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Research Article

The Effect of Fasting During Ramadan on Acute Metabolic Complications of Diabetes

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Abstract

Aim: Ramadan fasting involves abstaining from eating and drinking from dawn to sunset for 29–30 days, causing significant lifestyle changes. These changes can increase the risk of acute metabolic complications in individuals with diabetes. This study investigates the impact of fasting during Ramadan on the frequency and clinical course of such complications.
Material and Method: This retrospective cross-sectional study included diabetic patients aged 18 years or older who presented to the emergency department (ED) of a tertiary care hospital between 2020 and 2024. Patients were grouped as fasting (≥10 days during Ramadan) or non-fasting. Key diagnoses included diabetic ketoacidosis (DKA), hyperglycemia, and hypoglycemia.
Results: Of the 229 patients (mean age 57.8 years; 56.3% female), 114 were in the fasting group. Both groups were predominantly diagnosed with Type 2 diabetes (85.1% vs. 86.1%). Hypoglycemia accounted for 42.1% of admissions in the fasting group, whereas hyperglycemia was predominant (93%) in the non-fasting group ($p<0.001$). No significant differences were found in in-hospital mortality or mechanical ventilation needs. However, fasting was associated with lower blood glucose levels in Type 2 diabetes patients ($p<0.001$).
Conclusion: Pre-fasting education is essential for effective diabetes management during Ramadan. Continuous education programs supported by updated evidence-based guidelines can mitigate risks and improve outcomes for fasting diabetic patients.

Keywords: Diabetes, emergency, fasting, Ramadan

INTRODUCTION

Diabetes Mellitus (DM) is a chronic systemic pathology characterized by hyperglycemia, resulting from varying degrees of insulin deficiency or resistance to insulin in peripheral tissues (1). The World Health Organization reports that there are currently 422 million people living with DM worldwide, and 1.5 million deaths annually are attributed to DM-related complications (2). The treatment and prevention of DM, a significant global public health issue, are of critical importance. To address this, numerous local and global guidelines on DM management and treatment have been published. These guidelines emphasize not only medical therapy but also lifestyle modifications and dietary habits as integral components of DM prevention and treatment (1,3).

Muslims constitute approximately one-quarter of the global population, with an estimated 1.6 billion Muslims worldwide as of 2010 (4). Ramadan, a sacred month in Islam, corresponds to the ninth month of the lunar Hijri calendar and lasts for 29–30 days. The length of Ramadan is determined based on the lunar calendar, which comprises 354 days per year. Due to the structure of the Hijri calendar, Ramadan cycles through all four seasons over approximately 33 years (5,6). Fasting during the month of Ramadan is obligatory for every healthy adult Muslim according to Islamic teachings (7). This practice involves abstaining from all food and drink from dawn to sunset for approximately 29–30 days. The duration of fasting varies depending on geographical location and season, extending up to 20 hours in some regions. Throughout Ramadan, meals are generally limited to two

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main occasions: Suhoor, the pre-dawn meal, and Iftar, the meal taken immediately after breaking the fast at sunset (4,8). Fasting during Ramadan leads to significant lifestyle changes in individuals, including alterations in sleep-wake cycles, meal frequency and quantity, and physical activity levels. As a result, there may be an increased risk of complications in diabetic patients. Among the acute metabolic complications of diabetes, hypoglycemia, dehydration, hyperglycemia, diabetic ketoacidosis (DKA), and hyperosmolar hyperglycemic state are potential health risks for diabetic individuals observing fasting during Ramadan (4,9,10). Although fasting is one of the five pillars of Islam, in cases where fasting could significantly affect an individual's health or in certain medical conditions, Islam exempts the person from the fasting obligation. Nevertheless, many patients continue to fast despite the permissions of religious authorities and the recommendations of their doctors (8). According to the 2001 Epidemiology of Diabetes and Ramadan (EPIDIAR) study conducted across 13 countries, the percentage of Type 1 DM patients who fasted for at least 15 days during Ramadan was 42.8%, while for Type 2 DM patients, it was 78.7%. In the same study, it was found that 57.8% of Type 2 diabetes patients in Türkiye fasted for at least 15 days. Additionally, the average number of fasting days in Türkiye was 18.1 days for Type 1 DM and 23.9 days for Type 2 DM (11). Therefore, the aim of our study is to investigate the impact of fasting during Ramadan on the frequency and clinical course of acute metabolic complications in diabetes.

