack of monitoring of patients' daily dietary patterns and physical activity, both by healthcare providers and by patients themselves. Many patients tend to be

unaware that high intake of simple carbohydrates and insufficient physical activity can significantly increase blood glucose levels. In addition, some patients are not accustomed to recording or recalling the foods they consume and do not have regular exercise routines, making sustained blood glucose control difficult.

Diabetes mellitus is known as a "silent killer" because it often goes unnoticed and is only detected after complications arise. As a non-communicable disease, the prevalence of DM continues to increase. In 2023, there were 537 million people living with DM globally, most of whom were from low- to middle-income countries, with 1.5 million deaths annually (Sari Ririn, 2021). The International Diabetes Federation (IDF) projects that by 2045, one in eight adults, or approximately 783 million people, will be living with DM. Indonesia ranks seventh globally in the number of people with diabetes. The prevalence of DM among individuals aged ≥15 years increased from 2.0% in 2018 to 2.2% in 2023 (Sari Ririn, 2021). The East Java Provincial Health Office reported that in 2021 there were 929,535 cases of diabetes mellitus in East Java Province, of which an estimated 867,257 patients (93.3%) had been diagnosed and received health services (Dinkes Jatim, 2022). Data from the Blooto Primary Health Center in Mojokerto City, East Java, in 2023 showed 1,321 cases at Blooto Health Center, 1,280 at Mentikan, 1,162 at Kedungdung, 992 at Wates, 436 at Gedongan, and 137 at Kranggan. Based on these data, Blooto Health Center had the highest proportion of cases (Primary Data, 2025).

The causes of Type 2 DM include both modifiable and non-modifiable factors. Diet, physical activity, and obesity-related nutritional status are modifiable risk factors for Type 2 DM. Physical activity has a positive relationship with glucose tolerance (Audina et al., 2018). Diet and physical activity are interrelated factors that can influence blood glucose levels. For individuals with DM, regulating food intake—covering food composition, caloric needs, food types and choices, and meal schedules—is essential (Nurhaswinda et al., 2025). In diabetes mellitus, physical activity through structured exercise programs aims to reduce insulin resistance and improve insulin action so that glucose can more readily enter cells and be converted into energy. Regular exercise performed three to four times per week for approximately 30 minutes can improve insulin sensitivity and help control blood glucose levels. During physical activity, the number of GLUT-4 transporters on the cell membrane increases, an effect that persists for several hours or longer when accompanied by sustained activity and increased insulin sensitivity (Mutia Handayani, 2021).

Orem's self-care behavior theory also explains that in diabetes cases, patient behaviors related to self-care—such as dietary patterns, physical activity, and glucose control—affect treatment success (Katuuk et al., 2020). Unhealthy dietary patterns can increase the risk of developing Type 2 DM. Consumption of high-carbohydrate foods can raise blood glucose levels. Physical activity helps control blood glucose because glucose is converted into energy during activity. Engaging in physical activity, such as exercise, is an effective way to maintain appropriate blood glucose levels in people with diabetes, as it can increase insulin production, thereby lowering blood glucose levels (Nurhaswinda et al., 2025). Diet and physical activity contribute an effective 72.1% to random blood glucose levels in individuals with diabetes mellitus. Patients with poor dietary patterns and low physical activity are more likely to have uncontrolled blood glucose levels. Insufficient physical activity and excessive dietary intake can increase blood glucose levels and raise the risk of complications in patients with DM (Nurhaswinda et al., 2025).

Food plays an important role in increasing blood glucose levels. During digestion, consumed food is broken down in the gastrointestinal tract and converted into glucose, which is then absorbed by the

intestines and circulated in the bloodstream. Glucose absorption raises blood glucose levels and stimulates insulin secretion. Inadequate insulin secretion and insulin resistance in Type 2 DM inhibit glucose utilization by tissues, leading to elevated blood glucose levels. This results in postprandial increases in blood glucose, which are then distributed into body cells (Kurniasari et al., 2021). Several studies show that patients with Type 2 DM frequently consume foods high in simple sugars and fats and low in fiber, contributing to elevated blood glucose levels. One important parameter in monitoring diabetic patients' conditions is fasting blood glucose (FBG) (B. Yusuf et al., 2023). Uncontrolled FBG indicates suboptimal disease management, and insufficient physical activity further worsens FBG control (B. Yusuf et al., 2023). Physical activity plays a major role in improving insulin sensitivity and facilitating glucose utilization by muscle cells (Muthmainnah et al., 2025). However, various health surveys indicate that most patients with Type 2 DM tend to lead sedentary lifestyles due to work demands, low motivation, or limited understanding of the importance of regular exercise (Colberg et al., 2016). This condition prevents optimal glucose metabolism, resulting in persistently high FBG levels.

