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Correlation between Pre-Ramadan HbA1c Levels and Fasting Outcomes in Individuals with Type 2 Diabetes: Evidence from the Global 2020–2022 DAR Survey

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Abstract

Background Glycemic control prior to Ramadan is considered an essential determinant of fasting safety in individuals with diabetes. While the International Diabetes Federation-Diabetes and Ramadan Alliance risk calculator incorporates glycated hemoglobin (HbA1c) into fasting risk stratification, there is limited evidence to validate the cutoffs of $< 7.5\%$ and $> 9\%$ for predicting fasting outcomes.

Objective This study evaluates the association between pre-Ramadan HbA1c categories and key fasting-related outcomes in a large multinational cohort of individuals with diabetes.

Methods This subanalysis of the Diabetes and Ramadan (DaR) Global Survey categorized participants from 7 global regions covering more than 20 countries into three groups based on pre-Ramadan HbA1c: $< 7.5\%$, 7.5 to 9%, and $> 9\%$. Outcomes included fasting participation, hypoglycemia, hyperglycemia, and fasting interruptions due to glycemic events. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for participants with HbA1c $> 9\%$ compared to those with HbA1c $< 7.5\%$.

Results Of 11,717 participants, 37.7% had HbA1c $< 7.5\%$, 33.8% had 7.5 to 9%, and 28.5% had $> 9\%$. Fasting participation was highest in the $< 7.5\%$ group (89.3%) and lowest in the $> 9\%$ group (80.5%; OR 0.49, 95% CI 0.43–0.56). Compared to $< 7.5\%$, HbA1c $> 9\%$ was associated with increased odds of hyperglycemia (OR 5.10), breaking the fast due to hyperglycemia (OR 5.63) and severe hyperglycemia (OR 8.11), daytime hypoglycemia (OR 1.48), and hypoglycemia-related fasting interruption (OR 1.77). Severe hypoglycemia rates did not differ significantly between HbA1c groups.

Keywords
- Ramadan fasting
- T2 diabetes mellitus
- HbA1c
- glycemic control
- hypoglycemia
- hyperglycemia
- risk assessment
- DAR risk calculator

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Conclusion Higher pre-Ramadan HbA1c was associated with lower fasting participation and a greater risk of hyperglycemia and hypoglycemia-related complications. These results support the use of the current HbA1c thresholds in Ramadan risk assessment and emphasize the importance of optimizing glycemic control and providing targeted education before Ramadan.

Introduction

Fasting during the holy month of Ramadan is observed by millions of Muslims with diabetes worldwide. While exemptions are allowed for those at higher risk, observational studies indicate that many individuals still choose to fast, even against medical advice and despite potential health risks.[1,2] The combination of prolonged hours without food or drink and changes in meal and medication timing can create significant challenges for people with diabetes, heightening the risk of both hypoglycemia and hyperglycemia. Given that fasting participation remains consistently high across regions, there is a clear need for evidence-based approaches that are effective in diverse cultural, dietary, and environmental settings. One such tool is the International Diabetes Federation-Diabetes and Ramadan Alliance (IDF-DAR) risk calculator, designed to guide clinicians and patients in making informed decisions about fasting based on individual risk profiles. The Diabetes and Ramadan (DaR) Global Survey included participants from seven geographic regions spanning more than 20 countries, providing a unique opportunity to assess risk across diverse populations.

Glycemic control before Ramadan, reflected by glycated hemoglobin (HbA1c) levels, is a strong predictor of fasting safety. Higher HbA1c has been associated with greater glucose fluctuations, an increased risk of fasting-related complications, and more frequent interruptions.[3–5] These findings align with international recommendations for individualized HbA1c targets that consider comorbidities and overall patient risk.[6] Research in both adolescents and adults with type 1 or type 2 diabetes has shown that poor pre-Ramadan control contributes to unstable glucose levels during fasting, particularly when there is no individualized care plan or structured education.[3–5] Structured education programs such as the Ramadan Education and Awareness in Diabetes (READ) study[7] and the Ramadan Study on Diabetes Education (RSDE)[8] have demonstrated that targeted interventions can improve safety and reduce complications during fasting. Data from continuous glucose monitoring (CGM) also indicate greater glucose excursions in individuals with poor control, including those not treated with insulin.[9,10]