MATERIAL AND METHOD

Study Design and Select of Participants

This is a cross-sectional study conducted retrospectively with approval from the local ethics committee (22.04.2024/ Decision No: 2024/82) at a tertiary care hospital between January 1, 2020, and January 1, 2024.

Patients aged 18 and older, who were previously diagnosed with DM and presented to the emergency department between the specified dates with diagnoses of DKA, hyperglycemia, or hypoglycemia, were included in the study. Patients under 18 years of age, those identified as pregnant, and those with missing data in their medical records were excluded from the study.

Patients who met the inclusion and exclusion criteria were divided into two groups based on their fasting status. Those who presented between 01.01.2020 and 01.01.2024 during the Ramadan period, reported fasting for at least 10 days, and adhered to the rituals of fasting such as suhoor and iftar, were categorized into the Fasting group. These patients took their diabetic medications during the suhoor and iftar times. Patients who presented outside of the Ramadan period were included in the Non-fasting group. Within this group, patients were randomly selected from months other than the two months before and after Ramadan, as dietary habits among Muslims tend to differ during those periods.

Hypoglycemia is defined as a blood glucose level of less than 70 mg/dL.

The diagnosis of DKA was made based on the following criteria:

1. **Hyperglycemia:** Blood glucose level >250 mg/dL
2. **Ketosis:** Presence of ketones in the urine or blood
3. **Acidosis:** Arterial pH <7.3 or bicarbonate level <18 mEq/L

The diagnosis of hyperglycemia refers to hyperglycemic conditions that require hospitalization but do not meet the criteria for DKA.

Data Collection

The data collection form included demographic information such as age and gender from the patients' medical records; vital signs at the time of emergency department presentation; laboratory values from blood samples including white blood cell count (WBC, cells/ mm^3), glucose levels (g/dL), creatinine levels (mg/ dL), blood urea (mg/dL), blood gas parameters, lactate (mmol/L), and ketone levels in urine tests.

The patients' hospitalization status (ward/intensive care unit (ICU)), admission diagnoses (hypoglycemia, DKA, hyperglycemia), length of hospital stay, need for mechanical ventilation, and in-hospital mortality were evaluated and recorded on the data collection form.

Statistical Analysis

Statistical analysis was performed using the SPSS V.26 software. The normality of the data was assessed using both analytical and visual methods. Descriptive statistics were presented as mean±standard deviation, median (25th and 75th percentiles), and frequency (%). The analysis of categorical variables was conducted using the Chi-square test. The analysis of continuous and categorical variables was performed using the Mann-Whitney U test and independent T-test, depending on the normality of the distribution. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 229 patients were included in the study, with 114 in the fasting group and 115 in the non-fasting group. The average age of the patients was 57.77±16.80, with 56.3% (n=129) of the patients being female. The majority of participants were diagnosed with Type 2 DM (85.6%). In both groups, patients with Type 2 DM were the majority, and their distribution was similar (85.1% in the fasting group and 86.1% in the non-fasting group). No statistically significant difference was found between the vital signs of the two groups (p>0.05). The median glucose level in the fasting group was significantly lower compared to the non-fasting group (p<0.001). The admission diagnoses differed between the two groups. In the non-fasting group, hyperglycemia was the most common admission diagnosis (93%), while no patients were admitted with

hypoglycemia. In the fasting group, 35.1% of patients were admitted due to hypoglycemia. A statistically significant difference was found between the groups in terms of admission diagnoses (p<0.001). In-hospital mortality and the need for mechanical ventilation were similar in both groups, with no statistically significant relationship found (p-values of 0.543 and 0.993, respectively). The demographic characteristics, clinical, and laboratory findings of the patients in the two groups are shown in Table 1.