The combination of inappropriate dietary patterns and low physical activity makes fasting blood glucose control difficult to achieve in patients with Type 2 DM. Unstable FBG not only worsens disease conditions but also increases the risk of chronic complications such as coronary heart disease, diabetic nephropathy, neuropathy, and retinopathy. Therefore, lifestyle factors are a critical focus of interventions in the management of Type 2 DM (B. Yusuf et al., 2023). Patients who are not adequately educated about dietary management and the importance of physical activity will have difficulty maintaining stable blood glucose levels. This leads to dangerous blood glucose fluctuations and accelerates the onset of complications. In addition, the lack of effective daily monitoring systems makes it difficult for healthcare providers to deliver timely interventions (Evert et al., 2019). One potential solution to address this issue is systematic monitoring of dietary patterns through food recall and physical activity, which can serve as effective tools for identifying dietary and lifestyle behaviors (Aritonang Yunita Evawany & Nur Huzaila, 2022). By maintaining daily records of food intake and physical activity, patients can become more aware of behaviors that directly affect their blood glucose levels.

However, complications such as retinopathy, nephropathy, and neuropathy can have a distressing impact on patient's quality of life and a significant increase in financial burden.(Sami, W. et al. 2015)

METHOD

This study is a quantitative research using a descriptive correlational design with a cross-sectional approach.The study was conducted at UPTD Blooto Public Health Center. Data collection was carried out in September 2025. The population in this study consists of all Diabetes Mellitus patients registered at Blooto Public Health Center, totaling 1.321 patients. A sample is a selected group of individuals from the population that is expected to represent the entire population. Inclusion criteria included **:** Patients diagnosed with Type 2 Diabetes Mellitus, Patients willing to participate and who sign the informed consent, Patients without memory impairment and Patients without communication or language difficulties. Exclusion criteria included : Patients who have difficulty communicating or recalling information. Data collection is an essential stage of research and must be aligned with the research method to achieve accurate results. The following steps were taken: The researcher prepared the proposal and visited the location and explained the purpose of the study and provided information about the study to all respondents and distributed informed consent to participants. Those who agreed signed.

After the respondents were recruited, they were asked to sign an informed consent form. This study used **non-probability sampling**, specifically **convenience sampling.** Convenience sampling selects participants who are readily available at the research location. Primary data were collected directly from respondents using structured interviews and questionnaires. A questionnaire is a set of prepared questions used to collect research data. This study used the following instruments: ***Food Recall Questionnaire*** used to assess food intake and daily dietary patterns over the last three days. A 3-day recall improves accuracy and represents dietary habits more effectively (Rahayu, Halim, and ... 2022) **and *International Physical Activity Questionnaire* (IPAQ)** was used to measure physical activity (Putri et al. 2019)

After the food recall questionnaire data were collected, the Fat Secret application was used to calculate total caloric intake, with a specific focus on daily sugar consumption. Respondents who consumed more than 50 grams of sugar per day were classified as having excessive intake, whereas those who consumed less than 50 grams per day were classified as meeting the standard or normal intake. In addition to questionnaire-based data collection, another required variable was fasting blood glucose level, which was measured once using a glucometer.

Respondents report the number of days and duration of vigorous, moderate, and light activities, including walking. All activities are converted to **MET-minutes/week**, where MET is the ratio of work metabolic rate to resting metabolic rate. Values used in IPAQ analysis. Categorization of physical activity levels. **Light**: < 600 MET, **Moderate**: 600–1,500 MET and **Vigorous**: > 1,500 MET. Completed questionnaires were collected and processed for data analysis. The data analysis techniques used in this study were the Chi-Square test.

