E-ISSN: 2962-6110
P-ISSN: 2964-7843
JSRET
jsret.knpub.com
Journal of Scientific Research, Education, and Technology

Energy Adequacy During Suhoor and Glycemic Stability for Elderly Diabetics

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ABSTRACT

Fasting is a mandatory worship practice for Muslims, including for the elderly with type 2 diabetes mellitus (DM2). However, this condition poses challenges in maintaining glycemic stability and energy adequacy from suhoor to iftar time. The study identified optimal nutritional strategies to achieve energy sufficiency during suhoor and to maintain stable blood glucose levels in the elderly with DM2. The research uses the Systematic Literature Review (SLR) approach, examining scientific articles indexed in Scopus and Web of Science from 2010–2024. Literature selection is carried out through the stages of identification, screening, and eligibility using the PRISMA guidelines. The results of the study showed that a balanced composition of suhoor food including complex carbohydrates (100–150 g), animal protein (50–75 g), vegetable protein (±50 g), fibrous vegetables (±100 g), low glycemic index fruit (±100 g), healthy fats (30–50 g), low-fat milk (±200 ml), and adequate hydration (2–3 glasses of water) play an important role in maintaining glycemic stability in the elderly with DM2. The energy needs of the elderly with diabetes range from 25–30 kcal/kg of body weight per day, with suhoor contributing around 30–40% of the total daily energy needs (±450–600 kcal). Energy intake below the sufficiency threshold can increase the risk of hypoglycemia, fatigue, and impaired metabolic function. In contrast, energy intake above the maximum limit can lead to hyperglycemia, obesity, and insulin resistance. The importance of planning a balanced suhoor menu to maintain stable blood glucose levels in elderly individuals with DM2 during fasting

Keywords: *Type 2 Diabetes Mellitus, Elderly, Suhur, Glycemic Stability, Systematic Literature Review*

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INTRODUCTION

Ramadan fasting is a form of worship with a spiritual dimension and implications for a Muslim's health behaviour (Rouhani & Azadbakht, 2014). In the practice of refraining from eating, drinking, and lust from dawn to sunset, a believer is trained to increase piety, discipline, and self-control.

From an Islamic perspective, maintaining the health of the body is also part of the mandate that humans must fulfil, so that the practice of suhoor and breaking the fast with halal food and thayyib is a form of gratitude for the health blessings given by Allah. In addition to this spiritual dimension, the practice of fasting is also beginning to be studied in

a modern health perspective because it has potential metabolic benefits when done with the right diet (Hassanein et al., 2017; Mohd Yusof et al., 2021).

Several studies show that Ramadan fasting can positively impact metabolic health when accompanied by a balanced diet. Observational studies and meta-analyses report that Ramadan fasting may be associated with weight loss, reduced waist circumference, lower blood pressure, lower fasting blood glucose levels, in improved lipid profiles (Babineaux et al., 2015; AbuShihab et al., 2024). The findings suggest that fasting not only has spiritual value but also has the potential to support the prevention and control of metabolic diseases, including type 2 diabetes mellitus.

This is becoming increasingly relevant as the prevalence of diabetes globally increases. The International Diabetes Federation reports that by 2024, about 589 million adults in the world will be living with diabetes, or about 1 in 9 adults, and this number is projected to rise to about 853 million people by 2050 if there are no effective prevention efforts (IDF, 2025; Duncan et al., 2026). This increase in prevalence suggests that diabetes has become one of the major global public health challenges.

On the other hand, the world is also facing the phenomenon of population ageing. As life expectancy increases and birth rates decline, the number of older adults is projected to increase significantly until the middle of this century (Zhao et al., 2024). The elderly are a group that has a higher susceptibility to chronic non-communicable diseases, including type 2 diabetes mellitus (Bradley & Hsueh, 2016). Therefore, the increasing number of older adults with diabetes will pose a major challenge to the health system in various countries.

Type 2 diabetes mellitus (DM2) is a chronic metabolic disease characterised by impaired glucose regulation due to insulin resistance and decreased pancreatic beta-cell function. In the elderly group, diabetes is not only related to impaired glucose metabolism but also to various complications such as cardiovascular disease, neuropathy, and decreased quality of life (Genitsaridi et al., 2026; LeRoith et al., 2019). This condition makes the management of nutrition and metabolism in the elderly with diabetes an increasingly important public health issue.

