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Original article

Assessment of the Effect of Fasting Ramadan on Renal Functions in Type 2 Diabetic Egyptian Patients

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Abstract:

Background: Many diabetic patients insist on fasting Ramadan against medical advice. Aim: to assess how fasting Ramadan impacts kidney functions in Egyptian patients with type 2 diabetes. **Patients and Methods:** the study included 180 individuals fasted Ramadan: divided into 3 equal groups; classified into group I (Non diabetic patients with normal renal functions), group II (diabetic patients without albuminuria) and group III (diabetic patients with micro albuminuria) attending to Menoufia University Hospitals clinics. They were assessed for height, weight, blood pressure, body mass index and investigated for fasting and post prandial blood glucose , hemoglobin a1c, serum urea, creatinine, estimated GFR, and urinary albumin/ creatinine ratio one month before and after Ramadan. **Results:** A significant decrease in hemoglobin A1c levels was observed in groups II and III and no change in it in Group I. Regarding kidney function tests, group I did not exhibit any significant differences, whereas groups II and III displayed a marked deterioration in these parameters, including serum urea, creatinine, and estimated GFR. No significant change in A/C ratio in Group I, but it decreased in groups II and III. **Conclusion:** Fasting Ramadan enhanced glycemic regulation in type 2 diabetic patients with no deterioration in kidney functions within group I, however, deterioration was noted in groups II and III. Patients should receive guidance on maintaining proper hydration and adopting healthy dietary changes during the period before Ramadan, and it is also advisable for them to consult their healthcare providers regarding their suitability for fasting.

Keywords: Type 2 diabetes; Fasting Ramadan; Albuminuria; renal functions

Introduction

Fasting Ramadan is a fundamental religious practice performed by Muslims globally. It spans one month according to the lunar calendar. During daylight hours, Muslims refrain from consuming food and beverages, taking medications, smoking, and engaging in sexual activities, after being the primary meal eaten at nightfall, and suhoor being a light meal consumed before dawn [(1)].

Even though individuals with diabetes may consume fewer meals, studies showed that their total caloric intake over the month of Ramadan tends to rise [(2)].

Fasting involve of many psychological and sociological aspects. Fasting diabetic patients are at a higher risk of experiencing variations in their blood glucose levels, which can be influenced by food type, content, and amount they eat, consistency in medication intake, and changes in their daily physical activity [(3)].

Diabetic kidney disease (DKD) is the world's leading cause of end-stage renal disease .It is a clinical syndrome characterized by increase urine albumin excretion and or reduction in the estimated glomerular filtration rate in diabetic patients who lack indicators of other renal disease [(4)].

Physicians should advise diabetic patients who fast about risks of fasting such as hypoglycemia, hyperglycemia, diabetic ketoacidosis and dehydration. Diabetic patients with moderate to severe CKD should be monitored during Ramadan to prevent any harmful consequences [(5)].

Certain research indicated that patients with diabetic kidney disease (DKD) generally tolerated, remained safe, and experienced positive results during fasting Ramadan [(6)].

Conversely, other research revealed negative impacts on kidney health in tropical climates characterized by high heat and humidity [(7)].

The IDF-DAR Practical Guidelines 2021, established by the International Diabetes Federation, are the authoritative guidelines for preventing complications related to Fasting in individuals with chronic kidney disease and diabetes [(8)].

Patients and methods

A cross-sectional study assessed 180 Egyptian patients, divided into 3 groups of equal numbers; non-diabetic patients with normal renal functions (Group I), diabetic patients with a GFR higher than 60 ml/min/1.73 m² and no albuminuria (Group II), and diabetic patients with a GFR between (60 ml/min/1.73 m² and 90 ml/min/1.73 m²) with micro albuminuria (30-300) mg/g (Group III).

Every patient planning to fast Ramadan (2024) will experience an average fasting duration of 14 hours, approximately from 4:30 AM to 6:30 PM, with surrounding temperatures ranging from 25°C to 30°C.Patients attending Endocrine & diabetic clinics in Menoufia University hospitals. Samples collected according to inclusion and exclusion criteria one month before and after Ramadan from February 2024 to May 2024, an informed consent was obtained from all individual participants included in the study, and the Research Ethical Committee of Menoufia University granted approval for the study of IRP number {4/2023 INTM 42}.

