Article published online: 2025-10-31

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Impact of Albuminuria and Renal Function on Ramadan Fasting in Type 2 Diabetes

Bachar Afandi[1,2] Yakoob Ahmedani[3] Yousef Boobes[4] Alaaeldin Bashier[5,6] Sanobia Yousef[3] Georgios Ponirakis[7] Rayaz A. Malik[7] Reem Alamoudi[8] Inass Shaltout[9] Rashed Malek[10] Zanariah Hussein[11] Khadija Hafidh[12] Mohamed Hassanein[5,6]

[1] Division of Endocrinology, Tawam Hospital and Sheikh Tahnoun Medical City, Al Ain, United Arab Emirates
[2] Department of Internal Medicine, College of Medicine and Health Sciences, UAE University, Al Ain, United Arab Emirates
[3] Department of Diabetes, Tabba Heart Institute, Karachi, Pakistan
[4] Department of Nephrology, Seha Kidney Care, Tawam Hospital, Al Ain, United Arab Emirates
[5] Department of Diabetes and Endocrinology, Dubai Hospital, Dubai, United Arab Emirates
[6] Department of Medicine, Mohammed Bin Rashid University, Dubai, United Arab Emirates
[7] Department of Medicine, Weill Cornell Medicine-Qatar, Doha, Qatar
[8] Department of Endocrinology, King Saud bin Abdulaziz University, King Abdulaziz Medical City, King Saud University, Jeddah, Saudi Arabia
[9] Department of Medicine, Faculty of Medicine, Cairo University, Cairo, Egypt
[10] Department of Endocrinology, Setif University Ferhat Abbas, Algiers, Algeria
[11] Medical Endocrine Unit, Department of Internal Medicine, Endocrine Institute Hospital, Putrajaya, Malaysia
[12] Diabetes Unit, Rashid Hospital, Dubai, United Arab Emirates

Address for correspondence Bachar Afandi, MD, Division of Endocrinology, Tawam Hospital, P.O. Box 15258, Al Ain, United Arab Emirates (e-mail: bafandi1@hotmail.ae).

J Diabetes Endocrine Practice 2026;9:100–107.

Abstract

Background Diabetic kidney disease (DKD) is a common and serious complication, defined by albuminuria and/or reduced estimated glomerular filtration rate (eGFR).
Objectives This study explored the impact of DKD and its subgroups on glycemic control and fasting safety during Ramadan.
Patients and Methods We analyzed data from the Diabetes and Ramadan Global Survey (2020–2022), including 12,529 participants with type 2 diabetes across seven regions. Participants were classified into four groups: no DKD ($n = 10{,}780$), DKD with albuminuria only ($n = 460$), DKD with low eGFR only ($n = 1{,}150$), and DKD with both albuminuria and low eGFR ($n = 140$). Outcomes included fasting patterns, hypoglycemia, hyperglycemia, and related interruptions.
Results Most participants intended to fast (no DKD 86.5%, albuminuria only 80.0%, low eGFR only 76.4%, and albuminuria + low eGFR 80.6%). Mean fasting duration was ~27 days across groups; however, those with reduced eGFR were more likely to fast only 1 to 7 days (6.4 vs. 2.4% without DKD, $p < 0.0001$). Daytime hypoglycemia occurred in 14.5% (no DKD), 19.0% (albuminuria only), 23.7% (low eGFR only), and 25.0% (albuminuria + low eGFR). Breaking fast due to hypoglycemia was more frequent in DKD groups (14.9–19.6 vs. 8.2% without DKD, $p < 0.0001$). Hyperglycemia was most frequent in albuminuria only (24.2%) and low eGFR only (18.4%) compared with no DKD (14.5%, $p < 0.0001$). Severe hyperglycemia was highest in low eGFR-only (2.0 vs. 0.8% without DKD, $p < 0.001$).

Keywords
- Ramadan fasting
- diabetic kidney disease
- eGFR
- albuminuria
- hypoglycemia
- hyperglycemia

article published online
October 31, 2025

DOI https://doi.org/10.1055/s-0045-1812089.
ISSN 2772-7653.

