Endotext

DIABETES MANAGEMENT DURING RAMADAN

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ABSTRACT

Muslims contribute to 25% of the world population and majority of them reside in the diabetes and obesity endemic Asia-Pacific region. Fasting during Ramadan is one of the five pillars of Islam and an obligatory duty for all healthy adolescents and adult Muslims. However, Islam exempts the ill and pregnant women from fasting. Despite this, many individuals with diabetes who are at high risk from fasting, fast during Ramadan. Individuals fasting during Ramadan are less likely to see their physicians before starting the fast and more likely to fast against medical advice. Hence, these individuals are at increased risk of hyperglycemia, hypoglycemia, and cardiovascular and renal complications. Management of diabetes during Ramadan needs a comprehensive and integrated planning and dissemination of knowledge through the healthcare providers and Muslim religious leaders. Diabetes care should start in the pre-Ramadan period, continue through Ramadan, and follow-up in the post-Ramadan period.

INTRODUCTION

Muslims contribute to approximately 25% of world population and are distributed across >200 countries across the globe (1,2). Of this, 61.7% of Muslims live in Asia-Pacific region, which is also a region experiencing the diabetes epidemic (3,4).

Ramadan is the 9th holy month of the Islamic lunar calendar. Fasting during Ramadan is one of the five pillars of Islam (5). Fasting during Ramadan is an obligatory duty for all healthy adolescents and adult Muslims aimed at spiritual and holistic wellbeing of the individual (1,5). The Holy Quran exempts the sick, medically unfit, or those traveling from fasting during the holy month (1,5).

Fasting during Ramadan involves complete abstinence from food, medication, drink (including water), or any other form of nutrition (including via a percutaneous endoscopic gastrostomy tube) from dawn to sunset (1, 2, 6). The fasting during Ramadan is a type of intermittent fasting as it is observed for 10–21 hours depending on the geographical location and solar season and is observed daily for 29–30 consecutive days (1, 2). Individuals fasting during Ramadan take two main meals, *Suhoor* (pre-dawn meal) and *Iftar* (post sunset meal) and eat nothing from sunrise to sunset (1, 2, 6).

It is estimated that about 79% of Muslims with type 2 diabetes (T2D) and about 43% of them with type 1 diabetes (T1D) fast during Ramadan (7). Of those who fast during Ramadan, 64% fasted every day, and 94.2% fasted for at least 15 days (8). The medication timings of these individuals with diabetes need to be adjusted to pre-dawn and post-sunset timings (1,2). Also, many of these individuals fast against medical advice (9, 10).

Since a huge proportion of individuals with diabetes fast during Ramadan, and many are at risk due to fasting, management of diabetes during Ramadan and proper fasting guidance is critical (1,2).

EFFECTS OF FASTING DURING RAMADAM

Physiological Changes

Fasting during Ramadan is associated with a number of physiological changes.

CHANGES IN FEEDING PATTERNS AND ENERGY INTAKE

Ramadan fasting differs from other forms of fasting as there is no consumption of any food or drink between dawn and sunset. Hence, the timing between the meals is very long, and this disrupts the normal physiology with disruption in the normal rhythm and fluctuations seen in various homeostasis and endocrine processes (Figure 1). Major changes occur in glucose homeostasis in individuals with diabetes that results in post *Iftar* hyperglycemia and risk of hypoglycemia during the day (Figures 2 and 3)