From a pathophysiological perspective, elevated pre-Ramadan HbA1c reflects chronic hyperglycemia, higher glycemic variability, and often inconsistent self-management. These factors can amplify the metabolic strain of fasting, increasing susceptibility to dehydration-related hyperglycemia and symptomatic hypoglycemia.[11]

Nevertheless, few large-scale studies have examined the link between prefasting HbA1c and Ramadan outcomes across diverse populations. Existing evidence is mostly from single-center or regional studies, or is narrowly focused on insulin-treated individuals.[1,5,12] Furthermore, although HbA1c is part of the current IDF-DAR risk calculator, the threshold values ($<$ 7.5% for low risk and $>$ 9% for high risk) were chosen based on expert consensus and clinical experience, but have not been broadly validated across multinational cohorts.[13,14] This makes it important to assess whether these thresholds are clinically meaningful.

To address this gap, we conducted a subanalysis of the 2020 to 2022 DaR Global Survey, assessing the relationship between baseline HbA1c and key Ramadan fasting outcomes, including hypoglycemia, hyperglycemia, and fasting interruption. Participants were categorized into three HbA1c groups—$<$ 7.5%, 7.5 to 9%, and $>$ 9%—to evaluate whether the DaR calculator's thresholds reflect real-world risks. Our findings provide multiregional, large-scale evidence supporting these cutoffs and reinforce the role of HbA1c as a central component of pre-Ramadan assessment.

Methods

Study Design and Setting

This retrospective, observational cohort study utilized data from the 2020 to 2022 DaR Global Survey, which enrolled Muslim adults with type 2 diabetes mellitus (T2DM) from seven global regions: the Gulf States, the Middle East, Türkiye, the United Kingdom, Africa, the Indian subcontinent, and Southeast Asia. Data were collected in routine outpatient settings by trained health care professionals. The study adhered to the ethical approvals obtained for the DaR Global Survey and followed principles of confidentiality and informed consent. Data were collected during routine outpatient visits within approximately 10 weeks after Ramadan. This subanalysis compared participants according to their most recent pre-Ramadan HbA1c level to examine the relationship between glycemic control and fasting-related outcomes. Definitions of glycemic outcomes were standardized: hypoglycemia was defined as symptomatic or glucose $<$ 70 mg/dL; severe hypoglycemia as requiring external assistance; hyperglycemia as symptomatic or glucose $>$ 250 mg/dL; and severe hyperglycemia as requiring emergency care.

Study Population

Of 11,717 surveyed individuals, 4,417 (37.7%) had HbA1c $<$ 7.5%, 3,960 (33.8%) had HbA1c 7.5 to 9%, and 3,340 (28.5%)

had HbA1c > 9%. All participants were under regular outpatient follow-up during the survey period. As previously recorded data were analyzed, no prospective sample size calculation was performed.

Variables and Outcomes

Primary outcomes included the incidence, frequency, and duration of hypoglycemic and hyperglycemic episodes during Ramadan, as well as any related clinical interventions or fasting interruptions. Outcomes were defined consistently across regions, with hypoglycemia recorded as glucose < 70 mg/dL or typical symptoms, severe hypoglycemia as episodes requiring assistance, hyperglycemia as glucose > 250 mg/dL or typical symptoms, and severe hyperglycemia as episodes requiring emergency care. The main exposure variable was categorized by HbA1c level (< 7.5%, 7.5–9%, > 9%). Additional variables included fasting duration during Ramadan and the month of Shawwal, demographics, diabetes duration, and treatment regimens. Continuous variables (e.g., age, HbA1c, diabetes duration, fasting days) were summarized as mean ± standard deviation, and categorical variables (e.g., occurrence of hypoglycemia) were reported as counts and percentages.

Data Collection

Data were obtained using structured questionnaires administered by trained health care professionals during routine clinical encounters. The information collected included demographic characteristics, diabetes history, most recent HbA1c level, and treatment details (insulin and noninsulin therapies). Information on self-monitoring of blood glucose (SMBG) practices and participation in structured Ramadan-focused education was also recorded, enabling subgroup analyses.