Type 1 diabetic patient, DKD Patients stage 3 or more, Patients with history of heart failure or gestational diabetes and Patients with autoimmune kidney disease were not included in this study.

Every patient undergoes a comprehensive medical history assessment that includes their age, gender, chronic illnesses, and a clinical examination, which encompasses the measurement their height, weight, blood pressure, and body mass index in kg/m2.

Laboratory investigations

Laboratory tests are hemoglobin A1c(HbA1c), fasting blood glucose (FPG), 2-hour postprandial blood glucose (2-h PPG) , kidney function tests (serum creatinine, blood urea and urinary albumin/creatinine ratio) should be

evaluated one month prior to Ramadan, followed by a repeat of these tests within one month after Ramadan.

Assessments were performed in the clinical biochemistry lab, utilizing commercial kits that were modified for the auto analyzer, with blood glucose tests conducted using the glucose oxidase and peroxidase methods [(9)].

Berthelot's method was used to measure serum urea, [(10)] Creatinine levels were assessed using the alkaline Jaffe's Picrate technique; [(11)] the typical range for normal creatinine is from 0.7 to 1.4 mg/dL and levels of urea were between 18 to 45 mg/dL [(12)]. HbA1c levels were determined using the ion exchange resin technique with HbA1c diagnostic kits from Asritha Diatech [(13)].

Urine micro albumin levels were assessed using radioimmunoassay with Diagnostic Products Corp., Los Angeles, CA, USA, is the manufacturer of the DPC Coat-A-Count kit. The alkaline picrate method was used to assess the content of creatinine in the urine. [(14)]

Urinary albumin/creatinine Ratio was measured, it is classified into normal (A/C Ratio <30 μg/mg) or micro albuminuria (A/C Ratio between 30 and 300 μg/mg) and macro albuminuria (A/C Ratio greater than 300 μg/mg) [(15)].

The estimated glomerular filtration rate (eGFR) was calculated using the CKD-EPI creatinine-based eGFR equation

CKD-EPI21 = 142 × min (Scr/κ, L) α × max (Scr/κ, L) −1.200 × 0.9938Age ×1.012 [if female], where: Scr represents standardized serum creatinine measured in mg/dL

κ equals 0.9 for males 0.7 for females, and α is set at −0.302 for males−0.241 for females. [(16)]

Statistical analysis

Continuous variables are represented as the average ± standard deviation (SD) along with the range. Using quantitative data to compare more than two separate groups with quantitative data, One Way Analysis of Variance (ANOVA) was utilized. To determine the differences among the studied groups, the post-hoc Tukey's HSD test was conducted. The Student's t-test was employed for comparing two independent groups with quantitative data. The paired t-test assessed the changes in laboratory data before and after Ramadan. Categorical variables were expressed as frequency and percentage, analyzed using the Chi-squared test. Linear regression analysis was applied to examine the independent variables influencing the estimated GFR. A P value of less than 0.05 was deemed statistically significant. R Software version 4.1.2 (R Foundation for Statistical Computing, Vienna, Austria) was used for all analyses.

Results

Patients are managed to fast for about 30 days during Ramadan. Regarding fasting patients, none experienced any acute illnesses while fasting, and there were no new clinical symptoms or signs reported.

The groups under study were matched by sex (p =, 132). The average age was (49.91 ± 9.75) years and the average duration of diabetes was (10.88 ± 5.71) years for group II and group III, The cases were age matched (p=, 140) duration of diabetes was statistically different ($p < 0.001$).

Prior to the month of Ramadan, there was a highly significant difference ($p < 0.001$) among the three groups concerning SBP, creatinine, UACR, and estimated GFR.

In the comparison of each pair of groups using Tukey's test, groups II and III exhibited notably higher blood pressure and creatinine levels than group I. A significantly reduced estimated glomerular filtration rate (GFR) was observed in group III when compared to both groups II and I. The Urinary Albumin to Creatinine Ratio was also significantly elevated in group III in relation to groups II and I **(Table, 1)**.

Following Ramadan, there were no significant differences in SBP, DBP, FPG, 2hPPG, weight, and BMI across all the groups examined. Additionally, no

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statistically significant differences were observed in Hemoglobin A1C, urea, creatinine, GFR, and UACR in group I (the healthy group) before and after Ramadan.