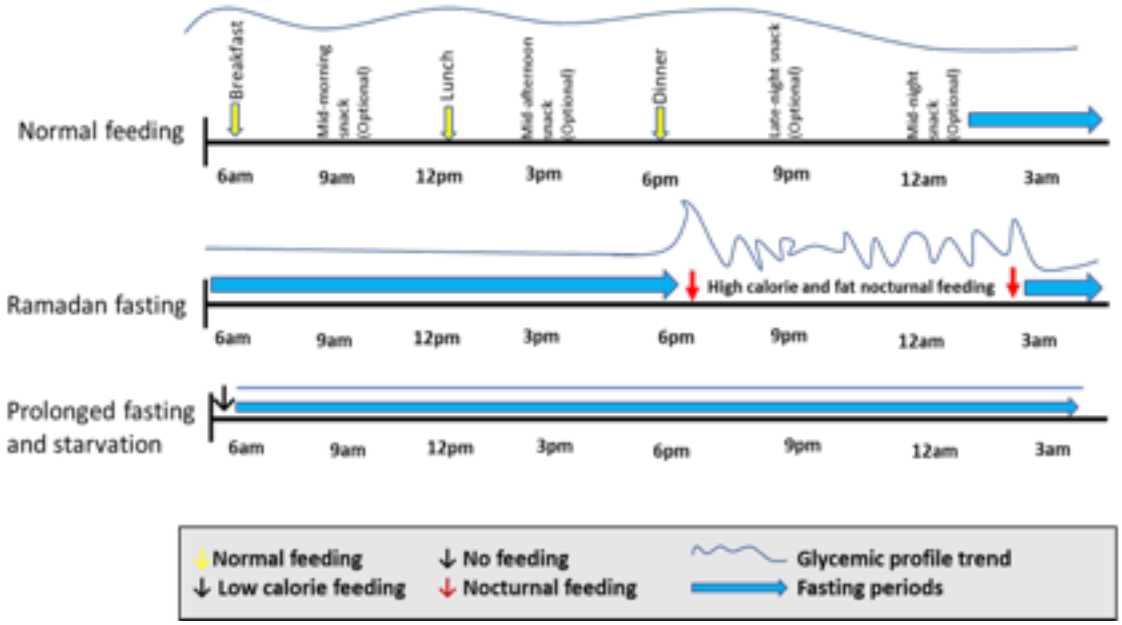

Figure 1. Changes in feeding patterns and energy intake during various fasting periods (11, 12). (I) normal feeding, (II) Ramadan fasting and (III) prolonged fasting and starvation.

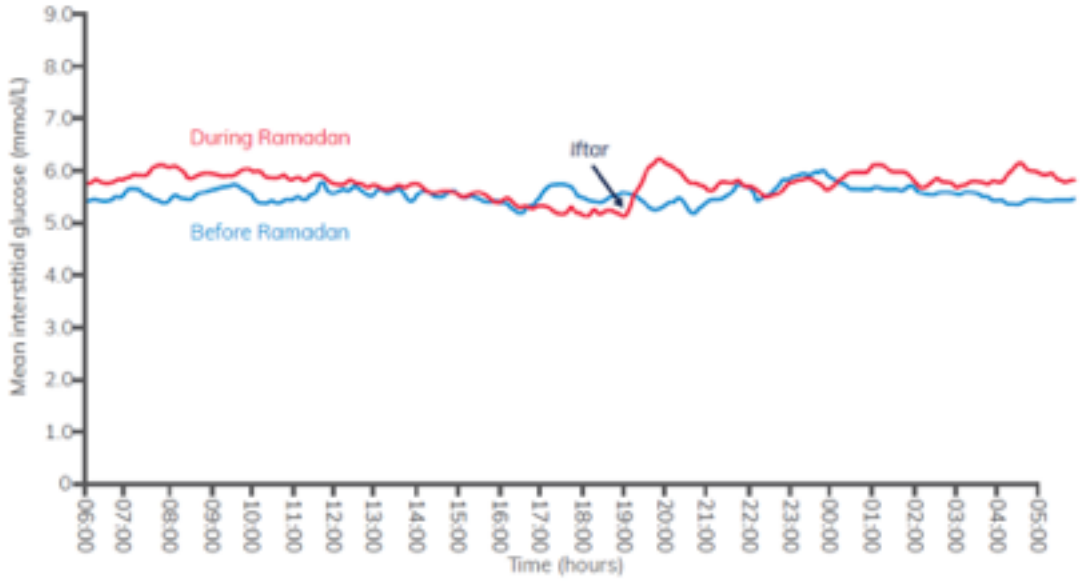

Figure 2. Mean continuous glucose monitoring (CGM) profiles from healthy individuals (12, 13).