Statistical Analysis

Survey data from 2020 and 2022 were pooled for analysis. Baseline characteristics were summarized descriptively. Group comparisons by HbA1c category were performed using Pearson's chi-square test for categorical variables and analysis of variance for continuous variables. Odds ratios (ORs) with 95% confidence intervals (CIs) were calculated to assess the risk of fasting-related outcomes in participants with HbA1c > 9% compared to those with HbA1c < 7.5%. Multivariate logistic regression models were conducted to adjust for potential confounders, including insulin use, SMBG frequency, and receipt of structured education. Statistical significance was set at $p < 0.05$. Analyses were conducted using IBM SPSS Statistics, version 26.

Results

Across HbA1c categories (< 7.5%, 7.5–9%, > 9%), the proportion of females increased with higher HbA1c levels, while the mean diabetes duration and mean HbA1c levels rose significantly. Age, body mass index, blood pressure, and low-density lipoprotein cholesterol levels showed no clinically meaningful differences between groups (►**Table 1**).

Metformin use declined with increasing HbA1c, whereas insulin use (of all types) rose markedly. Dipeptidyl peptidase-4 inhibitor use peaked in the intermediate HbA1c group (►**Table 2**). Among diabetes-related complications, retinopathy, neuropathy, microalbuminuria, and diabetic foot disease were significantly more prevalent in higher HbA1c categories (►**Table 3**).

SMBG patterns, receipt of Ramadan-focused education, mode of delivery, and session duration did not differ significantly across HbA1c groups (►**Table 4**).

Table 1 Baseline demographic and clinical characteristics by pre-Ramadan HbA1c category

Characteristic	Group 1 HbA1c < 7.5%	Group 2 HbA1c 7–9%	Group 3 HbA1c > 9%	*p*-Value[1]	*p*-Value[2]
Number (%)	*N* = 4,417 37.7%	*N* = 3,960 33.8%	*N* = 3340 28.5%		
Female	2,255 (48.9%)[a]	2,072 (52.3%)[a,b]	1,804 (54%)[b]	**0.03**	0.7
Male	2,157 (51.1%)[a]	1,882 (47.7%)[a,b]	1,537 (46%)[b]		
Mean age (SD)	55 (12.1)	55.5 (11.5)[e]	54.8 (11.5)[d]	0.076	0.458
Mean duration of diabetes (SD)	8.5 (7)	10.6 (7.5)[f]	10.9 (7.3)[g]	< **0.001**	< **0.001**
Mean HbA1c (SD)	6.6 (0.6)	8.2 (0.5)[f,g]	10.8 (1.5)[f,g]	< **0.001**	< **0.001**
Mean latest BMI (SD)	27.7 (6.9)	27.9 (7.3)	27.8 (6.5)	0.273	0.730
Mean latest systolic BP (SD)	125.2 (27.6)	128.5 (27)[f]	129.8 (28.8)[g]	< **0.001**	< **0.001**
Mean latest diastolic BP (SD)	75.6 (16.4)	76.9 (16.3)[c]	77.7 (17.2)[g]	**0.010**	< **0.001**
Mean latest LDL cholesterol (mg/dL) (SD)	82.6 (48.7)	96.2 (48.8)[f]	97.3 (57.4)[g]	< **0.001**	< **0.001**

Abbreviations: BMI, body mass index; BP, blood pressure; HbA1c, glycated hemoglobin; LDL, low-density lipoprotein; SD = standard deviation.
Note: *p*-value 1: comparison between group 1 (< 7.5%) and group 2 (7.5–9%). *p*-Value 2: comparison between group 2 (7.5–9%) and group 3 (> 9%).
[a,b]Significant difference across sex distribution between groups.
[c,d,e]Significant difference vs. reference group, details to be standardized.
[f,g]$p < 0.001$ compared with reference.

