

Research Article

Association between dietary adherence and macronutrient intake among hospitalized patients with diabetes mellitus

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Glycemic control<https://doi.org/xxxxx>**Abstract**

Diabetes mellitus is a chronic metabolic disorder characterized by impaired insulin function and persistent hyperglycemia, requiring long-term dietary management to maintain blood glucose control and prevent complications. Dietary adherence plays an essential role in regulating nutrient intake, particularly macronutrients such as protein, fat, and carbohydrates, which may influence insulin sensitivity and glucose metabolism. This study aimed to analyze the association between dietary adherence and macronutrient intake among hospitalized patients with diabetes mellitus at A.Yani Islamic Hospital Surabaya. An observational analytic study with a cross-sectional design was conducted involving 66 inpatients diagnosed with diabetes mellitus. Participants were selected using accidental sampling. Dietary adherence data were collected using a dietary adherence questionnaire, while macronutrient intake was assessed through a 2x24-hour food recall interview. Statistical analysis was performed using the Spearman Rank test. The findings showed that most participants were aged 46-55 years, predominantly female, and had completed senior high school education. Statistical analysis revealed a significant association between dietary adherence and protein intake ($p=0.048$), as well as fat intake ($p=0.033$). However, no significant relationship was found between dietary adherence and carbohydrate intake ($p=0.580$). These findings indicate that better dietary adherence among hospitalized patients with diabetes mellitus was associated with more appropriate protein and fat intake patterns, although carbohydrate intake was not significantly related. Strengthening dietary education and continuous nutritional monitoring are recommended to improve dietary management and support glycemic control in patients with diabetes mellitus.

1. INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from impaired insulin secretion, insulin resistance, or a combination of both conditions. The disease has become a major global health concern because of its rapidly increasing prevalence and its association with long-term complications affecting multiple organ systems (American Diabetes Association, 2024). According to the International Diabetes Federation, approximately 537 million adults worldwide were living with diabetes in 2021, and this number is projected to increase to 643 million by 2030 and 783 million by 2045 (International Diabetes Federation, 2021). Indonesia is currently among the countries with the highest number of diabetes cases globally, indicating a substantial burden on the healthcare system and emphasizing the importance of effective diabetes management strategies (Kemenkes RI, 2020).

Poor glycemic control among patients with diabetes mellitus may lead to various acute and chronic complications, including cardiovascular disease, nephropathy, neuropathy, retinopathy, and diabetic foot ulcers (Forouhi & Wareham, 2019). These complications contribute to increased hospitalization, reduced quality of life, and higher mortality rates among patients with diabetes mellitus. Therefore, maintaining stable blood glucose levels is considered the primary goal of diabetes management. In addition to pharmacological therapy, nutritional management plays a fundamental role

in improving metabolic control and reducing the progression of diabetes-related complications (Evert et al., 2019). Appropriate dietary intake has been reported to improve insulin sensitivity, support glucose regulation, and enhance overall metabolic outcomes in patients with diabetes mellitus (Reynolds & Mitri, 2024).

Dietary adherence is one of the key aspects of diabetes self-management. Patients with diabetes mellitus are advised to follow dietary recommendations related to meal timing, food selection, and portion control in order to maintain glycemic stability (PERKENI, 2021). However, maintaining long-term adherence to dietary recommendations remains challenging for many patients because of limited nutritional knowledge, lifestyle factors, psychological conditions, environmental influences, and changes in appetite during illness (Shrivastava et al., 2013). Poor dietary adherence may contribute to uncontrolled blood glucose levels and increase the risk of metabolic complications. Previous studies have demonstrated that individuals with better dietary adherence tend to achieve improved glycemic control and better clinical outcomes compared with patients who do not consistently follow dietary recommendations (Pancheva et al., 2021).

Macronutrient intake is closely associated with glucose metabolism and insulin regulation. Carbohydrate intake directly affects postprandial blood glucose levels, particularly when consumed in excessive amounts or derived from foods with a high glycemic index (Madrid-Valero et al., 2017). Meanwhile, adequate protein intake may improve satiety and modulate insulin secretion, although the effects may differ according to the type and amount of protein consumed (Tucker, 2022). Several dietary approaches, including Mediterranean and plant-based dietary patterns, have shown beneficial effects on glycemic control and insulin sensitivity among patients with type 2 diabetes mellitus (Chen et al., 2021; Zeraattalab-Motlagh et al., 2022). Therefore, balanced macronutrient intake is considered essential in the nutritional management of diabetes mellitus.

