ISSN. 2338-7475
E-ISSN. 2620-7869
Hearty
Jurnal Kesehatan Masyarakat
Beriman, Tulus, Sepenuh Hati,Berbesar Hati, Jujur, Sehat dan Kuat
Vol. 14 No. 4, Agustus 2026, Hal. 975-982

GLUCOSE SPIKE DURING FASTING: PHYSIOLOGICAL MECHANISMS, RISK FACTORS, AND POLICY IMPLICATIONS FOR METABOLIC DISEASE PREVENTION

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Abstract

Fasting is a physiological condition in which the body does not receive energy intake from food for a defined period, thereby relying on endogenous energy reserves to maintain metabolic homeostasis. During fasting, multiple metabolic adaptations occur, including hormonal regulation involving insulin and glucagon, as well as alterations in hepatic and peripheral tissue metabolism. Although fasting is widely associated with metabolic health benefits, some individuals experience a phenomenon known as a glucose spike, characterized by a rapid increase in blood glucose levels following food intake, particularly after consuming high glycemic index foods. Recurrent glucose spikes are associated with an increased risk of insulin resistance, type 2 diabetes mellitus, and cardiovascular diseases. This study aims to analyze the physiological mechanisms underlying glucose spikes during fasting, identify key risk factors, and evaluate policy implications for metabolic disease prevention. A literature review with a descriptive approach was conducted using scientific articles published within the last three years, sourced from Google Scholar, PubMed, and accredited national journals. The findings indicate that glucose spikes are influenced by multiple factors, including altered insulin sensitivity, high glycemic index food consumption, obesity, pancreatic dysfunction, and sedentary behavior. Evidence suggests that balanced dietary patterns, low glycemic index foods, regular physical activity, and intermittent fasting contribute to improved glucose stability. These findings underscore that controlling glucose spikes requires both behavioral modification and comprehensive health policies, including nutrition education, diabetes management during fasting, and targeted lifestyle interventions for high-risk populations.

Keywords: Glucose Spike, Fasting, Glucose Metabolism, Diabetes Mellitus, Health Policy

INTRODUCTION

Fasting is a physiological condition in which the body does not receive energy intake from food for a certain period, requiring the utilization of internal energy reserves to maintain metabolic functions. Under normal conditions, blood glucose levels are regulated through homeostatic mechanisms involving insulin and glucagon, as well as metabolic activities in the liver and peripheral tissues (Ridwanto et al., 2024). In the early phase of fasting, the body utilizes glycogen stores in the liver through glycogenolysis to maintain blood glucose stability. As these reserves decline, gluconeogenesis is increased using substrates such as amino acids, lactate, and glycerol as alternative energy sources (Ridwanto et al., 2024).

Although fasting is often considered beneficial for metabolic health, some individuals experience glucose spikes, characterized by rapid increases in blood glucose levels after food intake. When this condition occurs repeatedly, it may lead to insulin resistance and impaired glucose metabolism (Rosita

Submitted: April-2026 Received: June-2026 Available Online: August-2026

& Wahyuni, 2024). This phenomenon is more frequently observed in individuals with metabolic syndrome, obesity, or type 2 diabetes mellitus, due to impaired insulin regulation that limits the body's ability to control postprandial glucose surges (Christine & Elon, 2023).

Additionally, dietary patterns during breaking the fast, often dominated by high glycemic index foods such as sugary beverages and simple carbohydrates, further accelerate increases in blood glucose levels (Putri & Handayani, 2023). Repeated glucose spikes may elevate the risk of metabolic diseases, including type 2 diabetes mellitus and cardiovascular disorders. Therefore, understanding the physiological mechanisms of glucose spikes during fasting is essential for effective metabolic disease prevention (Li et al., 2025).

Based on these considerations, this article aims to examine the physiological mechanisms of glucose spikes, associated risk factors, and health policy implications for metabolic disease prevention.

Research Methods

This study employs a literature review approach using descriptive-analytical methods to examine scientific findings related to glucose metabolism during fasting, the glucose spike phenomenon, and health policy implications. This approach allows for systematic integration of previous research to obtain a comprehensive understanding of the relationship between fasting and metabolic disease risk. Data sources include national and international scientific articles published between 2023 and 2025. Literature searches were conducted through Google Scholar, PubMed, and accredited national journals, considering relevance and publication quality.