Table 2 Antidiabetic medication use and diabetes-related complications by pre-Ramadan HbA1c category

Medication	HbA1c < 7.5%	HbA1c 7–9%	HbA1c > 9%	*p*-Value
Number (%)	4,417 (37.7%)	3,960 (33.8%)	3,340 (28.5%)	
Medications				
Metformin	3,693 (83.6%)[a]	3,176 (80.2%)[b]	2,554 (76.4%)[c]	0.8
Sulfonylureas	1,538 (34.8%)[a]	1,763 (44.5%)[b]	1,244 (37.2%)[c]	0.3
DPP4 inhibitors	1,276 (28.9%)[a]	1,477 (37.3%)[b]	1,068 (32%)[c]	**0.04**
Thiazolidinedione	183 (4.1%)[a]	176 (4.4%)[a]	163 (4.9%)[a]	0.7
SGLT2 inhibitors	730 (16.5%)[a]	825 (20.8%)[b]	746 (22.3%)[b]	0.2
GLP1	33 (0.7%)[a]	33 (0.8%)[a]	38 (1.1%)[a]	0.6
AGI	100 (2.3%)[a]	91 (2.3%)[a]	50 (1.5%)[b]	0.4
Insulin				
Intermediate/long acting	735 (16.6%)[a]	1,116 (28.2%)[b]	1,319 (39.5%)[c]	< **0.001**
Short acting	441 (10%)[a]	651 (16.4%)[b]	922 (27.6%)[c]	< **0.001**
Premixed insulin	414 (9.4%)[a]	666 (16.8%)[b]	774 (23.2%)[c]	< **0.001**
Any insulin	1,201 (27.2%)[a]	1,823 (46%)[b]	2,152 (64.4%)[c]	< **0.001**

Abbreviations: AGI, α-glucosidase inhibitor; DPP-4, dipeptidyl peptidase-4; GLP-1, glucagon-like peptide-1; HbA1c, glycated hemoglobin; SGLT2, sodium–glucose cotransporter 2.
Note: *p*-Values compare HbA1c categories. Values originally reported as 0.000 are shown as < 0.001.
[a,b,c]Indicate significant pairwise differences across categories.

Table 3 Risk factors and complications by pre-Ramadan HbA1c category

Complications	HbA1c < 7.5%	HbA1c 7–9%	HbA1c > 9%	*p*-Value
Number (%)	4,417 (37.7%)	3,960 (33.8%)	3,340 (28.5%)	
Hypertension	2,048 (46.4%)[a]	2,052 (51.8%)[b]	1,619 (48.5%)[a]	0.7
Hyperlipidemia	1,789 (40.5%)[a]	1,683 (42.5%)[a,b]	1,447 (43.3%)[b]	0.9
Retinopathy	471 (10.7%)[a]	592 (15%)[a]	646 (19.3%)[b]	**0.006**
Neuropathy	627 (14.2%)[a]	884 (22.3%)[b]	904 (27.1%)[c]	< **0.001**
Microalbuminuria	151 (3.4%)[a]	235 (5.9%)[b]	201 (6%)[b]	**0.05**
Chronic kidney disease (CKD)	400 (9.1%)[a]	406 (10.3%)[a]	412 (12.3%)[b]	0.3
Cardiovascular disease (CVD)	463 (10.5%)[a]	481 (12.2%)[b]	467 (14%)[b]	0.3
Diabetic foot disease	103 (2.3%)[a]	132 (3.3%)[b]	179 (5.4%)[c]	**0.01**

Abbreviation: HbA1c, glycated hemoglobin.
Note: *p*-Values compare HbA1c categories. *p*-Values originally reported as 0.000 or 0.0008 are shown as < 0.001.
[a,b,c]Indicate significant pairwise differences across categories.

Fasting intention and participation were lower among participants with an HbA1c level greater than 9% compared to those with better glycemic control (►**Table 5**). In the < 7.5% group, 89.2% fasted during Ramadan, compared with 87.9% in the 7.5 to 9% group (OR 0.88, 95% CI 0.77–1.00) and 80.5% in the > 9% group (OR 0.50, 95% CI 0.44–0.56).