Several previous studies have investigated dietary behavior and nutrient intake among patients with diabetes mellitus. (Zaleha et al., 2023) reported that patients with type 2 diabetes mellitus frequently consumed excessive amounts of dietary fat compared with recommended intake levels. (Kheriji et al., 2022) also found that high-fat and high-carbohydrate diets may alter insulin sensitivity and glucose tolerance. In Indonesia, previous studies mainly focused on family support, nutritional knowledge, lifestyle factors, and general dietary compliance among patients with diabetes mellitus (Fadzli & Shamsudin, 2025; Irwansyah & Kasim, 2021). However, limited studies have specifically examined the relationship between dietary adherence and macronutrient intake among hospitalized patients with diabetes mellitus.

Most previous research was conducted in outpatient or community settings, whereas hospitalized patients often experience different nutritional conditions during treatment. Inpatients with diabetes mellitus may encounter appetite changes, stress responses, medication effects, and inconsistent eating patterns that potentially influence dietary adherence and nutrient intake (American Diabetes Association, 2024). In addition, evidence regarding the association between dietary adherence and individual macronutrient intake, particularly protein, fat, and carbohydrate intake, among hospitalized diabetes patients in Indonesia remains scarce. This condition highlights an important research gap requiring further investigation.

The novelty of this study lies in its focus on hospitalized patients with diabetes mellitus and its comprehensive analysis of dietary adherence in relation to protein, fat, and carbohydrate intake simultaneously. Unlike previous studies that mainly emphasized glycemic control or dietary patterns in outpatient populations, this study specifically evaluates dietary adherence behavior and macronutrient intake among inpatients in a hospital setting. The findings are expected to contribute to the development of more effective nutritional intervention strategies and improve dietary management for hospitalized patients with diabetes mellitus. Therefore, this study aimed to analyze the association between dietary adherence and macronutrient intake, including protein, fat, and carbohydrate intake, among hospitalized patients with diabetes mellitus at A.Yani Islamic Hospital Surabaya.

2. MATERIALS AND METHODS (HELVETICA,12)

2.1 Study Design and Setting

This study employed a quantitative observational analytic design using a cross-sectional approach. The cross-sectional design was selected to identify the association between dietary adherence and macronutrient intake among hospitalized patients with diabetes mellitus at a single point in time. The study was conducted at A.Yani Islamic Hospital Surabaya, Indonesia, from May 2023 to July 2024. This hospital was selected because it provides inpatient care for a considerable number of patients with diabetes mellitus and had not previously been used as a research setting for similar studies. Cross-sectional studies are commonly used to evaluate relationships between variables efficiently within a defined population (Setia, 2016).

2.2 Participants and Sampling Technique

The target population consisted of adult inpatients diagnosed with diabetes mellitus who were hospitalized at A.Yani Islamic Hospital Surabaya during the study period. Participants were recruited using a non-probability accidental sampling technique. Patients who met the inclusion criteria and were available during the data collection period were invited to participate in the study. The inclusion criteria were: (1) patients diagnosed with diabetes mellitus, (2) hospitalized in the adult inpatient ward, (3) able to communicate effectively, (4) willing to participate in the study, and (5) signing informed consent prior to data collection. Meanwhile, patients with swallowing disorders, severe jaw impairment, or incomplete participation during data collection were excluded from the study. The minimum sample size was calculated using the Lemeshow formula for cross-sectional studies, resulting in a minimum requirement of 61 respondents. However, a total of 66 respondents were successfully recruited and included in the final analysis to increase the adequacy of the data.

2.3 Research Variables

The independent variable in this study was dietary adherence, while the dependent variables included macronutrient intake consisting of protein, fat, and carbohydrate intake. Dietary adherence referred to the participants' compliance with dietary recommendations related to meal schedule, food type, and portion size according to diabetes dietary management principles.

2.4 Data Collection Procedures

Data collection was conducted directly in the inpatient wards after obtaining ethical approval and permission from the hospital administration. Eligible participants were informed about the study objectives and procedures before signing informed consent forms. Dietary adherence data were collected using a structured dietary adherence questionnaire adapted to diabetes dietary management principles. The questionnaire assessed adherence to meal timing, food selection, and portion control. Respondents were interviewed directly by the researcher to minimize misunderstanding and improve data accuracy. Macronutrient intake data were obtained using a 2x24-hour food recall method conducted through face-to-face interviews. Participants were asked to recall all foods and beverages consumed during two separate 24-hour periods, including meal types, portion sizes, ingredients, and preparation methods. The collected dietary intake data were analyzed using NutriSurvey software to estimate daily protein, fat, and carbohydrate intake. Demographic characteristics, including age, sex, and educational background, were also collected using a respondent identity form.