RESULTS

Table 1. Frequency Distribution Based on Age, Gender and Education

No	Food Recall	(n)	(%)
1	High Sugar Intake > 50gr	48	60.0
2	Normal Sugar Intake < 50gr	32	40.0
Physical Activity			
1	Light activity	30	37.5
2	Moderate activity	30	37.5
3	Vigorous activity	20	25.0
Fasting Blood Glucose			
1	> 100mg/dL GDP Tinggi	50	62.5
2	< 100mg/Dl GDP Normal	30	37.5
	Total	**80**	**100**

Based on the table 1 above, the characteristics of respondents by age show that more than half of the respondents were 60–69 years old, totaling 42 respondents (52.5%). The results for sex distribution indicate that the majority of respondents were female, with 50 respondents (62.5%). Regarding education level, 55 respondents had a senior high school education, accounting for 68.8%.

Table 2. Frequency Distribution of Respondents Based on Food Recall Scores, IPAQ Scores, and Fasting Blood Glucose Levels among Type 2 Diabetes Mellitus Patients at UPTD Puskesmas Blooto

No	Age	(n)	(%)
1	45-59 yo	26	32.5
2	60-69 yo	42	52.5
3	> 65 yo	12	15,0
Gender			
1	Male	30	37.5
2	Female	50	62,5
Education			
1	Junior High School	15	18.8
2	Senior Hight Schoo	55	68.8
3	Bachelor	10	12.5
	Total	**80**	**100**

Based on Table 2, the characteristics of respondents were analyzed according to Food Recall values to assess daily sugar intake, calculated using the FatSecret application. The results showed that 48 respondents (60%) had high sugar intake, exceeding 50 grams per day. Regarding physical activity assessment using the IPAQ questionnaire, 60 respondents (60%) reported engaging in light to moderate activities, while 20 respondents (20%) performed vigorous activities. For fasting blood glucose levels, 50 respondents (62.5%) had levels above 100 mg/dL, categorized as high fasting blood glucose.

Tabel 3. Cross-tabulation of Food Recall results and Fasting Blood Glucose in Type 2 Diabetes Mellitus patients at UPTD Blooto Public Health Center

		Fasting Blood Glucose		Total	P Value
		High	Normal		
F.Recall	High Sugar Intake > 50gr	38	10	48	0,000
	Normal Sugar Intake < 50gr	12	20	32	
Total		**50**	**30**	**80**	

Based on Table 3 above presents the cross-tabulation results between Food Recall and Fasting Blood Glucose (FBG), showing that among respondents with high sugar intake (>50g), 38 had elevated FBG and 10 had normal FBG. Meanwhile, respondents with normal sugar intake (<50g) included 12 with elevated FBG and 20 with normal FBG. The Chi-square test results between food recall and fasting blood glucose levels in patients with Type 2 Diabetes Mellitus showed a p-value of 0.000, which is less than 0.05, indicating a significant association between food recall and fasting blood glucose levels

Tabel 4. Cross-tabulation based on Physical Activity and Fasting Blood Glucose (FBG) results in Type 2 Diabetes Mellitus patients at UPTD Blooto Public Health Center

		Fasting Blood Glucose		Total	P Value
		High	Normal		
IPAQ	Light activity	25	5	30	0,000
	Moderate activity	20	10	30	

	Vigorous activity	5	15	20
Total		**50**	**30**	**80**

Table 4 above shows the cross-tabulation results between physical activity (IPAQ) and fasting blood glucose (FBG), indicating that among respondents with light activity, 25 had high FBG and 5 had normal FBG. For moderate activity, 20 respondents had high FBG and 10 had normal FBG. Among those with vigorous activity, 5 had high FBG and 15 had normal FBG.

Based on Table 4.6, the Chi-square test results between physical activity and fasting blood glucose levels in patients with Type 2 Diabetes Mellitus showed a p-value of 0.000, which is less than 0.05, indicating a significant association between physical activity and fasting blood glucose levels

DISCUSSION

Food Recall in Type 2 Diabetes Mellitus Patients

The study found that 60% of patients consumed more than 50 grams of sugar per day, exceeding WHO and Indonesian Ministry of Health recommendations. Excessive sugar intake can potentially increase fasting blood glucose levels, particularly in T2DM patients with insulin resistance. Measurement was conducted using a 3-day food recall and analyzed with the FatSecret application, although this method has limitations due to recall bias. These findings are consistent with previous theories and studies (Tseng et al. 2021) which indicate that high sugar consumption increases the risk of hyperglycemia. Overall, patients' dietary patterns remain noncompliant with recommended guidelines and require intensive education and replace sugar-sweetened bever- ages (SSBs) with water as often as possible. c When sugar substitutes are used to reduce overall calorie and carbo-hydrate intake, people should be counseled to avoid compensating with intake of additional calories from other food sources. (Evert et al. 2019)