Conclusion Ramadan fasting is common among people with type 2 diabetes and DKD, but carries greater risks of both hypoglycemia and hyperglycemia. Albuminuria may signal reduced physiological resilience and glycemic stability, even when eGFR is preserved, while reduced eGFR confers the highest risk. Comprehensive pre-Ramadan assessment and tailored education are essential to support safer fasting in this high-risk population.

Introduction

During Ramadan fasting, Muslims are required to abstain from eating, drinking, using oral medications, and engaging in sexual activities from dawn until sunset. The duration of fasting varies between 11 and 20 hours, depending on the region and season. Ramadan fasting presents unique challenges for individuals with chronic health conditions such as diabetes and chronic kidney disease (CKD), which affect millions worldwide.[1] Diabetic kidney disease (DKD), a form of CKD that develops in people with diabetes, is usually defined by persistent albuminuria and/or a reduced estimated glomerular filtration rate (eGFR) (<60 mL/min/1.73 m^2) in the absence of other causes of CKD. Albuminuria often indicates early glomerular injury, whereas reduced eGFR reflects more advanced renal dysfunction, and separating the two provides distinct clinical insights. By 2030, the prevalence of CKD among individuals with diabetes is projected to increase from 2.8 to 4.4%.[2]

People with DKD and moderate albuminuria (MA), which is an early marker of nephropathy, are at increased risk of complications such as hypotension, electrolyte imbalances, hypoglycemia, elevated uric acid levels, and dehydration during fasting.[3] Although previous studies have shown that prolonged fasting can be tolerable for individuals with CKD, these patients may face serious risks such as dehydration and renal damage, particularly during long summer days. Dehydration can exacerbate health issues, especially in older individuals.[4]

The International Diabetes Federation (IDF) and the Diabetes and Ramadan International Alliance (IDF-DAR) now recommend against fasting for people with diabetes with stage 3 kidney failure based on their updated risk stratification.[5] Despite these recommendations, many individuals with both type 2 diabetes and CKD may still wish to fast. Thus, clear guidelines are needed to ensure that fasting is conducted safely for these individuals. While the elderly population may be keen on fasting, the higher risk of renal function deterioration in this age group must also be considered. Clinicians often face challenges in managing chronic conditions such as DKD, when patients decide to fast for extended periods, and concerns may arise if patients fast against medical advice.[6]

Due to the complexities and challenges faced by DKD patients during Ramadan fasting, there is a significant gap in evidence on whether these patients should be advised to fast. Although numerous observational studies have shown no significant impact of fasting on renal parameters in CKD patients,[1,7] other research indicates adverse effects on kidney and cardiovascular health outcomes.[8–10] A recent study published in BMC Nephrology highlights further evidence on the renal risks associated with fasting in DKD patients, adding to the growing body of literature on this topic.[11]

The previous DAR-Global CKD survey conducted during the COVID-19 pandemic evaluated fasting patterns, practices, and outcomes in individuals with DKD during Ramadan 2020. The findings showed that these patients experienced higher rates of hypoglycemia and hyperglycemia, leading to emergency visits and hospital admissions.[12] Building on these findings, the current global survey aims to explore the characteristics and outcomes of fasting in a larger cohort of individuals with type 2 diabetes and DKD, including those with more advanced complications, during Ramadan 2020 to 2022.

By distinguishing between albuminuria and reduced eGFR, this study aims to clarify their individual contributions to fasting safety and outcomes.

Patients and Methods

Study Design and Setting

This study is a retrospective observational cohort analysis based on data from the DaR Global Survey (2020–2022). The survey included Muslim individuals with type 2 diabetes mellitus from seven geographic regions: the Gulf, the Middle East, Türkiye, the United Kingdom, Africa, the Indian subcontinent, and Southeast Asia. Data were collected during routine outpatient clinic visits within 10 weeks following the end of Ramadan. This subanalysis specifically compares clinical outcomes between participants with and without confirmed DKD to assess the implications of DKD on fasting safety and management versus a control group without DKD. Participants with incomplete information on albuminuria or eGFR were excluded.