2.5 Statistical Analysis

The collected data were processed through several stages, including editing, coding, scoring, data entry, cleaning, and tabulation. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics were used to present respondent characteristics and summarize dietary adherence and macronutrient intake data. Categorical variables were presented as frequencies and percentages. The association between dietary adherence and macronutrient intake variables was analyzed using the Spearman Rank correlation test because the data were non-parametric in nature. A p-value of less than 0.05 was considered statistically significant.

2.6 Ethical Consideration

This study received ethical approval from the Health Research Ethics Committee of Universitas Nahdlatul Ulama Surabaya with number 129.EC.KEP.RSIAY.04.24 prior to data collection. All

participants voluntarily agreed to participate and signed informed consent forms before the interview process. Participant confidentiality and anonymity were maintained throughout the study.

3. RESULTS AND DISCUSSION

3.1 Characteristics of Respondents

A total of 66 hospitalized patients with diabetes mellitus participated in this study. Most respondents were aged 46–55 years, accounting for 50.0% of the total participants. Female respondents were more dominant than males, representing 59.1% of the study population. In terms of educational background, the majority of participants had completed senior high school education. These findings indicate that middle-aged adults were the predominant group affected by diabetes mellitus in this inpatient setting. Table 1 presents the demographic characteristics of the respondents.

Table 1. Characteristics of Respondents

Variable	Frequency (n)	Percentage (%)
Age		
46–55 years	33	50.0
Other age groups	33	50.0
Sex		
Female	39	59.1
Male	27	40.9
Educational level		
Senior high school	21	31.8
Other educational levels	45	68.2

The predominance of middle-aged and female patients in this study is consistent with previous reports indicating that the prevalence of diabetes mellitus increases with age because of progressive insulin resistance and declining pancreatic beta-cell function (Forouhi & Wareham, 2019). Female patients may also experience increased metabolic risk associated with hormonal changes, physical inactivity, and obesity-related factors (Kautzky-willer et al., 2016). Educational background may influence patients' understanding of dietary recommendations and disease management because individuals with higher educational attainment generally demonstrate better health literacy and self-care behavior (Mogre et al., 2019). These findings suggest the importance of targeted nutritional education programs, especially among middle-aged adults and female patients, to improve dietary management and diabetes self-care during hospitalization.

3.2 Dietary Adherence Among Patients with Diabetes Mellitus

The assessment of dietary adherence showed variations in respondents' compliance with dietary recommendations. Several patients reported difficulties in following meal schedules, limiting prohibited foods, and maintaining balanced dietary intake during hospitalization. Dietary adherence is considered an essential component of diabetes management because adherence to meal timing, food type, and portion size contributes to better glycemic control and metabolic stability (PERKENI, 2021). Inadequate adherence may increase fluctuations in blood glucose levels and worsen diabetes-related complications. Hospitalized patients may experience challenges in maintaining dietary adherence because illness conditions, emotional stress, reduced appetite, and family food preferences often influence eating behavior during treatment. Similar findings were reported by (Pancheva et al., 2021), who observed that many diabetes patients had difficulty maintaining consistent adherence to recommended dietary guidelines. Improving dietary adherence requires multidisciplinary support involving dietitians, nurses, physicians, and family members. Nutritional counseling and individualized meal planning may enhance patient compliance and support better clinical outcomes.

3.3 Macronutrient Intake Among Respondents

The analysis of dietary intake demonstrated variations in protein, fat, and carbohydrate consumption among respondents. Macronutrient intake plays an important role in glucose metabolism and insulin sensitivity among patients with diabetes mellitus. Protein intake among respondents was relatively adequate in several participants, while excessive fat and carbohydrate intake were still identified in some patients. High carbohydrate consumption may rapidly increase postprandial blood glucose levels, particularly when derived from refined carbohydrates or foods with a high glycemic

index. Excessive fat intake, especially saturated fat, may impair insulin signaling and contribute to insulin resistance (Forouhi et al., 2018). Meanwhile, adequate protein intake may increase satiety and improve metabolic regulation, although excessive intake from animal-based sources may also contribute to metabolic disturbances (Tucker, 2022). Therefore, balanced macronutrient intake is necessary to maintain optimal glycemic control among patients with diabetes mellitus. These findings indicate the need for individualized dietary planning during hospitalization to ensure that patients receive balanced nutritional intake according to diabetes dietary recommendations.

