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Breakfast Macronutrients and Blood Glucose Levels in Type 2 Diabetes at X Hospital in Gresik Regency

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ABSTRACT

Background : Type 2 diabetes mellitus (T2DM) is one of the most common metabolic diseases and is characterized by persistent hyperglycemia resulting from insulin resistance accompanied by impaired insulin secretion. Breakfast plays an important role in daily glycemic regulation because both its energy contribution and macronutrient composition may influence glucose metabolism.
Objective : This study investigated the association between breakfast energy proportion, macronutrient composition, and fasting blood glucose among pre-elderly outpatients with T2DM at Hospital X, Gresik.
Methods : An observational analytic study with a cross-sectional design was conducted among 70 participants recruited using accidental sampling. Breakfast intake was assessed using two non-consecutive 24-hour food recalls collected in different months, while fasting blood glucose values were obtained from medical records. Pearson's correlation test was applied to examine the relationships between variables.
Results : The average breakfast energy contribution accounted for 19.46% of total daily energy requirements. The mean proportions of carbohydrate, protein, and fat were 53.24%, 17.54%, and 29.01%, respectively, whereas the mean fasting blood glucose level was 179.85 mg/dL. No significant associations were identified between breakfast energy proportion, macronutrient composition, and fasting blood glucose levels.
Conclusions : Breakfast energy proportion and macronutrient composition were not associated with fasting blood glucose among pre-elderly patients with T2DM.
Keyword : Type 2 diabetes mellitus; breakfast; energy proportion; macronutrients; fasting blood glucose.

Cite this Article

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INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a metabolic disease characterized by elevated blood glucose levels resulting from insulin resistance, impaired insulin secretion, or a combination of both (1). T2DM is the most prevalent type of diabetes and accounts for approximately 90–95% of all diabetes cases worldwide (2). In 2021, Indonesia ranked fifth among the ten countries with the highest number of people living with diabetes, with approximately 19.5 million cases. The International Diabetes Federation (IDF) estimates that this number will continue to increase, reaching 28.57 million by 2045, representing an approximately 47% increase compared with 2021 (2).

The increasing prevalence of T2DM in Indonesia has become a public health concern requiring attention. Based on the results of the Basic Health Research (Riskesdas), the prevalence of physician-diagnosed diabetes mellitus among individuals aged ≥15 years increased from 1.5% in 2013 to 2.0% in 2018 (3). The growing number of people living with T2DM may increase the risk of complications, including acute complications such as hypoglycemia and diabetic ketoacidosis, as well as chronic microvascular and macrovascular complications that can lead to damage to various organs (4).

A similar condition has also been observed in East Java Province. According to the 2022 Hospital Information System (SIRS), T2DM ranked second among non-communicable diseases with the highest number of cases after hypertension, accounting for 172,917 cases (5). Gresik Regency is among the areas with a relatively high prevalence of diabetes. The prevalence of physician-diagnosed diabetes among individuals aged ≥15 years was 3.44%, higher than the national figure reported in the 2018 Riskesdas. In addition, data from the Gresik Regency Health Office showed an increase in the number of diabetes mellitus cases from 62,642 cases in 2022 to 63,597 cases by the third quarter of 2023 (5).

According to the age classification established by the Indonesian Ministry of Health, the pre-elderly population comprises individuals aged 45–59 years and represents a transitional stage toward older adulthood. During this stage, various physiological changes occur, including a decline in metabolic function, which may increase the risk of degenerative diseases such as type 2 diabetes mellitus (6). The 2018 Riskesdas reported that the prevalence of T2DM was 14.4% among individuals aged 45–54 years and increased to 19.6% among those aged 55–64 years. These figures indicate that the pre-elderly population is one of the age groups with a high prevalence of T2DM, following individuals aged ≥65 years (3).

The management of type 2 diabetes mellitus is based on four main pillars: education, medical nutrition therapy (MNT), physical activity, and pharmacological therapy (4). Among these pillars, MNT plays an important role by focusing on dietary regulation according to individual needs. The development of an MNT plan takes into account energy requirements, body weight, metabolic status, eating habits, and the patient's lifestyle (7). Through appropriate regulation of energy and nutrient intake, MNT supports blood glucose control as part of the non-pharmacological management of T2DM (8). Conversely, persistent hyperglycemia can lead to various chronic complications, including damage to the eyes, kidneys, nerves, heart, and blood vessels (9).