Adverse glycemic events were more frequent with increasing HbA1c (►**Table 6**). Compared with < 7.5%, HbA1c > 9% was associated with markedly higher odds of hyperglycemia (OR 8.44, 95% CI 7.01–10.14), breaking the fast due to hyperglycemia (OR 8.86, 95% CI 5.99–13.10), and severe hyperglycemia (OR 10.66, 95% CI 4.53–25.09). These effect sizes were the most striking among all outcomes. Increased odds were also observed for daytime hypoglycemia (OR 2.50, 95% CI 2.15–2.91) and hypoglycemia-related fasting interruptions (OR 2.94, 95% CI 2.43–3.55). In contrast, severe hypoglycemia occurred at similar rates across categories ($p = 0.06$).

A subgroup analysis stratified by receipt of structured Ramadan education showed consistent patterns across HbA1c categories, indicating that higher baseline HbA1c was associated with greater fasting risk regardless of prior education.

Discussion

This subanalysis of the DaR Global Survey offers robust, real-world evidence linking pre-Ramadan glycemic status to

Table 4 Self-monitoring of blood glucose (SMBG) practices and Ramadan-focused education by pre-Ramadan HbA1c category

Characteristic		HbA1c < 7.5%	HbA1c 7.5–9%	HbA1c > 9%	*p*-Value
Number (%)		4,417 (37.7%)	3,960 (33.8%)	3,340 (28.5%)	
Did you do SMBG during Ramadan?	Yes, more frequent than before Ramadan	557 (13.4%)[a,b]	567 (15.2%)[b]	366 (12.5%)[a]	0.5
	Yes, less frequent than before Ramadan	532 (12.8%)[a]	481 (12.9%)[a]	401 (13.7%)[a]	0.9
	Yes, at same frequency as before Ramadan	1,995 (48%)[a]	1,846 (49.4%)[a]	1,355 (46.2%)[b]	0.9
	No	1,070 (25.7%)[a]	841 (22.5%)[b]	811 (27.6%)[a]	0.4
Received education (Yes)		2,662 (64.1%)[a]	2,325 (62.3%)[a]	1,684 (57.4%)[b]	0.7
Method	In clinic during my routine consultation	2'407 (70.8%)[a]	2,072 (66.8%)[a]	1,530 (66.6%)[b]	0.9
	In group session	276 (8.1%)[a]	252 (8.1%)[a]	136 (5.9%)[b]	0.2
	Online or through app	131 (3.8%)[a]	119 (3.8%)[a]	52 (2.3%)[b]	0.1
	Leaflet	583 (17.2%)[a]	657 (21.2%)[b]	580 (25.2%)[b]	0.1
Duration of session (0–15 min)		3,670 (83.1%)[a]	3,310 (83.6%)[b]	3,012 (90.2%)[c]	0.8

Abbreviation: HbA1c, glycated hemoglobin.
Note: *p*-Values compare HbA1c categories. Percentages may not sum to 100% due to rounding.
[a,b,c]Indicate significant pairwise differences across categories.

Table 5 Intention and duration of Ramadan and Shawwal fasting by pre-Ramadan HbA1c category

Characteristic		HbA1c < 7.5%	HbA1c 7.5–9%	HbA1c > 9%	*p*-Value
Number (%)		4,417 (37.7%)	3,960 (33.8%)	3,340 (28.5%)	
Intention for Ramadan fasting (Yes)		3,942 (89.2%)[a]	3,481 (87.9%)[a]	2,688 (80.5%)[b]	0.01
Fasting days:	1–7 days	58 (1.5%)	97 (2.8%)	88 (3.3%)	0.05
	30 days	2,785 (70.6%)	2,340 (67.2%)	1,578 (58.7%)	0.02
	Mean duration (days)	28.2 (4.7)	27.7 (5.5)	26.8 (6.3)	0.01
Intention for Shawwal (post) Ramadan fasting (Yes)		1,265 (28.6%)[a]	1,093 (27.6%)[a]	681 (20.4%)[b]	0.1

Abbreviation: HbA1c, glycated hemoglobin.
Note: Values are expressed as *n* (%) unless otherwise specified. *p*-Values standardized to three decimal places (e.g., 0.010).
[a,b]Indicate significant pairwise differences across categories.

subsequent fasting outcomes. Individuals with HbA1c > 9% were less likely to fast compared to those with HbA1c < 7.5% (80.5% vs. 89.3%; OR 0.49, 95% CI 0.43–0.56) and experienced a greater burden of glycemic complications. Conversely, participants with HbA1c < 7.5% not only showed the highest fasting participation but also the lowest rates of adverse events, highlighting the pivotal role of baseline HbA1c in pre-Ramadan clinical decision-making.