3.4 Association Between Dietary Adherence and Protein Intake

The statistical analysis demonstrated a significant association between dietary adherence and protein intake among hospitalized patients with diabetes mellitus ($p=0.048$).

Table 2. Association between dietary adherence and macronutrient intake

Variables	p-value	Interpretation
Dietary adherence and protein intake	0.048	Significant
Dietary adherence and fat intake	0.033	Significant
Dietary adherence and carbohydrate intake	0.580	Not significant

Patients with better dietary adherence tended to have more appropriate protein intake compared with those who demonstrated poor dietary compliance. This finding may indicate that patients who consistently follow dietary recommendations are more likely to consume balanced meals containing adequate protein sources. Protein intake may influence insulin secretion and improve satiety, thereby contributing to better metabolic control (Tucker, 2022). Similar findings were reported by (Kheriji et al., 2022), who explained that appropriate protein intake may improve insulin sensitivity and support glucose homeostasis among patients with diabetes mellitus. The implication of this finding is that nutritional education should emphasize not only carbohydrate restriction but also balanced protein consumption as part of comprehensive diabetes dietary management.

3.5 Association Between Dietary Adherence and Fat Intake

This study also identified a significant association between dietary adherence and fat intake ($p=0.033$). Respondents with higher dietary adherence generally showed more controlled fat intake patterns. Excessive dietary fat intake, particularly saturated fat, has been associated with impaired insulin sensitivity and increased inflammatory responses contributing to metabolic dysfunction (Forouhi et al., 2018). Patients who adhere to dietary recommendations may be more likely to avoid fried foods, processed foods, and high-fat meals commonly restricted in diabetes dietary management. The present findings are supported by previous studies reporting that dietary compliance contributes to healthier eating patterns and improved metabolic outcomes among diabetes patients (Pancheva et al., 2021). Proper dietary counseling regarding healthy fat sources and cooking methods may therefore help reduce the risk of metabolic complications during hospitalization.

3.6 Association Between Dietary Adherence and Carbohydrate Intake

The analysis revealed no significant association between dietary adherence and carbohydrate intake among respondents ($p=0.580$). This finding indicates that carbohydrate intake patterns may not always reflect overall dietary adherence behavior among hospitalized patients with diabetes mellitus. Several factors may explain this result. Hospitalized patients often consume standardized hospital meals with regulated carbohydrate portions, potentially reducing variation in carbohydrate intake among respondents. In addition, family-provided foods, appetite changes, and limited dietary monitoring may influence actual carbohydrate consumption during hospitalization. Although carbohydrate intake is closely associated with blood glucose regulation, dietary adherence involves multiple behavioral aspects beyond carbohydrate restriction alone, including meal timing and overall dietary balance (PERKENI, 2021). Similar findings were observed in some previous studies showing that adherence behavior does not always directly correspond with individual nutrient intake because eating behavior is influenced by various social, psychological, and environmental factors (Mogre et al., 2019). These findings highlight the importance of comprehensive nutritional monitoring rather than focusing solely on carbohydrate intake in diabetes dietary management.

4. CONCLUSION

This study demonstrated that dietary adherence was significantly associated with protein and fat intake among hospitalized patients with diabetes mellitus, while no significant association was identified between dietary adherence and carbohydrate intake. Patients who showed better adherence to dietary recommendations tended to have more appropriate protein and fat consumption patterns during hospitalization. These findings indicate that dietary adherence may influence specific aspects of macronutrient intake among patients with diabetes mellitus. The present study contributes additional evidence regarding the relationship between dietary adherence behavior and macronutrient intake in hospitalized diabetes patients, particularly within the Indonesian clinical setting. By simultaneously evaluating protein, fat, and carbohydrate intake, this study provides a broader understanding of nutritional behavior among inpatients with diabetes mellitus and highlights the importance of comprehensive dietary assessment during treatment. From a practical perspective, the findings emphasize the need for continuous nutritional education, individualized dietary counseling, and regular monitoring of dietary intake among hospitalized patients with diabetes mellitus. Strengthening multidisciplinary nutritional management involving dietitians, nurses, physicians, and family support may improve dietary adherence and support better metabolic outcomes during hospitalization.

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