Participants

Of the 12,529 participants with type 2 diabetes included in the study, the majority (86%) did not have DKD (normal eGFR without albuminuria). DKD with low GFR but no albuminuria was present in 9.2% of participants, while smaller proportions had DKD with normal GFR (albuminuria only, 3.7%) or DKD with albuminuria + low GFR (1.1%). All participants were regular attendees of outpatient clinics during the study period. As this was a retrospective analysis of preexisting data, no formal sample size calculation was undertaken. Missing data were excluded listwise from the analysis.

DKD Definitions

DKD was defined as either reduced renal function or albuminuria, in the absence of other causes of CKD. Albuminuria was classified according to the urine albumin-to-creatinine ratio (ACR $\geq$30 mg/g). eGFR was calculated using the Chronic Kidney Disease Epidemiology Collaboration equation, with impaired renal function defined as eGFR <60 mL/min/1.73 m^2. Stage 3 CKD was defined as eGFR 30 to 59 mL/min/1.73 m^2.

Laboratory Variables

Lipid parameters collected in the survey included low-density lipoprotein (LDL) cholesterol, which was systematically available, whereas triglycerides were not consistently reported. Hyperlipidemia was classified by physicians as elevated LDL and/or low high-density lipoprotein, according to survey definitions.

Outcome Measures

The primary outcomes assessed included the incidence, frequency, and duration of hypoglycemic and hyperglycemic episodes during Ramadan, as well as any related medical interventions. Severe hypoglycemia was defined as plasma glucose <3.0 mmol/L (<54 mg/dL) with symptoms or requiring assistance. Severe hyperglycemia was defined as plasma glucose >16.7 mmol/L (>300 mg/dL) or requiring medical attention. The main exposure variable was the degree of fasting during Ramadan and the following month of Shawwal. Continuous variables—such as age, glycated hemoglobin (HbA1c), diabetes duration, and the number of fasting days—were summarized using means and standard deviations (mean $\pm$ SD). Categorical variables—including the occurrence of hypoglycemia—were reported as frequencies and percentages.

Data Collection

Data were obtained via structured questionnaires administered by trained health care professionals during routine clinic visits. Information collected included demographic details, duration of diabetes, HbA1c levels, and current treatment regimens (both insulin and noninsulin therapies).

Statistical Analysis

Survey data from the 2020 to 2022 study years were combined for analysis. Descriptive statistics were used to summarize baseline characteristics. Comparisons between the different groups were performed using Pearson's chi-square test for categorical variables. Comparisons of continuous variables between the groups were performed using Analysis of variance or *t*-tests, as appropriate. A *p*-value of <0.05 was considered statistically significant. No formal adjustment for multiple comparisons was applied; analyses were exploratory and results should be interpreted with caution. All analyses were conducted using IBM SPSS Statistics, version 26. As this was a survey-based study, potential recall bias is acknowledged.

Results

Participants Characteristics

Patients with DKD and low GFR with albuminuria were older, had longer diabetes duration, and higher blood pressure. Age ($p = 0.01$), diabetes duration ($p = 0.03$), BMI ($p = 0.01$), and systolic/diastolic BP ($p = 0.008$ and $p = 0.01$, respectively) differed significantly across groups. Mean systolic BP was 133.5 $\pm$ 20.9 mm Hg in the albuminuria-only group. No significant differences were observed in HbA1c or LDL levels (►**Table 1**). There was a male predominance in DKD subgroups ($p = 0.05$).