Table 1. Relationship between fasting and patient demographic characteristics, clinical and laboratory findings

		Fasting status		
		Non-fasting (n=115)	Fasting (n=114)	p values
Sex; n (%)	Male	51 (44.3%)	49 (43.0%)	0.835*
	Female	64 (55.7%)	65 (57.0%)	
Type of diabetes; n (%)	Type 1 DM	16 (13.9%)	17 (14.9%)	0.830*
	Type 2 DM	99 (86.1%)	97 (85.1%)	
Age (year)		59 (45-68)	60 (47-71.25)	0.555[u]
SBP (mmHg)		134.14±25.23	131.79±23.47	0.466[t]
DBP (mmHg)		77.6±13.57	74.18±15.31	0.075[t]
MAP (mmHg)		96.33 (83.33-106.67)	90 (83.33-100.33)	0.067[u]
Pulse rate (beats/min)		87.49±14.5	85.97±11.04	0.375[t]
WBC count (cells/mm^3)		9.6±3.79	10.32±4.76	0.209[t]
Glucose (mg/dl)		463 (375-561)	339.5 (60.75-502)	**<0.001[u]**
Urea (mg/dl)		23.9±20.45	24.01±16.58	0.966[t]
Creatinine (mg/dl)		1.16±0.67	1.21±0.99	0.662[t]
Sodium (mEq/L)		132.9±5.93	134.55±5.38	**0.029[t]**
Potassium (mEq/L)		4.65±0.6	4.94±4.79	0.510[t]
Chloride (mEq/L)		98.91±5.46	100.83±7.25	**0.025[t]**
pH		7.38±0.07	7.35±0.09	**0.023[t]**
PCO2 (mmHg)		41.66±7.42	41.62±9.35	0.976[t]
PO2 (mmHg)		34.34±15.78	35.88±13.73	0.432[t]
Bicarbonate (mEq/L)		24.23±4.43	23.04±6.2	0.095[t]
Base excess (mEq/L)		-0.86±3.72	-2.09±6.3	0.074[t]
Lactate (mmol/L)		1.97±1.09	2.6±2.75	**0.025[t]**
Keton (Dipstick); n (%)	Negative	93 (80.9%)	100 (87.7%)	**0.015***
	Trace amouth	6 (5.2%)	0 (0%)	
	1 Positive	2 (1.7%)	0 (0%)	
	2 Positive	12 (10.4%)	7 (6.1%)	
	3 Positive	2 (1.7%)	7 (6.1%)	
Hospital admission status; n (%)	Ward	102 (88.7%)	95 (83.3%)	0.242*
	ICU	13 (11.3%)	19 (16.7%)	
Diagnosis on admission to hospital; n (%)	Hypoglycemia	0 (0.0%)	40 (35.1%)	**<0.001***
	Hyperglycemia	107 (93.0%)	60 (52.6%)	
	DKA	8 (7.0%)	14 (12.3%)	
Need for MV; n (%)	No	110 (95.7%)	107 (93.9%)	0.543*
	Yes	5 (4.3%)	7 (6.1%)	
In-hospital mortality; n (%)	No	113 (98.3%)	112 (98.2%)	0.993*
	Yes	2 (1.7%)	2 (1.8%)	

*Chi-Square, [t]Student t test, [u]Mann-Whitney U Test; Values are presented as mean±SD, median (25th and 75th quartile), or n (%); DBP: diastolic blood pressure, DM: diabetes mellitus, ICU: intensive care unit, MAP: mean arteriel pressure, MV: mechanic ventilation, SBP: systolic blood pressure, SD: standart deviation, WBC: white blood cells

A total of 33 patients with Type 1 DM were included in the study, with 17 in the fasting group, while 206 patients had Type 2 DM, of which 97 were in the fasting group. In patients with Type 2 DM, blood glucose levels were significantly lower in the fasting group compared to the non-fasting group (p<0.001). However, in patients with Type 1 DM, there was no statistically significant difference in blood glucose levels between the groups (p=0.081). The demographic characteristics, clinical, and laboratory findings of patients in the two groups for both Type 1 and Type 2 DM are shown in Tables 2 and 3.