For Muslims, Ramadan fasting is an annual worship practice that involves significant changes in eating patterns and meal times. During Ramadan, individuals fast from sunrise to sunset, which can last for 12–16 hours depending on the geographical region. These dietary changes can affect glycemic control in people with diabetes, especially in the elderly who have more limited metabolic capacity (Hassanein et al., 2017). Several studies have shown that changes in meal times during Ramadan can affect insulin sensitivity, glucose metabolism, and energy balance in people with type 2 diabetes (El Toony et al., 2022; Salih A et al., 2025; Ibrahim et al., 2020).

In the context of Ramadan fasting, suhoor is a very important meal time because it functions as the main source of energy that the body will use during the fasting period. The right nutritional composition during suhoor can help maintain stable blood glucose levels throughout the day. Research shows that consuming foods with a low glycemic index, sufficient protein, and dietary fibre can slow glucose absorption and maintain stable blood sugar levels during fasting (Sadikot et al., 2017; Ibrahim et al., 2025). Conversely, high-

glycemic-index foods or insufficient energy intake can increase the risk of hypoglycemia or hyperglycemia in people with diabetes during fasting (Hanan Abdul et al., 2023).

A phenomenon that is often found in the elderly with diabetes who fast is the instability of blood glucose levels due to improper eating during suhoor. Many older adults eat foods high in simple carbohydrates or even skip suhoor, thus causing glycemic fluctuations during fasting. This condition can increase the risk of hypoglycemia during the day and hyperglycemia after eating (Hassanein et al., 2017). In addition, the elderly also experience physiological changes such as decreased muscle mass, changes in energy metabolism, and decreased insulin sensitivity that can affect glycemic control (LeRoith et al., 2019).

Although many studies have addressed diabetes management during Ramadan, most studies still focus on general aspects such as adjustments to drug therapy or physical activity. Studies specifically examining the relationship between energy sufficiency during suhoor and glycemic stability in the elderly with type 2 diabetes remain relatively limited. In addition, information on the optimal composition of suhoor food for the elderly in maintaining metabolic balance has not been systematically analysed in the scientific literature.

Several previous studies have provided an important foundation in nutrition management in people with diabetes. Sadeghirad et al. (2020) show that consuming low-glycemic-index foods during Ramadan can help control blood glucose levels in people with type 2 diabetes. Other research shows that adequate protein intake plays an important role in maintaining muscle mass and preventing sarcopenia in the elderly (LeRoith et al., 2019). In addition, Al Hayek et al. (2025) emphasise that regulating macronutrient composition is an important strategy in the nutrition management of diabetics. Dietary fibre is also reported to have an important role in slowing down glucose absorption and improving glycemic control (Reynolds et al., 2019). Another study shows that proper dietary planning during Ramadan can help maintain metabolic stability in patients with diabetes (Hassanein et al., 2017).

However, studies that specifically examine energy sufficiency strategies during suhoor and their association with glycemic stability in the elderly with type 2 diabetes, through a systematic literature review, remain very limited. In fact, understanding the relationship between energy adequacy, suhoor food composition, and metabolic risk is very important in developing evidence-based nutrition recommendations for the elderly with diabetes during fasting.

Based on this background, this study aims to identify optimal nutritional strategies in achieve energy sufficiency during suhoor and to maintain glycemic stability in the elderly with type 2 diabetes mellitus through a systematic literature review.

METHOD

This research uses a qualitative method. Creswell and Creswell (2018) state that qualitative research is an approach to exploring and understanding the meaning of a social or humanitarian problem by collecting and analysing interpretive, contextual data. This

approach was chosen because the study aims to examine in depth various findings of previous research on nutritional strategies in maintaining energy adequacy and glycemic stability in the elderly with type 2 diabetes during fasting.

The research approach used is a Systematic Literature Review (SLR). According to Kitchenham and Charters (2007), a systematic literature review is a research method that systematically identifies, evaluates, and synthesises research results relevant to a particular topic using structured and transparent procedures. Through this approach, the study seeks to identify and analyse the scientific literature related to nutritional strategies in the elderly with type 2 diabetes during fasting.

The article search is conducted across several reputable scientific databases, namely Scopus, Web of Science, PubMed, and ScienceDirect. Literature search using relevant keywords, including *type 2 diabetes*, *fasting*, *Ramadan nutrition*, *glycemic control*, and *elderly diabetes*. The use of several such databases aims to access comprehensive, high-quality scientific literature.

The research inclusion criteria include articles published in reputable international journals in the period 2010–2024, research that discusses nutrition, glycemic control, and diet management in people with diabetes during fasting. Meanwhile, the exclusion criteria include articles that are not relevant to the research focus, lack clear empirical data, or lack peer review.