Inclusion criteria comprised articles discussing glucose metabolism during fasting, glucose spikes, and lifestyle or nutritional interventions during fasting periods. Articles lacking relevance or adequate scientific data were excluded. Literature selection followed stages of identification, screening based on titles and abstracts, and in-depth content analysis. Data were analyzed using a narrative synthesis approach to identify relationships between metabolic changes, hormonal regulation, and the risk of glucose spikes.

Results

The review indicates that studies with various methodological designs—including randomized controlled trials, observational studies, and systematic reviews—generally conclude that controlled fasting provides metabolic benefits. However, inappropriate dietary patterns after fasting may trigger significant increases in blood glucose levels. Several clinical studies show that intermittent fasting improves insulin sensitivity and reduces blood glucose levels in at-risk individuals. Weight reduction among obese individuals also contributes to improved glucose metabolism.

Glucose stability during fasting is strongly influenced by the type of food consumed after breaking the fast. Balanced diets tend to produce more stable glucose profiles compared to high-sugar diets. Furthermore, appropriate medical education plays a critical role in helping diabetes patients maintain glycemic control during fasting.

No	Author	Research Title	Year	Method	Sampling Technique	Research Findings	Policy Implication Analysis
1	Obermayer et al.	Efficacy and Safety of Intermittent Fasting in People With Insulin-Treated Type 2 Diabetes	2023	Randomized Controlled Trial	Random sampling (46 patients with type 2 diabetes mellitus)	Intermittent fasting reduces HbA1c levels and insulin requirements	Supports the integration of fasting-based lifestyle interventions into national diabetes management guidelines
2	Sukkriang & Buranapin	Effect of Intermittent Fasting on Weight Reduction and Metabolic Outcomes	2024	Randomized Controlled Trial	Random sampling (99 obese patients with diabetes mellitus)	Intermittent fasting reduces body weight and blood glucose levels	Obesity control programs should be incorporated into diabetes prevention policies
3	Peters et al.	Glucose Profiles During Time-Restricted Eating	2024	Randomized Clinical Study	Volunteer sampling	Glucose variation remains relatively stable during time-restricted fasting	Time-based dietary guidelines can be utilized in metabolic health promotion strategies
4	Al-Shamsi et al.	Ramadan Fasting and Glycemic Control in Type 2 Diabetes	2025	Retrospective Cohort	Medical record data	Ramadan fasting does not worsen glycemic control in most patients	Health service policies should provide specific education for fasting diabetes patients
5	Li et al.	Meta-Analysis of Intermittent Fasting Effects on Glycaemic Control	2025	Systematic Review & Meta-analysis	17 studies	Intermittent fasting effectively improves glycemic control	Scientific evidence supports preventive dietary policy recommendations for at-risk populations
6	Harris et al.	Time-Restricted Eating for Weight Loss and	2023	Randomized Clinical Trial	Random sampling	Significant reduction in body weight and blood	Health promotion programs can incorporate

		Glycemic Control				glucose levels	time-restricted eating patterns
7	Rahman et al.	Dietary Management for Diabetes Patients During Fasting	2024	Clinical Review	Literature study	Dietary regulation can prevent glucose spikes	Nutrition education is a crucial component of diabetes control policies
8	Kurniawan & Sari	Dietary Patterns and Glycemic Control During Fasting	2023	Observational Study	Purposive sampling	High glycemic index foods increase glucose spikes	Regulation of sugar consumption and public education are necessary
9	Putri & Handayani	Glycemic Index of Foods Consumed During Ramadan	2023	Cross-Sectional Study	Random sampling	Sugary beverages increase glucose spikes	Health promotion policies should limit sugar consumption
10	Wibowo et al.	Nutrition Strategies to Prevent Glucose Spike	2024	Experimental Study	Purposive sampling	Combination of protein, fiber, and complex carbohydrates reduces glucose spikes	National dietary guidelines can incorporate balanced nutritional composition
11	Ahmed et al.	Lifestyle Intervention and Prediabetes Management	2025	Cohort Study	427 prediabetes patients	Lifestyle interventions reduce diabetes risk	Public health policies should focus on diabetes
12	Garfield et al.	Postprandial Glucose Spikes and Risk of Cognitive Decline	2025	Epidemiological Study	Large population data	Glucose spikes are associated with the risk of degenerative diseases	Glucose control is essential in chronic disease prevention strategies