Table 1 Baseline characteristics of participants according to DKD status

Characteristic	DM without DKD	DKD with albuminuria and normal GFR	DKD with low GFR without albuminuria	DKD with albuminuria + GFR <60	*p*-Value
Number	10,780	460	1,150	140	–
Female, *n* (%)	5,699 (52.9)	224 (48.8)	571 (49.7)	63 (45.3)	**0.05**
Male, *n* (%)	5,073 (47.1)	235 (51.2)	577 (50.3)	76 (54.7)	
Age, y	54.4 ± 11.6	57.2 ± 11.3	60.9 ± 11.4	61.3 ± 12	**0.01**
Diabetes duration, y	9.2 ± 7.1	13.1 ± 6.5	14.5 ± 8.3	15.6 ± 7.2	**0.03**
HbA1c, %	8.3 ± 1.9	8.4 ± 1.9	8.2 ± 1.8	8.2 ± 1.9	0.9
Latest BMI, kg/m^2	27.8 ± 6.9	29.1 ± 6.1	26.8 ± 8.7	27.6 ± 6.2	**0.01**
Latest systolic BP, mm Hg	127 ± 26.8	133.5 ± 20.9	128.7 ± 37.4	138.6 ± 28	**0.008**
Latest diastolic BP, mm Hg	76.7 ± 16.1	79.8 ± 13	73 ± 21.5	79.6 ± 16.9	**0.01**
Latest LDL, mg/dL	90.3 ± 52.3	90.2 ± 46.6	97.6 ± 51.7	91.7 ± 52.3	0.9

Abbreviations: BMI, body mass index; BP, blood pressure; DKD, diabetic kidney disease; DM, diabetes mellitus; GFR, glomerular filtration rate; HbA1c, glycated hemoglobin; LDL, low-density lipoprotein cholesterol; SD, standard deviation; T2D, type 2 diabetes.
Note: Values are presented as mean ± SD or *n* (%). Groups are defined as: T2D without DKD, DKD with albuminuria and preserved GFR, DKD with low GFR but no albuminuria, and DKD with both albuminuria and low GFR.

Table 2 Medications used by the DKD subgroup

Variable	T2D without DKD ($n = 10,780$)	DKD with albuminuria and preserved GFR ($n = 460$)	DKD with low GFR without albuminuria ($n = 1,150$)	DKD with albuminuria + low GFR ($n = 140$)	p-Value
Metformin	8,922 (82.7%)	375 (81.5%)	681 (59.2%)	72 (51.4%)	**0.002**
Sulfonylureas	4,311 (40%)	178 (38.7%)	366 (31.8%)	40 (28.6%)	**0.05**
DPP-4 inhibitors	3,485 (32.3%)	188 (40.9%)	337 (29.3%)	57 (40.7%)	0.08
Thiazolidinedione	463 (4.3%)	27 (5.9%)	51 (4.4%)	7 (5%)	0.5
SGLT2 inhibitors	1,991 (18.5%)	146 (31.7%)	195 (16.9 %)	48 (34.3 %)	< **0.0001**
GLP-1	296 (2.7%)	22 (4.8%)	39 (3.4%)	11 (7.8%)	< **0.0001**
Alpha-glucosidase inhibitor	201 (1.9%)	14 (3%)	37 (3.2%)	0 (0.0%)	< **0.0001**
Any insulin	4,250 (39.4%)	301 (65.4%)	800 (69.5%)	116 (82.8%)	< **0.0001**

Abbreviations: DKD, diabetic kidney disease DPP-4, dipeptidyl peptidase-4; GFR, glomerular filtration rate; GLP-1, glucagon-like peptide-1; SGLT2, sodium-glucose cotransporter-2; T2D, type 2 diabetes.

Medication Use and Comorbidities

Medication use and comorbidity burden increased with the presence of DKD. Insulin use (any type) was significantly more common among participants with DKD, particularly those with low GFR and/or albuminuria (301/460 [65.4%], 800/1,150 [69.5%], and 116/140 [82.8%] vs. 4,250/10,780 [39.4%] in no DKD, $p < 0.0001$) (►**Table 2**). Hypoglycemia was more frequent among participants treated with sulfonylureas ($p = 0.05$) or insulin compared with those not on these agents. The use of sodium-glucose cotransporter-2 inhibitors and glucagon-like peptide-1 receptor agonists was higher in the albuminuria groups (both $p < 0.0001$), while metformin use decreased with declining eGFR ($p = 0.002$). Participants with DKD also had higher rates of hypertension, hyperlipidemia, retinopathy, neuropathy, macrovascular disease, and diabetic foot compared with those without DKD (all $p < 0.0001$, ►**Table 3**).