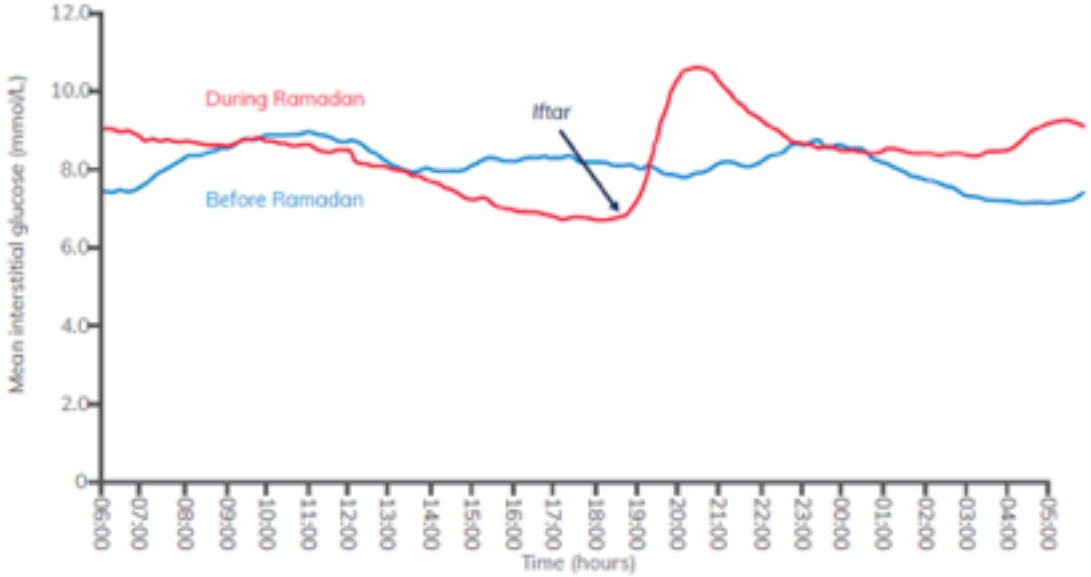

Figure 3. Mean continuous glucose monitoring (CGM) profiles from individuals with diabetes fasting during Ramadan (12, 13).

DECREASE IN TOTAL SLEEP TIME

Total sleep time decreases by approximately 1 hour, with a decrease in sleep period time, rapid eye movement (REM) sleep proportion and duration. Additionally, delayed sleep and an increase in non-REM sleep proportion, sleep latency, and daytime

sleepiness by1-point on the Epworth sleepiness scale is also observed (ESS) (12).

ALTERATION OF CIRCADIAN RHYTHM AND HORMONE LEVELS

Sudden alteration of circadian rhythm and hormone levels occurs due to sudden changes in sleep and wake cycles and feeding patterns. Fasting can induce epigenetic changes in genes that control the circadian rhythm (12). The change in circadian rhythm triggers many catametabolic changes, alteration in temperature, and changes in the normal rhythm of hormones like insulin, glucagon, leptin, ghrelin, cortisol, melatonin, growth hormone, and testosterone (12,14). The various changes seen are:

1) Insulin resistance and increased glucagon levels: excessive glycogen breakdown and increased gluconeogenesis
2) Cortisol circadian rhythm shows a shift with a blunting of the morning to evening ratio. However, serum cortisol levels do not change by end of Ramadan month.
3) Morning adiponectin levels are reduced
4) Morning and evening growth hormone levels are reduced
5) Large increases in morning leptin levels
6) No major shifts in diurnal ghrelin level

By the end of Ramadan significant decrease in serum levels of ghrelin, leptin, and melatonin are observed along with modest reductions in testosterone in men.

SHIFT IN FLUID BALANCE

A sudden shift in fluid balance is seen because of an absolute restriction of fluid intake between dawn and sunset. This may precipitate dehydration in a hot climate which may in turn cause hypotension and falls (6). Uncontrolled hyperglycemia can exacerbate the
dehydration due to an osmotic diuresis (6). Dehydration in individuals with T2D can present as low blood pressure, lethargy, or syncope. Dehydration can also increase the risk of thrombosis and stroke due to hemoconcentration and hypercoagulability (6). Other fluid related changes are not considered a major cause of concern and include higher fluid and total water intake between sunset and dawn; urine osmolality increases significantly in the afternoon to conserve water and reduce urine output (12).

ALTERED ENERGY BALANCE

Altered energy balance is seen due to a sudden increase in food intake at *Iftar.* During Ramadan there is a reduction in activity and energy expenditure which is offset by the reduced time spent during sleep (12).

GUT MICROBIOTA

Intermittent fasting during Ramadan can have direct impact on the gut microbiota which could lead to positive changes in health (12).

LIPID CHANGES

Fasting during Ramadan has been shown to be associated with a significant increase in high-density lipoprotein-cholesterol (HDL-C) and a significant decrease in total triglycerides, total cholesterol, and low-density lipoprotein-cholesterol (LDL-C) (6, 15).

Physical and Mental Wellbeing

Fasting during Ramadan can have both positive and negative effects on the physical and mental wellbeing of the individuals (Table 1) (16).

Table 1. Positive and Negative Effects on Physical and Mental Wellbeing of Individuals Fasting During Ramadan (16)	
Positive benefits	**Negative effects**
Sense of fulfilment	Sleep deprivation and disruption of circadian rhythm leading to an increase in fatigue and reduction in cognition More lethargy
Improvements in: Weight and BMI Self-control and ability to resist temptations	Glucose excursions causing feelings of being unwell
Greater sense of: Empathy for less fortunate Community Fostering relationships	Heightened feelings of fear for diabetes related complications
Participation in *Sunnah* practices for greater spiritual benefits	Temporary changes in weight
Reducing potentially harmful vices, such as smoking, for greater physical and mental wellbeing	Short term feelings of stress anxiety, irritability, and agitation

BMI- body mass index

The month long fasting during Ramadan has been associated with significant reduction in weight, waist circumference, and fat mass, especially in those who are overweight or obese (15, 17).