The article selection process follows the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, which include the identification, screening, eligibility, and inclusion stages (Page et al., 2021). Through these stages, articles that meet the criteria are selected for further analysis to ensure that the literature used is truly relevant to the research objectives.

The data analysis technique used is content analysis. According to Mayring (2014), content analysis is a research technique used to generate valid and replicable inferences from text or document data by considering the context. Through this technique, researchers categorised, interpreted, and synthesised previous research findings to identify patterns of nutritional strategies that are effective in achieving energy sufficiency and maintaining glycemic stability in the elderly with type 2 diabetes during the fasting period.

FINDING AND DISCUSSION

RESEARCH RESULT

Article selection was carried out using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, comprising the identification, screening, eligibility, and inclusion stages. At the identification stage, 1,248 articles were obtained from various databases. After deleting 212 duplicate articles, 1,036 articles remain for the screening stage based on titles and abstracts. At this stage, as many as 892 articles were eliminated as not relevant to the research focus. Furthermore, 144 articles entered the *full-text review* stage. After a feasibility assessment based on inclusion and exclusion criteria, as many as 112 articles were eliminated because they did not meet the

methodological criteria or did not have adequate empirical data. Thus, a total of 32 articles were identified as meeting the criteria and were further analysed in this study.

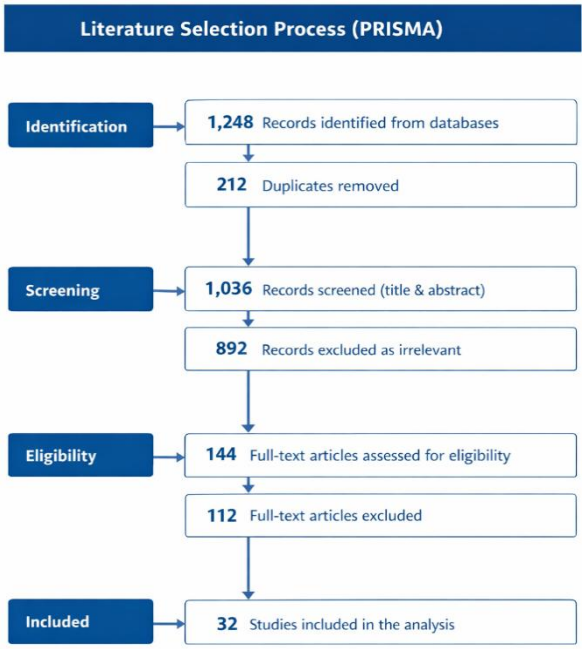

Figure 1. PRISMA Analysis

A total of 32 articles were analysed, including observational studies, cohort studies, meta-analyses, clinical guidelines, and international consensus reports on diabetes management during Ramadan. Most of the studies were conducted in countries with large Muslim populations in the Middle East, South Asia, and Europe, as well as in some multi-country studies involving global populations of people with diabetes.

Table 1. Energy Sufficiency and Risk Strategy for the Elderly with DM2

No	Nutrition Component/Strategy	Types of Food	Weight/Serving	Benefits to Glycemic Stability	Risks if < Energy Threshold	Risks if > Energy Limit
1	Complex carbohydrates of low glycemic index	Brown rice, oats, whole wheat bread	100–150 g	Provides gradual energy and reduces blood glucose spikes	Hypoglycemia, fatigue	Hyperglycemia, insulin resistance

2	Quality animal protein	Fish, skinless chicken, eggs	50–75 g	Slows down glucose absorption and maintains muscle mass	Risk of sarcopenia in the elderly	Excess metabolic load
3	Plant-based protein is high in fiber	Tempeh, tofu, nuts	±50 g	Adds protein and fibre for energy stability	Decreased immunity	Excess calorie intake from fried foods
4	High-fibre vegetables	Broccoli, spinach, carrots	±100 g	Slows down the absorption of carbohydrates	Indigestion occurs when there is a severe lack of fibre.	Minimal risk
5	Low glycemic index fruit	Apples, pears	±100 g	Sources of fiber and antioxidants	Micronutrient deficiency	Spike in sugar if the GI is high
6	Healthy fats	Avocado, almonds	30–50 g	Slows down gastric emptying and conserves energy	Insufficient energy	Obesity and dyslipidemia.
7	Low-fat milk	Unsweetened milk	±200 ml	Adding protein and calcium	Risks of calcium deficiency	Excess calories
8	Hydration	Water	2–3 cups	Supports glucose metabolism	Dehydration	Minimal risk
9	The time of suhoor is approaching imsak	Suhoor before dawn	–	Reduces the risk of hypoglycemia	Energy depletes quickly	–