Self-Monitoring of Blood Glucose and Ramadan-Focused Education

Self-monitoring of blood glucose (SMBG) practices during Ramadan varied significantly across subgroups ($p < 0.0001$). Participants with albuminuria only (normal GFR) were more likely to increase SMBG frequency (110/460 [29.9%] vs. 1,286/10,780 [12.7%] without DKD). Around half of the participants in each group maintained their pre-Ramadan SMBG frequency, while approximately one-quarter did not monitor at all. Ramadan-focused diabetes education was reported in 58.0% of those without DKD, 77.7% with albuminuria only, 63.5% with low GFR only, and 76.1% with both albuminuria and low GFR; however, these differences were not statistically significant ($p = 0.15$, ►**Table 4**).

Fasting Patterns

Most participants intended to fast: 9,327/10,780 (86.5%) without DKD, 368/460 (80.0%) with albuminuria only,

Table 3 Comorbidities and complications

Variable	T2D without DKD ($n = 10,780$)	DKD with albuminuria and preserved GFR ($n = 460$)	DKD with low GFR without albuminuria ($n = 1,150$)	DKD with albuminuria + low GFR ($n = 140$)	p-Value
Hypertension	4,777 (44.3%)	335 (72.8%)	895 (77.8%)	119 (85%)	< **0.0001**
Hyperlipidemia	4,103 (38%)	289 (62.8%)	743 (64.6%)	109 (77.8%)	< **0.0001**
Retinopathy	1,098 (10.2%)	175 (38%)	450 (39.1%)	71 (50.7%)	< **0.0001**
Neuropathy	1,959 (18.2%)	152 (33%)	414 (36%)	64 (45.7%)	< **0.0001**
Macrovascular disease	1,069 (9.9%)	84 (18.3%)	324 (28.2%)	42 (30%)	< **0.0001**
Diabetic foot disease	309 (2.9%)	29 (6.3%)	91 (7.9%)	13 (9.3%)	< **0.0001**

Abbreviations: DKD, diabetic kidney disease; DPP-4, dipeptidyl peptidase-4; GFR, glomerular filtration rate; GLP-1, glucagon-like peptide-1; LDL, low-density lipoprotein cholesterol; SGLT2, sodium-glucose cotransporter-2; T2D, type 2 diabetes.
Note: Values are n (%). Groups are defined as: T2D without DKD, DKD with albuminuria and preserved GFR, DKD with low GFR but no albuminuria, and DKD with both albuminuria and low GFR.

Table 4 SMBG practices and Ramadan-focused diabetes education in DKD subgroups

Variable	T2D without DKD ($n = 10,780$)	DKD with albuminuria and preserved GFR ($n = 460$)	DKD with low GFR without albuminuria ($n = 1,150$)	DKD with albuminuria + low GFR ($n = 140$)	*p*-Value
Yes, more frequent[a]	1,286 (12.7%)	110 (29.9%)	113 (11.1%)	16 (14.1%)	< 0.0001
Yes, less frequent[a]	1,288 (12.7%)	44 (11.9%)	134 (13.2%)	18 (15.9%)	
Yes, at the same frequency[a]	4,923 (48.7%)	141 (38.3%)	497 (48.9%)	48 (42.5%)	
No	2,615 (25.8%)	73 (19.8%)	273 (26.8%)	32 (28.3%)	
Received education	5,867 (58%)	286 (77.7%)	644 (63.5%)	86 (76.1%)	0.15

Abbreviations: DKD, diabetic kidney disease; GFR, glomerular filtration rate; SMBG, self-monitoring of blood glucose; T2D, type 2 diabetes.
Note: Values are *n* (%). SMBG frequency reflects changes compared with pre-Ramadan practices. Education includes any structured Ramadan-specific advice or counseling received before Ramadan.
[a]comparisons are with practice before Ramadan.

879/1,150 (76.4%) with low GFR only, and 112/140 (80.6%) with both albuminuria and low GFR. Those with reduced GFR were more likely to fast only 1 to 7 days (73/1,150 [6.4%] vs. 224/10,780 [2.4%] without DKD, $p < 0.0001$), although mean fasting duration was similar across groups (~27 days, $p = 0.9$). Intention to fast during Shawwal was lower in the low GFR + albuminuria group (27/140 [19.3%] vs. 2,749/10,780 [25.5%] without DKD, $p = 0.01$, ►**Table 5**).