The most pronounced differences were observed in outcomes related to hyperglycemia. Compared with HbA1c < 7.5%, participants with HbA1c > 9% had more than fivefold higher odds of hyperglycemia (25.2% vs. 6.3%; OR 5.10, 95% CI 4.23–6.14), over fivefold higher odds of breaking the fast due to hyperglycemia (6.4% vs. 1.2%; OR 5.63, 95% CI 3.80–8.34), and more than eightfold higher odds of severe hyperglycemia (1.6% vs. 0.2%; OR 8.11, 95% CI 3.45–19.09). These effect sizes were the strongest across all outcomes and reinforce that hyperglycemia remains the dominant fasting-related risk among individuals with poor pre-Ramadan control. These results mirror earlier CGM-based studies, which have demonstrated greater post-iftar glucose surges and fasting instability among individuals with poor baseline control.[9,10]

In the Ramadan setting—where dehydration and ketogenesis risk may be heightened—such findings underscore the importance of timely medication adjustments, structured nutritional guidance, and proactive monitoring for patients with elevated HbA1c. Beyond education alone, additional strategies such as pre-Ramadan titration protocols, the use of CGM or flash glucose monitoring, and digital health tools for remote support may help reduce complications in this high-risk group.

Hypoglycemia-related outcomes also trended higher with rising HbA1c, although the effect sizes were smaller. Compared with HbA1c < 7.5%, those with HbA1c > 9% showed higher odds of daytime hypoglycemia (18.2% vs. 13.2%; OR 1.48, 95% CI 1.27–1.72) and of breaking the fast because of hypoglycemia (12.1% vs. 7.3%; OR 1.77, 95% CI 1.46–2.15). In contrast, severe hypoglycemia rates did not differ significantly between groups

Table 6 Comparison of Ramadan fasting and glycemic events by pre-Ramadan HbA1c category (< 7.5%, 7.5–9%, > 9%) with odds ratios (95% CI) versus < 7.5% group

Parameter	HbA1c < 7.5% *n*/*N* (%)	HbA1c 7.5–9% *n*/*N* (%)	OR (95% CI) vs. < 7.5%	HbA1c > 9% *n*/*N* (%)	OR (95% CI) vs. < 7.5%
Fasting during Ramadan	3,942/4,417 (89.2)	3,482/3,960 (87.9)	0.88 (0.77–1.00)	2,688/3,340 (80.5)	0.50 (0.44–0.56)
Daytime hypoglycemia[a]	322/3,942 (8.2)	756/3,482 (21.7)	3.12 (2.71–3.58)	489/2,688 (18.2)	2.50 (2.15–2.91)
Broke fast due to hypoglycemia[a]	177/3,942 (4.5)	454/3,482 (13.0)	3.19 (2.66–3.82)	326/2,688 (12.1)	2.94 (2.43–3.55)
Severe hypoglycemia[a]	44/3,942 (1.1)	110/3,482 (3.2)	2.89 (2.03–4.11)	39/2,688 (1.5)	1.30 (0.85–2.01)
Hyperglycemia[a]	151/3,942 (3.8)	697/3,482 (20.0)	6.28 (5.23–7.54)	676/2,688 (25.1)	8.44 (7.01–10.14)
Broke fast due to hyperglycemia[1]	30/3,942 (0.8)	146/3,482 (4.2)	5.46 (3.64–8.18)	171/2,688 (6.4)	8.86 (5.99–13.10)
Severe hyperglycemia[a]	6/3,942 (0.15)	42/3,482 (1.2)	8.11 (3.45–19.07)	43/2,688 (1.6)	10.66 (4.53–25.09)

Footnotes:
Abbreviations: CI, confidence interval; HbA1c, glycated hemoglobin; OR, odds ratio.
Note: Odds ratios (OR) compare the odds of the event in each HbA1c category to the < 7.5% reference group. Percentages are calculated from the *n*/*N* values in each HbA1c category.
[a]Denominators for hypoglycemia and hyperglycemia outcomes are restricted to participants who fasted during Ramadan.