Discussion

1. Adaptation of Glucose Metabolism During Fasting

Fasting induces metabolic changes as an adaptive response to limited energy intake. In the early phase, the body utilizes hepatic glycogen stores through glycogenolysis to maintain blood glucose stability (Ridwanto et al., 2024). As glycogen reserves decline, gluconeogenesis is upregulated using substrates such as amino acids, lactate, and glycerol as alternative energy sources (Li et al., 2025). This process is essential for maintaining energy supply to vital organs, particularly the brain (Rahman et al., 2024). In addition, fasting enhances fatty acid oxidation, resulting in the production of ketone bodies as an alternative energy source. This adaptation reflects the body's metabolic flexibility in maintaining energy balance during fasting (Peters et al., 2024). However, these responses may vary depending on individual metabolic conditions (Sukkriang & Buranapin, 2024).

Beyond these mechanisms, recent studies indicate that fasting also improves mitochondrial efficiency and activates metabolic pathways such as AMP-activated protein kinase (AMPK) and sirtuins, which contribute to enhanced insulin sensitivity and improved energy homeostasis (Garcia & Lopez, 2024). Activation of these pathways not only promotes more efficient substrate utilization but also reduces oxidative stress, a key factor in the development of metabolic diseases. Therefore, metabolic adaptation during fasting is not merely compensatory but also exhibits protective potential against metabolic dysfunction (Chen et al., 2025).

2. Physiological Mechanisms of Glucose Spike

A glucose spike refers to a rapid increase in blood glucose levels following food consumption, particularly foods with a high glycemic index (Christine & Elon, 2023). Physiologically, elevated blood glucose stimulates insulin secretion from the pancreas to facilitate glucose uptake into cells (Kurniawan & Sari, 2023). In individuals with insulin resistance, cellular responsiveness to insulin is impaired, resulting in prolonged hyperglycemia due to inefficient glucose uptake (Rosita & Wahyuni, 2024). Furthermore, hormonal changes during fasting, including increased glucagon and cortisol levels, can enhance hepatic glucose production, thereby exacerbating postprandial glucose spikes (Al-Shamsi et al., 2025).

Recent evidence further suggests that gastric emptying rate and incretin responses, particularly glucagon-like peptide-1 (GLP-1), play a significant role in determining the magnitude of postprandial glucose excursions (Martinez et al., 2024). Dysregulation of incretin hormones may accelerate glucose absorption without adequate compensatory insulin secretion. Additionally, gut microbiota has emerged as an important determinant in modulating postprandial glycemic responses, where dysbiosis may worsen glucose variability (Nguyen et al., 2025).

3. Risk Factors for Glucose Spike

The occurrence of glucose spikes is influenced by both metabolic and behavioral factors. Obesity is a major contributor, primarily due to increased inflammatory mediators that induce insulin resistance (Ahmed et al., 2025). Diets high in sugar and refined carbohydrates, including sugary beverages and processed foods, significantly contribute to elevated glucose levels (Putri & Handayani, 2023). In addition, low physical activity exacerbates impaired glucose metabolism, as physical activity enhances insulin sensitivity and promotes glucose uptake by skeletal muscles (Harris et al., 2023). The combination of these factors substantially increases the risk of glucose spikes (Sukkriang & Buranapin, 2024).

Moreover, advancing age and genetic predisposition also contribute to an increased risk of glucose spikes due to declining pancreatic beta-cell function and altered insulin sensitivity (Yamada et al., 2024). Comorbid conditions such as hypertension and dyslipidemia further impair glucose regulation through chronic inflammation and endothelial dysfunction. Therefore, preventive strategies should adopt a

multifactorial approach encompassing biological, behavioral, and environmental determinants (Khan et al., 2025).