Analysis using Tukey's test revealed that group III had significantly elevated levels of SBP, DBP, creatinine, HBA1c, and UACR when compared with group II. Additionally, group I exhibited significantly reduced levels of FBS, 2hPG, HBA1C, serum urea, creatinine, and UACR in comparison to both groups (II and III) **(Table, 2)**.

In examining each group results before and after Ramadan, groups II and III exhibited a noteworthy reduction in HbA1c and estimated GFR. There was a significant rise in creatinine levels and a minor increase in urea, alongside a decrease in UACR **(Table, 3)**.

Groups II and III displayed a notable negative correlation between estimated GFR and HbA1c (p = 0.001) prior to fasting, as well as a significant negative correlation was found between estimated GFR and the duration of diabetes (p = 0.001) following fasting.

Table (1)–A comparison of laboratory data among all researched groups prior to Ramadan fasting.

		Group I N= 60	**Group II N= 60**	**Group III N= 60**	**F**	**P-value**	**Tukey's HSD**
Body weight	Mean (SD)	76.32 (2.73)	82.75 (3.00)	84.69 (3.01)	38.08	**<0.001***	**P1=<0.001***
	Range	70-80	78-90	80-90			**P2=<0.001***
							P3=0.183
BMI	Mean (SD)	29.25 (1.15)	31.74 (1.08)	31.88 (1.03)	31.31	**<0.001***	**P1=0.032***
	Range	26.9-32	30.4-34.6	30-33.8			**P2=0.030***
							P3=0.931
SBP	Mean (SD)	122.11 (9.76)	133.75 (8.47)	137.69 (8.81)	13.16	**<0.001***	**P1=0.001***
	Range	110-145	120-145	120-150			**P2=<0.001***
							P3=0.482
DBP	Mean (SD)	78.42 (6.47)	83.12 (4.79)	83.46 (3.76)	6.569	**0.013***	**P1=0.032***
	Range	70-90	80-90	80-90			**P2=0.030***
							P3=0.984
FBS (mg/dL)	Mean ± SD	83.23 ± 7.10	151.88 ± 29.78	182.43 ± 29.53	256.8	**<0.001***	**P1=<0.001***
	Range	70-96	120-272	132-296			**P2=<0.001***
							P3=<0.001*
PPBS (mg/dL)	Mean ± SD	122.35 ± 8.92	216.82 ± 50.11	299.45 ± 50.30	276	**<0.001***	**P1=<0.001***
	Range	104-138	150-359	183-420			**P2=<0.001***
							P3=<0.001*
HbA1c	Mean ± SD	5.19 ± 0.22	8.73 ± 1.31	10.57 ± 1.25	405.4	**<0.001***	**P1=<0.001***
	Range	4.6-5.5	6.7-12.1	8.5-15.1			**P2=<0.001***
							P3=<0.001*
Serum urea (mg/dL)	Mean ± SD	31.06 ± 5.38	35.17 ± 5.04	43.50 ± 7.32	66.97	**<0.001***	**P1=<0.001***
	Range	15-40	22-49	21.6-65			**P2=<0.001***
							P3=<0.001*
Serum creatinine (mg/dL)	Mean ± SD	0.71 (0.06)	0.82 ± 0.10	1.07 ± 0.12	221.8	**<0.001***	**P1=<0.001***
	Range	0.6-0.8	0.7-1.1	0.8-1.3			**P2=<0.001***
							P3=<0.001*
eGFR (mL/min/1.73 m2)	Mean ± SD	110.83 ± 9.99	100.08 ± 13.31	73.07 ± 9.28	187.7	**<0.001***	**P1=<0.001***
	Range	90-133	67-125	60-89			**P2=<0.001***
							P3=<0.001*
Urinary albumin-creatinine ratio	Mean ± SD	7.10 ± 1.74	21.55 ± 6.99	204.50 ± 69.44	447.2	**<0.001***	P1=0.124
	Range	4-12	8-29	26-290			**P2=<0.001***
							P3=<0.001*

Data are presented as mean ± standard deviation. FBS; Group I, Healthy group; Group II, Normoalbuminuria group; Group III, Microalbuminuria group; systolic blood pressure, DBP; diastolic blood pressure; FBS, fasting blood sugar; PPBS, 2-hour postprandial blood sugar; HbA1c, glycosylated hemoglobin; eGFR, estimated glomerular filtration rate; t, paired t-test; N, number of participants. * p <0.05 is considered significant.