Physical Activity in Type 2 Diabetes Mellitus Patients

Most respondents had light and moderate physical activity levels, each accounting for 37.5%, while only 25% engaged in vigorous activity. Physical activity was assessed using the IPAQ based on MET values. Low physical activity reduces insulin sensitivity, resulting in elevated blood glucose levels. These results align with exercise physiology theory and previous studies

(Putri et al. 2019) emphasizing the importance of ≥600 MET for glucose control. Recall bias in IPAQ was also noted as a limitation. Findings suggest the need for interventions to increase physical activity according to ADA recommendations of at least 150 minutes per week. Daily exercise, or at least not allowing more than 2 days to elapse between exercise sessions, is recommended to enhance insulin action. Adults with type 2 diabetes should ideally perform both aerobic and resistance exercise training for op- timal glycemic and health out- comes.Structured lifestyle interventions that include at least 150min/week of physical activity and dietary changes resulting in weight loss of 5%–7% are recommended to prevent or delay the onset of type 2 diabetes in populations at high risk.(Colberg et al. 2016)

Fasting Blood Glucose

A total of 62.5% of respondents had fasting blood glucose >100 mg/dL, indicating suboptimal glycemic control. This aligns with T2DM pathophysiology, where insulin resistance and impaired glucose uptake by muscles occur. These results, combined with low physical activity and high sugar intake, highlight the need for strengthened dietary education and lifestyle modification.

Relationship Between Food Recall and Blood Glucose

A significant relationship was found between sugar intake and fasting blood glucose (p = 0.000). Higher sugar consumption increases the risk of hyperglycemia. This finding is supported by glucose metabolism theory and previous studies (Dwi et al. 2025) which indicate that simple sugars rapidly raise blood glucose, and insulin resistance in T2DM exacerbates the effect. The study reinforces that sugar restriction is a critical component of diabetes management.

Relationship Between Physical Activity and Blood Glucose

Physical activity was significantly associated with fasting blood glucose (p = 0.000). Low activity was linked to higher glucose levels, while moderate to vigorous activity helped maintain normal glucose levels. The mechanism involves increased GLUT-4 expression and insulin sensitivity.

This result is in line with previous research, changes in fasting blood glucose levels after physical activity showed a mean value of 160 mg/dL, a median of 158 mg/dL, a mode of 200 mg/dL, and a standard deviation of 40. The statistical analysis yielded a p-value of 0.000 with a significance level (α) of 0.05. Since $p < \alpha$, the null hypothesis (H_0) was rejected and the alternative hypothesis (H_a) was accepted, indicating that physical activity had a significant effect on fasting and random blood glucose levels in patients with Type 2 Diabetes Mellitus. (Darmawan and Darah 2025). These results are consistent with previous studies, which reported a p-value of 0.000 using the Kruskal–Wallis test, indicating a significant association between physical activity and blood glucose levels. Furthermore, post hoc analysis using the Mann–Whitney test also yielded a p-value of 0.000, demonstrating significant differences among all activity groups. Overall, there is a significant relationship between physical activity and blood glucose levels in patients with Diabetes Mellitus (Mufida, Qodir, and Trias 2024)

CONCLUSIONS

Based on the study results regarding the relationship between food recall and physical activity with blood glucose levels in Type 2 Diabetes Mellitus patients at Blooto Public Health Center, the following conclusions can be drawn:

1. The Chi-Square test between food recall and fasting blood glucose showed a significant relationship (p = 0.000). This indicates that higher sugar consumption is associated with higher fasting blood glucose levels.
2. The Chi-Square test between physical activity and fasting blood glucose also showed a significant relationship (p = 0.000). This indicates that higher levels of physical activity are associated with more stable fasting blood glucose levels
3. Simultaneously, food recall and physical activity did not have a significant effect on blood glucose levels in T2DM patients at Blooto Public Health Center. Other factors such as medication adherence, disease duration, BMI, stress, and lifestyle habits likely play a more influential role in determining blood glucose levels.
4. These findings indicate that glycemic control in T2DM patients is multifactorial and cannot be explained solely by these two lifestyle variables.

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