4. **Impact of Glucose Spike on Metabolic Diseases**

Repeated glucose spikes significantly increase the risk of metabolic disorders, particularly type 2 diabetes mellitus (Li et al., 2025). This condition is associated with progressive insulin resistance and pancreatic beta-cell dysfunction (Ahmed et al., 2025). Chronic hyperglycemia also induces oxidative stress and systemic inflammation, leading to vascular damage and an increased risk of cardiovascular diseases (World Health Organization, 2023). Furthermore, recent studies indicate that postprandial glucose spikes are associated with cognitive decline in older adults (Garfield et al., 2025), highlighting the systemic impact of glucose dysregulation beyond metabolic pathways.

Emerging evidence also demonstrates that extreme glucose fluctuations can activate inflammatory signaling pathways such as nuclear factor kappa B (NF-κB), which contribute to accelerated atherosclerosis (Zhang et al., 2024). Additionally, high glycemic variability is considered more detrimental than stable chronic hyperglycemia, as it induces repeated oxidative stress leading to cellular damage. These findings underscore the importance of not only controlling average glucose levels but also maintaining glucose stability in preventing metabolic diseases (Brown et al., 2025).

5. Role of Lifestyle Interventions

Lifestyle interventions represent the primary strategy for preventing glucose spikes. One widely studied approach is intermittent fasting or time-restricted eating (Obermayer et al., 2023). Evidence suggests that regulating meal timing improves insulin sensitivity and significantly reduces blood glucose levels (Harris et al., 2023). Moreover, this approach is effective in promoting weight loss among obese individuals (Sukkriang & Buranapin, 2024). However, these benefits are highly dependent on dietary quality. A balanced diet consisting of fiber, protein, and complex carbohydrates has been shown to be more effective in maintaining glucose stability (Wibowo et al., 2024). Therefore, a combination of healthy diet, physical activity, and structured eating patterns represents an optimal strategy (Rahman et al., 2024).

Furthermore, technology-based interventions such as continuous glucose monitoring (CGM) are increasingly utilized to help individuals understand real-time glucose fluctuations (Smith et al., 2024). This approach enables personalized dietary and physical activity interventions. In addition, digital health education has proven effective in improving patient adherence to lifestyle modifications, particularly among high-risk populations (Lee et al., 2025).

6. Health Policy Implications

From a public health perspective, controlling glucose spikes plays a crucial role in the prevention of non-communicable diseases. The rising prevalence of diabetes represents a global challenge that requires comprehensive policy interventions (World Health Organization, 2023). One key strategy is reducing sugar consumption through regulation of sugar-sweetened foods and beverages, along with public education initiatives (Putri & Handayani, 2023). Additionally, the promotion of low glycemic index diets should be strengthened within public health programs (Kurniawan & Sari, 2023). Targeted education for individuals with diabetes who engage in fasting is also essential to maintain glycemic stability and prevent complications (Al-Shamsi et al., 2025).

Moreover, multisectoral policy approaches involving education, the food industry, and healthcare systems are critical in addressing metabolic risk factors (Global Health Policy Consortium, 2024). Interventions such as improved nutritional labeling, sugar taxation, and the integration of diabetes prevention programs into primary healthcare have demonstrated effectiveness in reducing population-

level sugar consumption (Johnson et al., 2025). Therefore, health policies must be designed in a comprehensive, evidence-based manner to achieve sustainable public health outcomes.

Conclusion

Glucose spike during fasting is influenced by complex interactions between metabolic adaptation, hormonal regulation, and dietary patterns. While fasting induces metabolic shifts toward gluconeogenesis and fat oxidation, consumption of high glycemic index foods after fasting may trigger rapid glucose increases.

Key risk factors include insulin resistance, obesity, pancreatic dysfunction, poor diet, and low physical activity. Repeated glucose spikes increase the risk of metabolic diseases such as type 2 diabetes and cardiovascular disorders.

Effective prevention requires a combination of healthy dietary patterns, physical activity, and structured eating schedules such as intermittent fasting. Additionally, comprehensive health policies are necessary to support prevention strategies.

Recommendations

1. The public should adopt balanced diets during fasting by prioritizing low glycemic index foods and reducing sugar intake.
2. Healthcare professionals should provide intensive education for diabetes patients on glucose management during fasting.
3. Policymakers should develop health promotion programs focusing on healthy diets and metabolic disease prevention.
4. Future research should explore long-term associations between fasting dietary patterns, glucose spikes, and metabolic disease risk through advanced clinical studies.

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