Table (2): Comparison of laboratory results among all examined groups following fasting Ramadan.

		Group I N= 60	Group II N= 60	Group III N= 60	F	P-value	Tukey's HSD
Body weight	Mean (SD)	76.61 (2.88)	82.50 (3.35)	84.46 (3.07)	28.97	**<0.001***	**P1=<0.001***
	Range	71-82	77-91	79-91			**P2=<0.001***
							P3=0.217
BMI	Mean (SD)	29.38 (1.26)	31.69 (1.23)	31.77 (1.02)	22.35	**<0.001***	**P1=<0.001***
	Range	27.3-32.8	29.6-35	30.4-34.2			**P2=<0.001***
							P3=0.984
SBP	Mean (SD)	120.68 (7.71)	132.81 (8.56)	135.77 (7.03)	17.44	**<0.001***	**P1=<0.001***
	Range	110-135	120-145	120-145			**P2=<0.001***
							P3=0.574
DBP	Mean (SD)	78.53 (3.67)	81.50 (2.94)	82.31 (2.59)	6.569	**0.003***	**P1=0.022***
	Range	70-85	80-90	80-85			**P2=0.005***
							P3=0.775
FBS (mg/dL)	Mean ± SD	81.2 ± 8.29	152.05 ± 31.09	185.93 ± 31.78	251.4	**<0.001***	**P1=<0.001***
	Range	68-96	115-250	126-280			**P2=<0.001***
							P3=<0.001*
PPBS (mg/dL)	Mean ± SD	124.8 ± 8.84	231.25 ± 54.84	315.02 ± 53.37	275.6	**<0.001***	**P1=<0.001***
	Range	104-137	145-370	184-425			**P2=<0.001***
							P3=<0.001*
HbA1c	Mean ± SD	5.20 ± 0.25	8.02 ± 1.26	9.83 ± 1.29	295.5	**<0.001***	**P1=<0.001***
	Range	4.6-6	6-11	7.7-14.2			**P2=<0.001***
							P3=<0.001*
Serum urea (mg/dL)	Mean ± SD	32.83 ± 6.19	42.65 ± 6.43	53.22 ± 8.88	117.9	**<0.001***	**P1=<0.001***
	Range	18-45	22-58	27-76			**P2=<0.001***
							P3=<0.001*
Serum creatinine (mg/dL)	Mean ± SD	0.74 ± 0.09	1.07 ± 0.12	1.34 ± 0.15	389.7	**<0.001***	**P1=<0.001***
	Range	0.6-0.9	0.9-1.4	1-1.61			**P2=<0.001***
							P3=<0.001*
eGFR (mL/min/1.73 m2)	Mean ± SD	108.22 ± 12.31	75.38 (13.06)	55.5 ± 8.48	323.8	**<0.001***	**P1=<0.001***
	Range	79-133	50-116	43-73			**P2=<0.001***
							P3=<0.001*
Urinary albumin-creatinine ratio	Mean ± SD	7.27 ± 1.76	9.92 ± 3.36	102.72 ± 35.39	419.9	**<0.001***	**P1= 0.76**
	Range	5-17	25-110	81-395			**P2=<0.001***
							P3=<0.001*

N: Number of participants in the group
SD: Standard deviation
BMI: Body Mass Index
SBP: Systolic Blood Pressure
DBP: Diastolic Blood Pressure
FBS: Fasting Blood Sugar (mg/dL)
PPBS: Postprandial Blood Sugar (mg/dL)
HbA1c: Glycated Hemoglobin (percentage)
eGFR: Estimated Glomerular Filtration Rate (mL/min/1.73 m²)
P-value: Probability value (statistical significance)
Tukey's HSD: Tukey's Honest Significant Difference test
P1, P2, P3: Pairwise comparisons between groups in Tukey's HSD analysis

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Table (3): Analysis of laboratory data from all studied groups before and after the Ramadan fasting period.