Table 2. Relationship between fasting and patient demographic characteristics, clinical and laboratory findings according type 1 diabetes

		Fasting status		
		Non-fasting (n=16)	Fasting (n=17)	p values
Sex; n (%)	Male	8 (50.0%)	10 (58.8%)	0.611*
	Female	8 (50.0%)	7 (41.2%)	
Age (year)		50.5 (35.5-72.25)	44 (29-66.5)	0.763ᵘ
SBP (mmHg)		110 (100-136.75)	129 (120-140)	0.063ᵘ
DBP (mmHg)		70 (62.5-80)	70 (60-78.5)	0.510ᵘ
MAP (mmHg)		83.33 (75-98.33)	86.67 (80.83-93.83)	0.657ᵘ
Pulse rate (beats/min)		85 (71.25-103.5)	90 (84.5-97.5)	0.402ᵘ
WBC count (cells/mm³)		9.875 (6.41-14.1325)	12.11 (9.415-18.56)	0.074ᵘ
Glucose (mg/dl)		514.5 (439-666.75)	417 (282-610.5)	0.081ᵘ
Urea (mg/dl)		25.06±13.29	23.88±13.45	0.802ᵗ
Creatinine (mg/dl)		1.43±1.15	1.41±0.94	0.945ᵗ
Sodium (mEq/L)		131.5 (125.5-135)	132 (127.5-137.5)	0.929ᵘ
Potassium (mEq/L)		4.9 (4.05-5.175)	4.9 (4.4-5.45)	0.683ᵘ
Chloride (mEq/L)		97 (95-100.5)	98 (94-102.5)	0.683ᵘ
pH		7.36 (7.3225-7.38)	7.33 (7.115-7.39)	0.657ᵘ
PCO2 (mmHg)		40 (31.75-44)	41 (27.2-42.8)	0.533ᵘ
PO2 (mmHg)		29.5 (21.25-38.75)	40 (31-54.1)	**0.049ᵘ**
Bicarbonate (mEq/L)		20.7±6.49	18.64±8.92	0.451ᵗ
Base excess (mEq/L)		-0.1 (-8.75-1.5)	-2.2 (-16.5-1.5)	0.423ᵘ
Lactate (mmol/L)		1.75 (1.525-2.475)	1.7 (1.4-2.7)	0.873ᵘ
Keton (Dipstick); n (%)	Negative	3 (18.8%)	9 (52.9%)	**0.010***
	Trace amouth	0 (0%)	0 (0.0%)	
	1 Positive	2 (12.5%)	0 (0.0%)	
	2 Positive	9 (56.3%)	2 (11.8%)	
	3 Positive	2 (12.5%)	6 (35.3%)	
Hospital admission status; n (%)	Ward	8 (50.0%)	12 (70.6%)	0.226*
	ICU	8 (50.0%)	5 (29.4%)	
Diagnosis on admission to hospital; n (%)	Hypoglycemia	0 (0.0%)	3 (17.6%)	0.119*
	Hyperglycemia	10 (62.5%)	6 (35.3%)	
	DKA	6 (37.5%)	8 (47.1%)	
Need for MV; n (%)	No	14 (87.5%)	14 (82.4%)	0.680*
	Yes	2 (12.5%)	3 (17.6%)	
In-hospital mortality; n (%)	No	16 (100.0%)	16 (94.1%)	0.325*
	Yes	0 (0.0%)	1 (5.9%)	

*Chi-Square, ᵗStudent t test, ᵘMann-Whitney U Test; Values are presented as mean±SD, median (25th and 75th quartile), or n (%); DBP: diastolic blood pressure, DM: diabetes mellitus, ICU: intensive care unit, MAP: mean arteriel pressure, MV: mechanic ventilation, SBP: systolic blood pressure, SD: standart deviation, WBC: white blood cells