In the implementation of MNT, dietary management follows the 3J principle, which comprises jumlah (amount), jenis (type), and jadwal (timing) of meals. These three principles aim to

adjust energy and macronutrient intake to the metabolic needs of each patient (10). One meal occasion that deserves particular attention is breakfast, as it represents the first food intake after an overnight fast and plays a role in maintaining glucose homeostasis (11). Skipping breakfast has been reported to increase postprandial glucose levels, impair insulin and glucagon-like peptide-1 (GLP-1) responses, and ultimately increase the risk of T2DM and worsen glycemic control (12)

Breakfast is recommended to be consumed within two hours of waking and to contribute approximately 20–35% of total daily energy requirements (13). Several studies have reported that regularly skipping breakfast may increase postprandial glucose levels, impair insulin and glucagon-like peptide-1 (GLP-1) responses, and ultimately increase the risk of T2DM and worsen glycemic control (12). In addition to its energy contribution, breakfast macronutrient composition may also influence the glycemic response. A higher-protein breakfast has been shown to induce a greater insulin response than a high-carbohydrate breakfast (14), whereas a low-carbohydrate breakfast has been associated with reductions in HbA1c and improvements in glycemic control (15).

Therefore, this study aimed to investigate the association between breakfast energy proportion, macronutrient composition, and fasting blood glucose levels among pre-elderly outpatients with type 2 diabetes mellitus at Hospital X, Gresik Regency.

METHODS

This study employed an analytical observational design with a cross-sectional approach. The study was conducted from August to December 2025 at Hospital X, Gresik Regency, East Java. The study participants were pre-elderly outpatients with type 2 diabetes mellitus (T2DM) aged 45–59 years. A total of 70 participants were recruited using accidental sampling based on predetermined inclusion and exclusion criteria.

Data on breakfast energy proportion and macronutrient composition were collected through interviews using two non-consecutive 24-hour food recalls conducted in two different months. The breakfast energy proportion was calculated by entering the food recall data into NutriSurvey software to determine total breakfast energy intake (kcal). This value was then compared with each participant's estimated daily energy requirement, calculated using the Harris–Benedict equation, and multiplied by 100% to obtain the percentage contribution of breakfast energy to daily energy requirements.

Macronutrient composition was calculated by converting carbohydrate, protein, and fat intake from grams into kilocalories. The energy contribution of each macronutrient was then compared with total breakfast energy intake and expressed as a percentage to determine the proportions of carbohydrate, protein, and fat consumed at breakfast.

Fasting blood glucose data were obtained from medical records based on the average laboratory results from two different visits. The associations between breakfast energy proportion, macronutrient composition, and fasting blood glucose levels were analyzed using Pearson's correlation test.

RESULT

Sample Characteristics

This study included 70 pre-elderly outpatients with type 2 diabetes mellitus at Hospital X, Gresik Regency. The respondent characteristics analyzed included sex, educational attainment, occupation, duration of type 2 diabetes mellitus, and adherence to antidiabetic medication. The distribution of respondent characteristics is presented in Table 1.

Table 1 Distribution of Respondent Characteristics

Characteristics	n	%
Sex		
Male	20	28,6%
Female	50	71,5%
Educational attainment		
Elementary school	19	27,1%
Junior high school	12	17,1%
Senior high school	32	45,7%
Higher education	7	10%
Occupation		
Trader	16	22,9%
Housewife	26	37,1%
PNS/TNI/Police	3	4,3%
Private sector employee	3	4,3%
Farmer		
Unemployed/retired	11	15,7%
	11	15,7%
Duration of T2DM		
Long duration (>10 years)	5	7,1%
Moderate duration (6-10 years)	21	30%
Short duration (≤5 years)	44	62,9%
Antidiabetic medication use		
Regular	70	100%
Irregular	0	0%

Based on Table 1, the majority of respondents were female (71.4%). Most respondents had completed senior high school (45.7%) and were housewives (37.1%). The majority had been living with type 2 diabetes mellitus for ≤5 years (62.9%). All respondents (100%) were also recorded as regularly taking antidiabetic medication according to their prescribed treatment.

Descriptive Characteristics of Breakfast Energy Proportion, Macronutrient Coposition, and Fasting Blood Glucose

The descriptive characteristics of breakfast energy proportion, macronutrient composition, and fasting blood glucose levels among the respondents are presented in Table 2.