Glycemic Outcomes during Ramadan

Daytime hypoglycemia occurred in 1,351/10,780 (14.5%) without DKD, 70/460 (19.0%) with albuminuria only, 209/1,150 (23.7%) with low GFR only, and 28/140 (25.0%) with both albuminuria and low GFR ($p < 0.0001$). Breaking the fast due to hypoglycemia was also more frequent in DKD groups (14.9–19.6 vs. 8.2% in no DKD, $p < 0.0001$). Severe hypoglycemia remained uncommon but was more frequent in DKD, reaching up to 4.5% compared with 1.7% in those without DKD ($p = 0.03$, ►**Table 6**).

Hyperglycemia was more common in participants with albuminuria only (89/460, 24.2%) and low GFR only (162/1,150, 18.4%) compared with those without DKD (1,345/10,780, 14.5%, $p < 0.0001$). Rates in the low GFR with albuminuria group were comparable to other subgroups. Severe hyperglycemia was most frequent in low GFR only (18/1,150, 2.0% vs. 77/10,780, 0.8% without DKD, $p < 0.001$), while the other DKD subgroups were similar (►**Table 6**).

Discussion

Research on DKD and Ramadan fasting falls into three categories: studies assessing how DKD affects the ability to fast, studies examining how fasting impacts DKD progression, and studies addressing both aspects. This work belongs to the first category. We examined fasting patterns and outcomes in individuals with DKD, stratified by different combinations of albuminuria and reduced GFR, during Ramadan 2020 to 2022. To our knowledge, this is the first study to specifically evaluate the impact of albuminuria with or without reduced GFR on fasting behavior and safety in a large multinational cohort.

Consistent with previous studies, individuals with DKD in our survey were older, had a longer duration of diabetes, poorer glycemic control, greater reliance on insulin therapy, and a higher burden of chronic complications compared with

Table 5 Fasting characteristics during Ramadan and Shawwal by DKD subgroups

Characteristic		T2D without DKD ($n = 10,780$)	DKD with albuminuria and preserved GFR ($n = 460$)	DKD with low GFR without albuminuria ($n = 1,150$)	DKD with albuminuria + low GFR ($n = 140$)	*p*-Value
Intention for Ramadan fasting (yes)		9,327 (86.5%)	368 (80%)	879 (76.4%)	112 (80.6%)	0.8
Number of fasting days	1–7 d	224 (2.4%)	6 (1.6%)	73 (6.4%)	6 (5.4%)	**<0.0001**
	30 d	6,220 (66.7%)	237 (51.5%)	535 (60.9%)	67 (59.8%)	0.4
	Mean duration	27.7 ± 5.4	27.6 ± 5.1	26 ± 7.5	27 ± 6.4	0.9
Intention to fast during Shawwal (yes)		2,749 (25.5%)	152 (33%)	275 (23.9%)	27 (19.3%)	**0.01**

Abbreviations: DKD, diabetic kidney disease; GFR, glomerular filtration rate; T2D, type 2 diabetes.
Note: Values are *n* (%) unless otherwise stated. Groups are defined as: T2D without DKD, DKD with albuminuria and preserved GFR, DKD with low GFR but no albuminuria, and DKD with both albuminuria and low GFR.

Table 6 Association of Ramadan fasting and glycemic events by DKD subgroups

Parameter	T2D without DKD ($n = 10,780$)	DKD with albuminuria and preserved GFR ($n = 460$)	DKD with low GFR without albuminuria ($n = 1,150$)	DKD with albuminuria + low GFR ($n = 140$)	*p*-Value
Fasting during Ramadan, *n* (%)	2,749 (25.5)[a]	152 (33.1)[b]	276 (24.0)[a]	27 (19.4)[a]	≤**0.0001**
Daytime hypoglycemia, *n* (%)	1,351 (14.5)[a]	70 (19.0)[a,b]	209 (23.7)[b]	28 (25.0)[b]	≤**0.0001**
Broke fast due to hypoglycemia, *n* (%)	766 (8.2)[a]	55 (14.9)[b]	144 (16.3)[b]	22 (19.6)[b]	≤**0.0001**
Severe hypoglycemia, *n* (%)	161 (1.7)[a]	8 (2.2)[a]	23 (2.6)[a]	5 (4.5)[a]	≤**0.05**
Hyperglycemia, *n* (%)	1,345 (14.5)[a]	89 (24.2)[b]	162 (18.4)[b]	16 (14.3)[a,b]	≤**0.0001**
Broke fast due to hyperglycemia, *n* (%)	289 (3.1)[a]	25 (6.8)[b]	49 (5.5)[b]	1 (0.9)[a,b]	≤**0.0001**
Severe hyperglycemia, *n* (%)	77 (0.8)[a]	2 (0.5)[a,b]	18 (2.0)[b]	2 (1.8)[a,b]	≤**0.001**