Dependent: Group	Group I N=60		P-value	Group II N=60		P-value	Group III N=60		P-value
	Before	After		Before	After		Before	After	
Body weight	76.32 (2.73) 70-80	76.61 (2.88) 71-82	0.752	82.75 (3.00) 78-90	82.50 (3.35) 77-91	0.825	84.69 (3.01) 80-90	84.46 (3.07) 79-91	0.848
BMI	29.25 (1.15) 26.9-32	29.38 (1.26) 27.3-32.8	0.739	31.74 (1.08) 30.4-34.6	31.69 (1.23) 29.6-35	0.916	31.88 (1.03) 30-33.8	31.77 (1.02) 30.4-34.2	0.776
SBP	122.11 (9.76) 110-145	120.68 (7.71) 110-135	0.622	133.75 (8.47) 120-145	132.81 (8.56) 120-145	0.758	137.69 (8.81) 120-150	135.77 (7.03) 120-145	0.544
DBP	78.42 (6.47) 70-90	78.53 (3.67) 70-85	0.951	83.12 (4.79) 80-90	81.50 (2.94) 80-90	0.257	83.46 (3.76) 80-90	82.31 (2.59) 80-85	0.371
FBS (mg/dL)	83.23 ± 7.10 70-96	81.2 ± 8.29 68-96	0.152	151.88 ± 29.78 120-272	152.05 ± 31.09 115-250	0.976	182.43 ± 29.53 132-296	185.93 ± 31.78 126-280	0.533
PPBS (mg/dL)	122.35 ± 8.92 104-138	124.8 ± 8.84 104-137	0.133	216.82 ± 50.11 150-359	231.25 ± 54.84 145-370	0.135	299.45 ± 50.30 183-420	315.02 ± 53.37 184-425	0.103
HbA1c	5.19 ± 0.22 4.6-5.5	5.20 ± 0.25 4.6-6	0.757	8.73 ± 1.31 6.7-12.1	8.02 ± 1.26 6-11	**0.003***	10.57 ± 1.25 8.5-15.1	9.83 ± 1.29 7.7-14.2	**0.002***
Serum urea (mg/dL)	31.06 ± 5.38 15-40	32.83 ± 6.19 18-45	0.096	35.17 ± 5.04 22-49	42.65 ± 6.43 22-58	**<0.001***	43.50 ± 7.32 21.6-65	53.22 ± 8.88 27-76	**<0.001***
Serum creatinine (mg/dL)	0.71 (0.06) 0.6-0.8	0.74 ± 0.09 0.6-0.9	0.057	0.82 ± 0.10 0.7-1.1	1.07 ± 0.12 0.9-1.4	**<0.001***	1.07 ± 0.12 0.8-1.3	1.34 ± 0.15 1-1.61	**<0.001***
eGFR (mL/min/1.73 m2)	110.83 ± 9.99 90-133	108.22 ± 12.31 79-133	0.204	100.08 ± 13.31 67-125	75.38 (13.06) 50-116	**<0.001***	73.07 ± 9.28 60-89	55.5 ± 8.48 43-73	**<0.001***
Urinary albumin-creatinine ratio	7.10 ± 1.74 4-12	7.27 ± 1.76 5-17	0.603	21.55 ± 6.99 8-29	9.92 ± 3.36 25-110	**<0.001***	204.50 ± 69.44 26-290	102.72 ± 35.39 81-395	**<0.001***

Data are expressed as mean ± SD. FBS; Group I, Healthy group; Group II, Normoalbuminuria group; Group III, Microalbuminuria group; systolic blood pressure, DBP; diastolic blood pressure; FBS, fasting blood sugar; PPBS, 2-hour postprandial blood sugar; HbA1c, glycosylated hemoglobin; eGFR, glomerular filtration rate; t, paired t-test; N represents the count of patients. * ($p < 0.05$) indicates statistical significance.

Discussion

Every year endocrinologists face their duties towards fasting Muslim diabetic patients around the world. They concern about risks of fasting such as hypoglycemia, hyperglycemia, diabetic ketoacidosis, dehydration and its side effects on renal functions. [17]

We assessed the impact of fasting the month of Ramadan on kidney function in Egyptian patients with type 2 diabetes. The findings of this research indicated that there was no variation in BMI among the three studied groups following fasting Ramadan. This is consistent with the results reported by [18] who found no changes in BMI when comparing

measurements taken before and after fasting.