Table 2. Distribution of Breakfast Energy Proportion, Macronutrient Composition, and Fasting Blood Glucose Levels

	Min	Max	Mean	SD
Energy (kcal)	204,4	883	307,5	94,3
Carbohydrate (g)	21,7	114	40,9	14,3
Protein (g)	6,9	31,7	13,24	4,07
Fat (g)	5	33,4	10,04	4,19
Energy (%)	12,6	41,1	19,46	4,84
Carbohydrate (%)	36	68,5	53,24	8,03
Protein (%)	10,5	26,5	17,54	4,19
Fat (%)	17,5	45,0	29,01	6,45
Fasting blood glucose (mg/dL)	95	453	179,85	69,02

Table 2 presents the descriptive characteristics of breakfast energy proportion, macronutrient composition, and fasting blood glucose levels among the respondents. The mean breakfast energy proportion was 19.46% of total daily energy requirements, with values ranging from 12.6% to 41.1%. Carbohydrates constituted the largest proportion of macronutrient intake at breakfast, with a mean of 53.24%, followed by fat at 29.01% and protein at 17.54%. The mean fasting blood glucose level among the respondents was 179.85 mg/dL.

Association Between Breakfast Energy Proportion, Macronutrient Composition, and Fasting Blood Glucose Levels

Hubungan The associations between breakfast energy proportion, macronutrient composition, and fasting blood glucose levels were analyzed using Pearson's correlation test. The selection of this test was based on the results of the Kolmogorov–Smirnov normality test, which indicated that the data were normally distributed ($p = 0.063$). Therefore, Pearson's correlation test was used to analyze the associations between the variables. The results are presented in Table 3.

Table 3. Associations Between Breakfast Energy Proportion, Carbohydrate, Protein, and Fat Composition and Fasting Blood Glucose Levels

Variabel	Fasting Blood Glucose	
	n	*p-value*
%Energy	70	0,884
%Carbohydrate	70	0,113
%Protein	70	0,257
%Fat	70	0,260

Based on the results of Pearson's correlation test presented in Table 3, breakfast energy proportion was not significantly associated with fasting blood glucose levels ($p = 0.884$). Similar results were observed for carbohydrate composition ($p = 0.113$), protein composition ($p = 0.257$), and fat composition ($p = 0.260$). Thus, neither breakfast energy proportion nor macronutrient composition

was significantly associated with fasting blood glucose levels among pre-elderly outpatients with type 2 diabetes mellitus at Hospital X, Gresik Regency.

DISCUSSIONS

Association Between Breakfast Energy Proportion and Fasting Blood Glucose Levels

Based on the analysis results, breakfast energy proportion was not significantly associated with fasting blood glucose levels among pre-elderly outpatients with type 2 diabetes mellitus at Hospital X, Gresik Regency ($p = 0.884$). Studies specifically examining the association between breakfast energy proportion and fasting blood glucose levels in patients with T2DM remain relatively limited. Most previous studies have employed intervention designs, whereas the present study used a cross-sectional approach and therefore only describes the associations between variables at the time of data collection.

One study summarized in a review article by Jakubowicz et al. (12) examined the implementation of the big breakfast diet in patients with type 2 diabetes mellitus. This dietary pattern allocates the largest proportion of energy to breakfast, approximately 700 kcal or 50% of total daily energy requirements, followed by 600 kcal (36%) at lunch and 200 kcal (14%) at dinner. The review indicated that a greater distribution of energy intake in the morning was associated with reductions in postprandial glucose, HbA1c, hunger, and body weight compared with a dietary pattern in which a greater proportion of energy was consumed in the evening (12). Improvements in glycemic control are thought to be related to the body's circadian rhythm, which influences insulin sensitivity and secretion as well as glucose utilization by skeletal muscle, all of which may function more optimally in the morning. Under these conditions, energy consumed at breakfast may be utilized more efficiently. In addition, a higher energy proportion at breakfast may increase satiety, thereby helping regulate intake at subsequent meals through the second-meal effect and supporting blood glucose control (12).

The absence of a significant association in the present study may have been influenced by the distribution of fasting blood glucose levels among the respondents, which tended to be high. This condition may occur because insulin resistance allows hepatic glucose production to continue through gluconeogenesis and glycogenolysis during fasting, resulting in persistently elevated blood glucose levels even in the absence of food intake (16). In addition, the use of accidental sampling may have resulted in a sample whose characteristics did not fully represent the broader population of patients with type 2 diabetes mellitus.

An additional factor that may explain the lack of a significant association between the two variables is that dietary intake, including breakfast energy proportion, is not the only factor associated with fasting blood glucose levels in patients with T2DM. Fasting blood glucose is influenced by various factors, including physical activity, adherence to pharmacological therapy, diabetes duration, stress levels, and overall dietary patterns (17). Based on the characteristics of the respondents, most worked as housewives or traders. These occupational characteristics reflect varying levels of daily physical activity, which may potentially influence blood glucose levels.