10	Glucose monitoring	Self-monitoring glucose	–	Controls glycemic fluctuations	Risk of hypoglycemia due to not detecting	Risk of hyperglycemia

DISCUSSION

The analysis of the table above shows that the nutritional composition of suhoor strongly influences glycemic stability in the elderly with type 2 diabetes during fasting, the adequacy of daily energy intake, and the quality of the food consumed. This is in line with the opinion of Reynolds et al. (2019) that consuming complex carbohydrates with a low glycemic index can help slow glucose absorption, thereby maintaining stable blood sugar levels during the fasting period. In addition, adequate protein intake, from both animal and plant sources, plays an important role in maintaining muscle mass in the elderly and increasing satiety, thereby preventing excessive food consumption during iftar (Bradley & Hsueh, 2016).

The study's findings also show that dietary fibre from low-glycemic index vegetables and fruits helps slow the post-meal glycemic response. In addition, healthy fats and adequate hydration play a role in maintaining energy balance and supporting the body's metabolism during fasting. For this reason, Baharuddin and Wijaya (2024) consistently emphasise that regulating energy sufficiency during suhoor around 30-40% of daily energy needs is an important strategy in maintaining blood glucose stability in people with diabetes during Ramadan.

Instead, research by Rouhani and Azadbakht (2014) shows that an energy intake that is too low during suhoor can increase the risk of hypoglycemia, fatigue, and impaired metabolic function in the elderly. On the other hand, excessive energy consumption, especially from foods high in simple sugar, can lead to hyperglycemia, weight gain, and insulin resistance (LeRoith et al., 2019).

The results of the literature synthesis show that glycemic stability in the elderly with type 2 diabetes mellitus during fasting is strongly influenced by the nutritional composition of suhoor, energy adequacy, and the quality of the food consumed. In fasting conditions that last for 12–16 hours, the body relies on energy reserves obtained from suhoor food to maintain metabolic homeostasis. Therefore, the selection of the right type of food and the proper distribution of macronutrients are key factors in maintaining stable blood glucose levels during the fasting period (Hassanein et al., 2017). Previous research has also shown that proper diet planning during Ramadan can help reduce glycemic fluctuations and improve metabolic control in people with type 2 diabetes (Babineaux et al., 2015).

One of the most important nutritional components in maintaining glycemic stability is the consumption of complex carbohydrates with a low glycemic index, such as brown rice, whole wheat, and oatmeal. Carbohydrates with a low glycemic index are digested and absorbed more slowly compared to simple carbohydrates, resulting in a more

stable release of glucose into the bloodstream. Ibrahim et al. (2020) show that a low-glycemic-index diet can reduce fluctuations in blood glucose levels and improve metabolic control in people with type 2 diabetes. These findings are also supported by the International Diabetes Federation's report, which recommends consuming complex carbohydrates during Ramadan to reduce the risk of postprandial hyperglycemia and hypoglycemia during the fasting period (IDF, 2025).

In addition to complex carbohydrates, quality protein intake also has an important role in the management of diabetes in the elderly. Protein from animal sources such as fish, skinless chicken, and eggs can help slow down stomach emptying and increase satiety after eating. This condition helps lower the glycemic response after meals because nutrient absorption occurs more gradually (Genitsaridi et al., 2026). In the elderly group, protein intake is also very important for maintaining muscle mass and preventing sarcopenia, which often occurs with age (LeRoith et al., 2019). Therefore, a combination of complex carbohydrates and enough protein at suhoor time can help maintain energy balance during fasting.

Fibre-rich sources of plant-based protein, such as tempeh, tofu, and beans, also make an important contribution to metabolic stability. Vegetable proteins not only provide essential amino acids, but they also contain dietary fibre that can slow down the absorption of glucose in the intestines. Mohd Yusof et al. (2021) report that consuming plant-based protein during Ramadan can improve glycemic control and provide a longer-lasting satiety effect. In addition, a plant-based protein-based diet is also associated with a reduced risk of cardiovascular disease, which is often a complication in people with diabetes (Reynolds et al., 2019).

Consumption of high-fibre vegetables such as broccoli, spinach, and carrots also plays an important role in maintaining glycemic stability during fasting. Dietary fibre can slow down stomach emptying and decrease the rate of carbohydrate absorption, thereby reducing blood glucose spikes after meals (Slavin, 2005). In addition, fibre also helps to improve insulin sensitivity and maintain a healthy digestive system. Epidemiological studies show that individuals with higher fibre consumption have a lower risk of developing metabolic complications, including type 2 diabetes (Reynolds et al., 2019).