On the other side, [19] indicated that the body mass index reduced following Ramadan as the weight decreased, this was agreed with [20] who recorded a reduction in body weight following fasting Ramadan among diabetic patients in Algeria and Malaysia, but [21] demonstrated a notable rise in bodily mass. This might be explained by differences in sample sizes also the varying feeding habits among these communities.

The present study indicated that there was no notable variation in blood pressure, as neither systolic nor diastolic blood pressure showed any change in all groups following Ramadan. This finding is consistent with the results of [22] who found no significant alteration in systolic blood pressure after Ramadan. Additionally, [23] reported that there was no substantial decrease in systolic or diastolic blood pressure at the conclusion of fasting when compared to measurements taken prior to fasting.

On the contrary, [24] revealed that blood pressures were significantly lowered after month of Ramadan comparing results with before it.

In comparison data of glucose parameters before and after Ramadan, The current study demonstrated that there were no notable alterations in glucose indicators across all groups examined. Consistent with our results, [25] found that glucose parameters (fasting and postprandial) levels remained the same following Ramadan fasting.

Also, [26] reported that there was no marked reduction in fasting blood sugar, and the levels of 2-hour postprandial blood sugar, average blood glucose, and Hemoglobin A1c remained unchanged.

In this study HBA1c did not change in group I (healthy group), while it decreased in group II and group III, [27] showed a marked reduction in HbA1c after fasting.

In this study, there is a significant rise in serum urea and creatinine concentrations in groups II and III as well as a significant decrease in estimated GFR in these groups after fasting Ramadan, while no significant change in these parameters in group I. This aligns with the findings of [28] who demonstrated a notable increase in serum creatinine levels and a significant reduction in estimated GFR among patients with Type 2 DM with normal kidney functions, whether albuminuria is present or not, after fasting the month of Ramadan. Moreover, [29] reported that third of Chronic Kidney Disease patients encountered a deterioration in their kidney functions either while fasting during Ramadan or within three months afterward.

On the other hand, [30] noted that the serum creatinine level showed no significant variation following fasting Ramadan, and the estimated glomerular filtration rate (GFR) of individuals with chronic kidney disease (CKD) did not significantly alter during the Ramadan fast.

It was reported that there no marked alteration in serum creatinine levels, along with a marked enhancement in the estimated GFR during and following the fasting period of Ramadan [31].

A study was conducted on CKD individuals with Stage 3 or higher, categorized into two groups (those who fasted and those who did not), and it was determined that fasting did not correlate with a heightened risk of decline in kidney function among these individuals, except for elderly patients who may be at higher risk. [32].

As regarding Urinary A/C Ratio in this study, a significant decrease in A/C ratio after fasting Ramadan in groups II and III was noted, but not changed in healthy group I [33] reported a significant decrease in micro albuminuria during Ramadan, This suggests that the health of the glomerular membrane was not adversely impacted by fasting Ramadan.

It was shown that there was no significant change in the Urinary Albumin Creatinine Ratio in patients with type 2 diabetes after

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fasting during Ramadan, and it remained low six weeks after Ramadan [34].

On the other side, [35] the study demonstrated that the A/C ratio was elevated in individuals with both micro- and macro albuminuria, suggesting that fasting negatively impacted albuminuria in diabetic patients.

This research found a notable negative association between HbA1c levels and estimated GFR in groups II and III prior to Ramadan. This finding aligns with [36] who indicated that patients with reduced estimated GFR exhibited higher HbA1c levels, even after adjusting for age, body mass index, hemoglobin levels, and using erythropoietin.

In this research, a notable negative correlation was found between the duration of diabetes and the estimated GFR in groups II and III following Ramadan. This finding aligns with the work by [37] which indicated that the length of time a person has diabetes is a significant risk factor that greatly influences the occurrence of diabetic kidney disease.

Furthermore, [38] demonstrated that the average duration of diabetes was considerably longer in individuals who progressed to diabetic kidney disease compared to those who did not.

Conclusion

Fasting Ramadan enhanced glycemic control in type 2 diabetic patients, but there was a deterioration in kidney function among both albuminuric and normoalbuminuric patients. It is essential for patients to receive guidance on proper hydration and nutritious dietary changes throughout Ramadan, and they should also seek advice from their doctors to evaluate their capacity to engage in fasting.

Conflict of interest

None of the contributors declared any conflict of interest

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