Rahayuningsih et al. (18) reported a significant association between physical activity and blood glucose levels in patients with T2DM. Physical activity can increase glucose utilization by

muscles as an energy source and improve insulin sensitivity, thereby facilitating the uptake of glucose from the bloodstream into body cells and contributing to blood glucose control. Conversely, insufficient physical activity may reduce the efficiency of glucose utilization by body tissues, resulting in a tendency toward elevated blood glucose levels (18). Therefore, variations in fasting blood glucose levels in the present study may have been influenced not only by breakfast energy proportion but also by other factors that were not directly analyzed.

Association Between Breakfast Macronutrient Composition and Fasting Blood Glucose Levels

The analysis showed that breakfast macronutrient composition was not significantly associated with fasting blood glucose levels, whether for carbohydrate composition ($p = 0.113$), protein composition ($p = 0.257$), or fat composition ($p = 0.260$). These findings indicate that differences in the proportions of carbohydrates, protein, and fat consumed at breakfast were not accompanied by differences in fasting blood glucose levels among pre-elderly outpatients with type 2 diabetes mellitus at Hospital X, Gresik Regency. Studies specifically examining the association between breakfast macronutrient composition and fasting blood glucose levels in patients with type 2 diabetes mellitus remain limited, while most previous studies have employed intervention designs.

One study investigating the relationship between carbohydrate and fat composition at breakfast and glycemic control in individuals with T2DM was conducted by Oliveira et al. (2023) (19). The study used a randomized crossover trial design to compare the effects of a low-carbohydrate breakfast and a low-fat breakfast in patients with type 2 diabetes mellitus. The low-carbohydrate breakfast intervention provided approximately 465 kcal, consisting of 25 g of protein, 8 g of carbohydrates, and 37 g of fat, whereas the low-fat breakfast provided approximately 450 kcal, consisting of 20 g of protein, 56 g of carbohydrates, and 15 g of fat. The results showed that participants who consumed the low-carbohydrate breakfast experienced lower postprandial hyperglycemic exposure than those who consumed the low-fat breakfast. These findings suggest that restricting carbohydrate intake at breakfast may have the potential to improve postprandial glucose control in patients with type 2 diabetes mellitus (15).

The differences between the findings of the present study and those of Oliveira et al. (15) may be attributable to differences in study design, breakfast timing, dietary assessment methods, and the glycemic control indicators used. The present study employed a cross-sectional design, with breakfast timing varying among respondents, whereas experimental studies standardize meal timing, making the effects of breakfast composition on glycemic control easier to observe (12). The use of 24-hour food recalls is also subject to recall bias and social desirability bias, which may affect the accuracy of information regarding participants' dietary intake (19). In addition, the present study used fasting blood glucose levels as an indicator of glycemic control, whereas Oliveira et al. (15) used HbA1c, which reflects long-term blood glucose control. These differences in indicators may have contributed to the lack of a significant association between breakfast macronutrient composition and glycemic status in the present study.

CONCLUSION AND RECOMMENDATIONS

This study showed that the mean breakfast energy proportion among pre-elderly outpatients with type 2 diabetes mellitus at Hospital X, Gresik Regency, was 19.46% of total daily energy requirements. The macronutrient composition was predominantly carbohydrate (53.24%), followed by fat (29.01%) and protein (17.54%). The analysis showed that neither breakfast energy proportion nor macronutrient composition, including carbohydrate, protein, and fat, was significantly associated with fasting blood glucose levels among patients with type 2 diabetes mellitus. Patients with T2DM are advised to continue adopting a healthy dietary pattern, adhering to prescribed medication regimens, engaging in regular physical activity, and monitoring blood glucose levels regularly. Future studies are expected to employ stronger research designs and consider other factors that may influence blood glucose levels, including HbA1c parameters.

CONFLICT OF INTEREST

The authors declare that there were no commercial or financial relationships during the conduct of the study that could potentially give rise to a conflict of interest.

AUTHOR CONTRIBUTIONS

AAA contributed to the conceptualization of the study, data collection and analysis, interpretation of the results, and manuscript preparation. LAS contributed to study conceptualization, research supervision, data analysis and interpretation, as well as critical review and manuscript refinement. All authors have read and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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DECLARATION OF ARTIFICIAL INTELLIGENCE USE

ChatGPT (OpenAI, GPT-5 version) was used to assist with improving the language and grammar of the manuscript. The authors reviewed and verified the entire manuscript to ensure its accuracy and integrity.

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