In addition to vegetables, the consumption of low-glycemic-index fruits, such as apples and pears, can also be an important source of micronutrients and antioxidants for people with diabetes. These fruits contain vitamins, minerals, and phytonutrients that can help reduce oxidative stress that often occurs in people with chronic diabetes (Genitsaridi et al., 2026). However, the fruit type still needs to be considered, as some high-glycemic fruits can cause a spike in blood sugar when consumed in excess.

Another important nutritional component is healthy fats, such as those found in avocados and almonds. Healthy fats play a role in slowing down the process of emptying the stomach so that energy can be released more gradually during fasting. In addition, the consumption of unsaturated fats is also associated with improved lipid profiles and a reduced risk of cardiovascular disease in people with diabetes (Bradley & Hsueh, 2016).

However, fat consumption still needs to be controlled because excessive intake can increase the risk of obesity and dyslipidemia.

In addition to macronutrient aspects, adequate hydration is also an important factor in managing diabetes during fasting. Dehydration can affect glucose metabolism and increase blood sugar concentrations by reducing plasma volume. Therefore, consuming sufficient water at suhoor and iftar is highly recommended to maintain fluid balance and support energy metabolism (IDF, 2021).

This study also shows that the time of suhoor consumption has an important role in maintaining glycemic stability. Suhoor, which is carried out close to imsak, can help shorten the duration of fasting so that the body's energy reserves last longer throughout the day. The South Asian Health Foundation's guidelines suggest that people with diabetes should not skip suhoor because it can increase the risk of hypoglycemia during fasting (Hassanein et al., 2017).

In addition, self-monitoring of blood glucose levels is an important strategy in managing diabetes during Ramadan. Glucose monitoring allows people with diabetes to detect changes in blood sugar levels early, helping prevent hypoglycemia or dangerous hyperglycemia (Ibrahim et al., 2020).

The findings of this study have important implications for the development of evidence-based nutrition recommendations for seniors with type 2 diabetes who fast during Ramadan. The results of the research can serve as the basis for health workers, nutritionists, and policymakers in developing a balanced suhoor diet guide to maintain glycemic stability and prevent metabolic complications in elderly individuals with diabetes. In addition, this study confirms the importance of nutrition education and regular health monitoring for people with diabetes.

Overall, the results of this study show that glycemic stability in the elderly with type 2 diabetes during fasting can be achieved through a combination of nutritional strategies, including complex carbohydrates, high-quality proteins, dietary fibre, healthy fats, adequate hydration, and proper meal timing. This balanced nutritional approach not only helps keep blood glucose levels stable but also has the potential to improve the quality of life of older adults with diabetes who are fasting during Ramadan.

CONCLUSION

This study aims to identify optimal nutritional strategies in achieve energy sufficiency during suhoor and to maintain glycemic stability in the elderly with type 2 diabetes mellitus through a systematic literature review. Based on the synthesis of the analysed literature, it can be concluded that glycemic stability during fasting in the elderly with diabetes is strongly influenced by nutritional composition, energy adequacy, and the quality of food consumed during suhoor. The most consistent nutritional strategies reported in various studies include the consumption of complex carbohydrates with a low glycemic index, quality protein from animal and plant sources, fibrous vegetables and fruits, healthy fats, and adequate hydration. In addition, setting suhoor time close to imsak and

monitoring blood glucose levels independently also play an important role in reducing the risk of glycemic fluctuations during fasting.

The results of this study show that energy sufficiency during suhoor, around 30-40% of daily energy needs, can help maintain metabolic balance during the fasting period. Energy intake below the sufficiency threshold can increase the risk of hypoglycemia, fatigue, and decreased metabolic function in the elderly. Conversely, excessive energy consumption, especially from high-glycemic-index foods, can increase the risk of hyperglycemia, insulin resistance, and long-term metabolic complications.

This research has several limitations. First, the study uses a systematic literature review approach so that the findings produced depend on the quality and methodological variation of the studies analysed. Second, most of the studies analysed were observational, so they could not fully explain the causal relationship between nutritional strategies during suhoor and glycemic stability. Third, variations in population characteristics, food culture, and fasting duration in various countries can affect the generalisation of research results.

Further research is recommended to conduct an empirical study or a nutritional intervention test among older adults with type 2 diabetes who fast during Ramadan to directly evaluate the effectiveness of the composition of the suhoor menu in maintaining glycemic stability. In addition, future research can also examine the relationship between suhoor diet, physical activity, and pharmacological therapy in managing diabetes during fasting. The development of community-based nutrition intervention models or digital health technologies also has the potential to make an important contribution to improving the quality of life for older adults with diabetes who practice fasting.

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