Abbreviations: DKD, diabetic kidney disease; GFR, glomerular filtration rate; T2D, type 2 diabetes.
Notes: Severe hypoglycemia = plasma glucose <3.0 mmol/L (<54 mg/dL) with typical symptoms or requiring assistance. Severe hyperglycemia = plasma glucose >16.7 mmol/L (>300 mg/dL) or requiring medical attention. Values are *n* (%). Groups are defined as: T2D without DKD, DKD with albuminuria and preserved GFR, DKD with low GFR but no albuminuria, and DKD with both albuminuria and low GFR.
Superscripts ([a,b]): Groups sharing the same superscript letter do not differ significantly from each other (post hoc comparison); post hoc tests were exploratory with no adjustment for multiplicity.

those without DKD. These factors place them at elevated risk during Ramadan fasting. The profile of our DKD cohort closely aligns with findings from our previous survey, reinforcing the consistency of these risk patterns across different studies.[10] However, in this study, we assessed the effect of DKD independent of the other risk factors.

Despite their high-risk profile, most DKD participants intended to fast during Ramadan, and the mean fasting duration (~27 days) was similar across all groups. This finding is consistent with our earlier survey and aligns with previous epidemiological reports in showing high fasting adherence among individuals with diabetes, even in the presence of advanced multiple risk factors.[12–16] Although the overall intention to fast did not differ among DKD subgroups ($p = 0.8$), participants with reduced eGFR—particularly those without albuminuria—were more likely to fast for only 1 to 7 days ($p < 0.0001$), suggesting a subgroup unable to sustain fasting throughout the month. Intention to fast during Shawwal was significantly lower among those with both low eGFR (<60 mL/min/1.73 m^2) and albuminuria ($p = 0.01$), indicating greater sensitivity to disease severity in the post-Ramadan period. Similar findings have been reported in smaller CKD cohorts, where fasting duration approached the full month despite medical advice to limit it.[17] These results highlight strong cultural and religious drivers to fast despite medical risk, underscoring the need for proactive pre-Ramadan risk assessment and patient-centered counseling in high-risk groups.

Daytime hypoglycemia was more common in participants with reduced eGFR (<60 mL/min/1.73 m^2), with or without albuminuria, compared with those without DKD. In contrast, those with albuminuria only had intermediate rates that did not differ significantly from other groups. Breaking the fast due to hypoglycemia was more frequent across all DKD groups compared with participants without DKD, though there were no clear differences among the DKD subgroups. Overall, the low eGFR (<60 mL/min/1.73 m^2) cohort experienced higher rates of hypoglycemia than those with preserved eGFR. Hypoglycemia in Ramadan may be related to abrupt changes in medication timing, dosage adjustments, and altered eating patterns that occur during the fasting month. Rates of hypoglycemia and fasting interruption were similar to those reported in our previous survey.[10] However, emergency visits were more common and hospital admissions less frequent in the earlier dataset, likely reflecting differences in health care access during the COVID-19 pandemic in 2020. These findings are consistent with prior reports indicating an elevated risk of hypoglycemia in CKD, including studies in stage 3 CKD showing a twofold increase in the frequency and duration of mild hypoglycemic episodes, with severe events being rare.[18,19] Collectively, this supports the view that moderate to severe DKD confers increased susceptibility to hypoglycemia during Ramadan fasting, while highlighting that, in most cases, episodes are mild and manageable. The broader literature examining Ramadan fasting across CKD stages reports variable effects on renal function.[20–22]