Table 3. Relationship between fasting and patient demographic characteristics, clinical and laboratory findings according to type 2 diabetes

		Fasting status		
		Non-fasting (n=99)	Fasting (n=97)	p values
Sex; n (%)	Male	43 (43.4%)	39 (40.2%)	0.647*
	Female	56 (56.6%)	58 (59.8%)	
Age (year)		59 (49-68)	62 (48.5-71.5)	0.270[u]
SBP (mmHg)		136.77±24.95	132.78±24.86	0.264[t]
DBP (mmHg)		78.35±13.48	75.19±15.83	0.133[t]
MAP (mmHg)		96.67 (86.67-110)	93.33 (83.33-103.33)	0.054[u]
Pulse rate (beats/min)		85 (78-97)	85 (79-91)	0.627[u]
WBC count (cells/mm^3)		9.52±3.68	9.73±4.42	0.713[t]
Glucose (mg/dl)		462 (363-542)	318 (59.9-459.5)	**<0.001[u]**
Urea (mg/dl)		23.72±21.43	24.03±17.13	0.910[t]
Creatinine (mg/dl)		1.12±0.55	1.18±1	0.614[t]
Sodium (mEq/L)		133.07±5.76	134.93±5	**0.017[t]**
Potassium (mEq/L)		4.64±0.57	4.94±5.18	0.565[t]
Chloride (mEq/L)		99.1±5.54	101.3±7.17	**0.017[t]**
pH		7.38±0.06	7.36±0.07	**0.036[t]**
PCO2 (mmHg)		42.13±6.94	42.51±8.97	0.744[t]
PO2 (mmHg)		30 (23-42)	34 (25.15-43.2)	0.385[u]
Bicarbonate (mEq/L)		24.81±3.74	23.81±5.29	0.128[t]
Base excess (mEq/L)		-0.39±2.46	-1.19±5	0.157[t]
Lactate (mmol/L)		1.97±1.11	2.46±2.33	0.061[t]
Keton (Dipstick); n (%)	Negative	90 (90.9%)	91 (93.8%)	0.058*
	Trace amouth	6 (6.1%)	0 (0.0%)	
	1 Positive	0 (0.0%)	0 (0%)	
	2 Positive	3 (3.0%)	5 (5.2%)	
	3 Positive	0 (0.0%)	1 (1.0%)	
Hospital admission status; n (%)	Ward	94 (94.9%)	83 (85.6%)	**0.026***
	ICU	5 (5.1%)	14 (14.4%)	
Diagnosis on admission to hospital; n (%)	Hypoglycemia	0 (0.0%)	37 (38.1%)	**<0.001***
	Hyperglycemia	97 (98%)	54 (55.7%)	
	DKA	2 (2.0%)	6 (6.2%)	
Need for MV; n (%)	No	96 (97.0%)	93 (95.9%)	0.680*
	Yes	3 (3.0%)	4 (4.1%)	
In-hospital mortality; n (%)	No	97 (98.0%)	96 (99.0%)	0.573*
	Yes	2 (2.0%)	1 (1.0%)	

*Chi-Square, [t]Student t test, [u]Mann-Whitney U Test; Values are presented as mean±SD, median (25th and 75th quartile), or n (%); DBP: diastolic blood pressure, DM: diabetes mellitus, ICU: intensive care unit, MAP: mean arteriel pressure, MV: mechanic ventilation, SBP: systolic blood pressure, SD: standart deviation, WBC: white blood cells

DISCUSSION

EPIDIAR study was conducted in 2001. A total of 12,243 individuals from 13 countries were analyzed for this study. Of these, 8.7% had type 1 diabetes, and 91.3% had type 2 diabetes. The countries involved in the study were Algeria, Bangladesh, India, Egypt, Malaysia, Indonesia, Lebanon, Jordan, Pakistan, Morocco, Tunisia, Saudi Arabia, and Türkiye. EPIDIAR study conducted in 13 countries in 2001 highlighted the need for pre-fasting education and awareness, leading to increased awareness among

relevant clinicians (11). This global awareness is of great importance for our country as well. However, in our country, where a large proportion of the population is Muslim, education and efforts regarding diabetes management during Ramadan are not sufficient. Therefore, in our study, we decided to investigate the impact of fasting during Ramadan on the frequency and clinical course of acute metabolic complications of diabetes, with the aim of emphasizing the importance of necessary pre-fasting education and raising awareness.