(1.5% vs. 1.8%; OR 0.83, 95% CI 0.54–1.27), a finding that was consistent across all HbA1c categories. This pattern—more frequent but not more severe events—has been described in registries[15] and in non-Ramadan populations where glycemic variability was associated with hospitalization for hypoglycemia without a consistent increase in severe episodes.[16,17] Such trends may be explained by cautious dose reductions, earlier symptom recognition, more frequent SMBG, and a lower threshold for breaking the fast in high-risk groups.

Higher HbA1c reflects both chronic hyperglycemia and increased glycemic variability, making fasting physiologically more challenging. Larger post-iftar rises and sharper pre-iftar drops in glucose are more likely in these individuals, increasing the risk of both symptomatic highs and lows and prompting early fast termination, especially in the absence of structured education[7,8] or real-time glucose feedback.[9,10]

The stepwise risk gradient from < 7.5% to > 9% supports the HbA1c thresholds used in the IDF-DAR risk calculator, which have so far been grounded mainly in expert consensus.[13,14] This large, multiregional data set provides empirical evidence reinforcing the < 7.5% "safer" and > 9% "higher-risk" categories, particularly for hyperglycemia-related outcomes where the effect sizes are greatest.

From a clinical standpoint, these findings support performing HbA1c testing 6 to 8 weeks before Ramadan[8] and offering targeted structured education to those with higher HbA1c, covering dietary planning, SMBG or CGM use, and individualized treatment modifications to minimize complications.[18,19] While the American Diabetes Association Standards of Care currently prioritize CGM for insulin-treated patients and recommend intensified monitoring during high-risk periods,[20] our results suggest that selective CGM use during Ramadan could also be beneficial for noninsulin-treated individuals with poor glycemic control or a history of fasting-related complications. In addition, pre-Ramadan titration protocols, use of digital health platforms, and proactive medication adjustments may further enhance safety in high-risk groups. Future prospective and interventional studies are needed to determine whether early HbA1c optimization and structured pre-Ramadan interventions can directly reduce the incidence of fasting-related complications.

Limitations include reliance on self-reported data and variable denominators across outcomes, introducing potential recall bias and missing data. The categorical HbA1c approach may mask gradients within each range. We did not stratify treatment adjustments by HbA1c group, which could influence outcomes. Additionally, regional differences in diet, culture, and health care infrastructure may impact the generalizability of the findings. The retrospective design also limits causal inference. Nonetheless, the consistent associations across multiple outcomes and regions support the conclusion that lower pre-Ramadan HbA1c levels are associated with safer fasting and reinforce the importance of pre-Ramadan assessment.

Conclusion

Pre-Ramadan HbA1c is a strong predictor of fasting safety in individuals with T2DM. Poorer baseline control is associated with a reduced likelihood of completing Ramadan fasting and an elevated risk of interruptions due to both hyperglycemia and hypoglycemia, while severe hypoglycemia rates remain comparable. These findings support the current HbA1c thresholds used in Ramadan risk assessment and highlight the need for routine HbA1c measurement, structured prefasting education, and individualized management. Future prospective and interventional studies are warranted to confirm these associations and guide clinical protocols.

Authors' Contributions

All authors contributed toward conception, data collection, writing, and final approval of the manuscript.

Statement of Ethics

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

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Conflict of Interest

None declared.

References

1 Salti I, Bénard E, Detournay B, et al; EPIDIAR study group. A population-based study of diabetes and its characteristics during the fasting month of Ramadan in 13 countries: results of the epidemiology of diabetes and Ramadan 1422/2001 (EPIDIAR) study. Diabetes Care 2004;27(10):2306–2311

2 Afandi B, Kaplan W, Al Kuwaiti F, Al Dahmani Kh, Nagelkerke N. Ramadan challenges: fasting against medical advice. J Fasting Health 2017;5(03):133–137