Hyperglycemia was more frequent in participants with albuminuria only and those with reduced eGFR without albuminuria compared with individuals without DKD. In contrast, rates in those with both low eGFR and albuminuria were generally similar to other groups. Breaking the fast due to hyperglycemia followed a similar pattern, and severe hyperglycemia occurred more often in the low eGFR-only group. Among DKD participants, hyperglycemia was observed during both fasting and eating periods, likely influenced by calorie-dense iftar meals rich in refined carbohydrate and fat, increased intake of sugary desserts and beverages, larger predawn meals to offset hypoglycemia risk, and reduced daytime physical activity during Ramadan.[23–26] These observations align with existing evidence that Ramadan dietary patterns may contribute to hyperglycemia, particularly in individuals with impaired renal function or albuminuria.

SMBG is a crucial aspect of diabetes management, enabling individuals to manage their diabetes while observing Ramadan fasting successfully. Individuals at high risk who insist on fasting are advised to monitor their blood glucose levels regularly throughout the day.[5] Our DKD participants did not increase the SMBG frequency during Ramadan, similar to our previous survey,[10] even though many were aware of their risk of developing hypoglycemia and hyperglycemia.

Evidence suggests that effective blood glucose monitoring combined with Ramadan-specific diabetes education may play a crucial role in reducing complications among people with diabetes during fasting.[19] Over half of our participants with DKD received specific Ramadan diabetes education, primarily during routine clinic consultations before Ramadan. However, one-third still lacked this educational support. From a practical standpoint, interventions such as closer glucose monitoring (including continuous glucose monitoring where available), structured Ramadan-focused education, and medication adjustments (e.g., insulin dose reduction, cautious use of sulfonylureas) should be emphasized for DKD subgroups.

MA emerged as an important marker of Ramadan fasting outcomes among individuals with DKD. While the overall intention to fast during Ramadan was similar across DKD subgroups, individuals with MA were more likely to break their fast early in the month (1–7 days) and showed a significantly lower intention to fast during Shawwal, suggesting reduced tolerance of prolonged fasting in the post-Ramadan period. They also experienced higher rates of both hypoglycemia and hyperglycemia compared with those without albuminuria, reflecting a greater degree of metabolic instability. These findings suggest that albuminuria, even with preserved eGFR, may represent an early signal of reduced physiological resilience during fasting, supporting its inclusion in pre-Ramadan risk stratification algorithms. By integrating both albuminuria and reduced eGFR, clinicians may better individualize counseling and anticipate risks.

This study has several limitations. Its retrospective design and reliance on survey data may introduce recall bias, as hypoglycemia and hyperglycemia were self-reported rather than systematically validated. DKD status and subgroups were determined from available laboratory data; however, measurements were not standardized across centers and countries, and persistence of albuminuria for more than 3 months could not be confirmed for all participants. Recruitment was clinic-based, which may have introduced selection bias, and fasting behaviors in 2020 may have been influenced by the COVID-19 pandemic. Geographic or country-specific analyses were not feasible due to small subgroup sizes, limiting the ability to interpret regional differences. Medication use was self-reported, and some participants with eGFR <30 remained on metformin, which may reflect real-world practice variability. Generalizability of the findings should also be considered with caution, as the data were collected across diverse countries with varying health care systems and fasting practices. Nevertheless, the consistency of patterns observed across regions supports their external validity.

Conclusion

Ramadan fasting is common among people with type 2 diabetes and DKD, but carries greater risks of both hypoglycemia and hyperglycemia. Albuminuria may signal reduced physiological resilience and glycemic instability, even when eGFR is preserved, while reduced eGFR confers the highest risk. Comprehensive pre-Ramadan assessment and tailored education are essential to support safer fasting in this high-risk population. Future prospective studies with standardized DKD staging and objective outcomes are needed to confirm these findings.

Authors' Contribution
All authors contributed to the conception, data collection, writing, and final approval of the manuscript.

Compliance with Ethical Principles
Ethical approval was granted for the initial DAR Global Survey from the Dubai Health Authority.

Funding Sources
None.

Conflict of Interest
None declared.

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