DM has emerged as a significant public health issue, with a notable increase in its prevalence in recent years. A review of the literature shows that globally, approximately 90% of diabetes cases are classified as Type 2 and 10% as Type 1 (12). The distribution of diabetes mellitus types among the 229 patients included in our study is consistent with this global trend.

It is estimated that hypoglycemia is responsible for 2-4% of mortality in patients with Type 1 diabetes. Although a reliable estimate is not available for patients with Type 2 diabetes, it is known to be a rare cause of death. Comparing the rates of hypoglycemia, they are several times lower in patients with Type 2 diabetes compared to those with Type 1 diabetes. Reduced food intake is known to be a strong risk factor for hypoglycemia, particularly in patients with diabetes (13). The duration of fasting during Ramadan, where no food is consumed, constitutes a significant factor in this context. The largest dataset on this topic is the EPIDIAR study, which shows that fasting during Ramadan increases the risk of hypoglycemia by 4.7 times in patients with Type 1 diabetes and by 7.5 times in patients with Type 2 diabetes (12). In our study, the fact that 7% of patients in the non-fasting group and 42.1% of patients in the fasting group were admitted to the hospital due to hypoglycemia is consistent with the information in the literature.

In the experimental study conducted by Perk and colleagues, no significant difference was found in blood pressure measurements before and during Ramadan. The study concluded that it is safe for patients who are taking antihypertensive medication to fast while continuing their current treatment (14). The literature on this topic is consistent, and no negative effects of fasting on blood pressure have been demonstrated. In our study, in accordance with the literature, no significant differences were found in vital signs between the two groups.

Prolonged fasting, changes in patients' diets, and dehydration during fasting are thought to increase the risk of DKA in individuals with diabetes. However, in a study conducted by Beshyah and colleagues, data from 283 patients over a 10-year period were analyzed, and no increase in the incidence of DKA during Ramadan fasting was observed (15). In our study, no significant difference was found between the fasting and non-fasting groups regarding DKA, and therefore, our results are consistent with the literature.

Proper education for diabetic patients before Ramadan plays a critical role in achieving successful disease management. Given the complexity of diabetes management, the challenges of maintaining blood glucose balance during fasting, and individual differences, it is essential for healthcare professionals to maintain regular and informative communication with patients. As healthcare providers, we must thoroughly communicate personalized treatment plans to minimize the risks patients may face during fasting and raise awareness about the potential dangers of fasting when necessary. This educational process will not only help maintain health throughout Ramadan but also make a lasting impact on patients' overall health management.

This study has certain limitations. First, it was conducted as a single-center, retrospective study, which may have introduced selection bias. Due to the retrospective design of the study, the antidiabetic medications used by the patients were not recorded, and therefore, their effects could not be evaluated. Additionally, the small sample size poses limitations on the generalizability of the results. Furthermore, hyperosmolar hyperglycemic states were not separately analyzed among hyperglycemic conditions.

Future studies should consider analyzing hyperosmolar hyperglycemic states as a separate category and increasing the sample size to expand the scope of the research. Moreover, conducting multicenter and prospective studies could help eliminate potential biases. Recording the antidiabetic medications used by patients would enable the evaluation of their effects. Consequently, more comprehensive and objective studies could be conducted.

CONCLUSION

In line with this approach, ensuring the continuity of educational programs for diabetic patients and supporting them with annually updated scientific data will remain one of the primary responsibilities of healthcare professionals.

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