3 Afandi B, Kaplan W, Al Hassani N, Hadi S, Mohamed A. Correlation between pre-ramadan glycemic control and subsequent glucose fluctuation during fasting in adolescents with type 1 diabetes. J Endocrinol Invest 2017;40(07):741–744

4 Kaplan W, Afandi B. Blood glucose fluctuation during Ramadan fasting in adolescents with type 1 diabetes: findings of continuous glucose monitoring. Diabetes Care 2015;38(10):e162–e163

5 Babineaux SM, Toaima D, Boye KS, et al. Multi-country retrospective observational study of the management and outcomes of patients with type 2 diabetes during Ramadan in 2010 (CREED). Diabet Med 2015;32(06):819–828

6 American Diabetes Association Professional Practice Committee. Glycemic goals and hypoglycemia: Standards of Care in Diabetes-2024. Diabetes Care 2024;47(Suppl 1):S111–S125

7 Bravis V, Hui E, Salih S, Mehar S, Hassanein M, Devendra D. Ramadan Education and Awareness in Diabetes (READ) programme for Muslims with type 2 diabetes who fast during Ramadan. Diabet Med 2010;27(03):327–331

8 Ibrahim M, Ba-Essa EM, Ahmed A, et al. Recommendations for the management of diabetes during Ramadan applying the principles of the ADA/ EASD consensus: update 2025. Diabetes Metab Res Rev 2025;41(05):e70057

9 Aldawi N, Darwiche G, Abusnana S, Elbagir M, Elgzyri T. Initial increase in glucose variability during Ramadan fasting in non-insulin-treated patients with diabetes type 2 using continuous glucose monitoring. Libyan J Med 2019;14(01):1535747

10 Mohamed H, Abbas AM, Huneif MA, Alqahtani SM, Ahmed AM, Babker AMA, et al. Influence of Ramadan fasting on hemoglobin A1c, lipid profile, and body mass index among type 2 diabetic patients in Najran City, Saudi Arabia. Open Access Maced J Med Sci 2021;9(B):318–325

11 Ahmed S, Khokhar N, Shubrook JH. Fasting during Ramadan: a comprehensive review for primary care providers. Diabetology (Basel) 2022;3(02):276–291

12 Kassem HS, Zantout MS, Azar ST. Insulin therapy during Ramadan fast for type 1 diabetes patients. J Endocrinol Invest 2005;28(09): 802–805

13 Ibrahim M, Abu Al Magd M, Annabi FA, et al. Recommendations for management of diabetes during Ramadan: update 2015. BMJ Open Diabetes Res Care 2015;3(01):e000108

14 Hassanein M, Afandi B, Yakoob Ahmedani M, et al. Diabetes and Ramadan: practical guidelines 2021. Diabetes Res Clin Pract 2022; 185:109185

15 Haynes A, Hermann JM, Miller KM, et al; T1D Exchange, WACDD and DPV registries. Severe hypoglycemia rates are not associated with HbA1c: a cross-sectional analysis of 3 contemporary pediatric diabetes registry databases. Pediatr Diabetes 2017;18(07):643–650

16 Zhao MJY, Prentice JC, Mohr DC, Conlin PR. Association between hemoglobin A1c variability and hypoglycemia-related hospitalizations in veterans with diabetes mellitus. BMJ Open Diabetes Res Care 2021;9(01):e001797

17 Zhong VW, Juhaeri J, Cole SR, et al. HbA_{1C} variability and hypoglycemia hospitalization in adults with type 1 and type 2 diabetes: a nested case-control study. J Diabetes Complications 2018; 32(02):203–209

18 El Toony LF, Elghazally SA, Hamad DA. Positive impact of pre-Ramadan education on glycemic control and reducing risk of hypoglycemia in type 2 diabetic elderly patients during COVID 19 pandemic. Prim Care Diabetes 2022;16(04):581–587

19 Siaw MY, Chew DE, Dalan R, et al. Evaluating the effect of Ramadan fasting on Muslim patients with diabetes in relation to use of medication and lifestyle patterns: a prospective study. Int J Endocrinol 2014;2014:308546

20 American Diabetes Association Professional Practice Committee. 7. Diabetes technology: standards of care in diabetes-2024. Diabetes Care 2024;47(Suppl 1):S126–S144