RISKS OF FASTING DURING RAMADAN IN INDIVIDUALS WITH DIABETES

The various risks of fasting in individuals with diabetes who fast during Ramadan are:

1) Hyperglycemia
2) Hypoglycemia
3) Macrovascular: Cardiovascular disease (CVD) including stroke
4) Microvascular: Chronic kidney disease (CKD)
5) Dehydration

Dual Risk of Hyperglycemia and Hypoglycemia

In people with diabetes fasting during Ramadan there can be an increase in glucose variability and therefore there is increased risk of both hyperglycemia and hypoglycemia (12).

HYPERGLYCEMIA

The meals at *Iftar* are calorie dense and can cause a significant and rapid rise in blood glucose (BG) levels in people with diabetes (12). The EPIDIAR study showed that the hospitalization rate for severe

hyperglycemia during Ramadan increased significantly in individuals with T2D (P<0.001). The hospitalization rate for severe hyperglycemia (with or without ketoacidosis) during Ramadan increased insignificantly for individuals with T1D (P = 0.1635) (6,7).

HYPOGLYCEMIA

The CREED study showed that hypoglycemia incidence before Ramadan was associated with significantly increased risk of hypoglycemia during Ramadan (18). This association between hypoglycemia incidence before and during Ramadan has been seen through multiple studies across continents (1,18,19). Similarly, the EPIDAR study[7] showed that T1D and T2D patients had a 4.7-fold and a 7.5-fold increase, respectively, in severe hypoglycemia requiring hospitalization during Ramadan. Hypoglycemia during Ramadan was significantly associated with the use of sulfonylureas and insulin (18,19). Severe and non-severe hypoglycemia rates are fewer with second-generation sulfonylureas, Glucagon-like peptide-1 receptor agonists (GLP-1 RAs), insulin analogues, and sodium-glucose transporter-2 (SGLT-2) inhibitors (20-25). During the early Ramadan period, patients on sulfonylureas and those on ≥2 antidiabetic medications have significant increase in mean amplitude of glycemic excursions (26).

Other factors influencing the incidence of hypoglycemia during Ramadan include season, geographical location, fasting duration, time since diagnosis, gender, anthropometric measures, dietary behaviors, and pre-fasting education (1).

Macrovascular (Cardiovascular and Cerebrovascular) and Microvascular Risk (Renal Complications)

Diabetes increases the risk of CVD and stroke, and individuals with diabetes who have pre-existing CVD or stroke are at greater risk of complications when fasting (27). Individuals with unstable CVD or stroke are also at very high risk from fasting. Individuals with diabetes and CKD stage 3 are at high-risk from fasting while those with stage 4-5 are at very high risk from fasting during Ramadan (27). Patients on dialysis or those who had a kidney transplant are also considered high risk from fasting (27).

Factors associated with increased risk of fasting during Ramadan are high carbohydrate intake, inadequate hydration, high activity levels, poor sleeping patterns, and missing doses of essential medicines (27).

All these high to very high-risk individuals should be discouraged from fasting. If they still decide to fast, then pre-Ramadan assessment and education and monitoring during Ramadan and post-Ramadan should be carried out under the expert guidance of a multidisciplinary team (diabetologist, cardiologist, neurologist, nephrologist, nutritionist etc.) (27). Weekly monitoring during Ramadan by a health care provider should be encouraged.

Pre-Ramadan assessment and education should begin three months prior to Ramadan and all efforts should be made to stabilize the doses of the various drugs, adjust them to morning and evening dose, and those on insulin should be taught self-titration of dose based on SMBG (27).
Patients with CKD, on dialysis or those who had a kidney transplant should be encouraged to routinely monitor electrolytes and creatinine at various time-points during Ramadan (27). A diet rich in potassium and phosphorus should be avoided (27).

MANAGEMENT OF DIABETES DURING RAMADAN

5 R's of Ramadan Care

The management of diabetes during Ramadan and in general can be summarized under the mnemonic termed as the 5 R's of Ramadan care (Table 2).

Table 2. The 5 R's of Ramadan Care (28)

The 5 R	Significance
Respect	Respect the patient's attitudes, wishes, and needs, and consider these while planning therapy Speak with the patient with empathy for his religious beliefs
Risk stratification	This is an essential backbone for pre-Ramadan counseling
Revision of Therapy	Diabetes therapy will need to be revised based on risk of hyperglycemia and hypoglycemia, and other risk factors
Regular Follow Up	Regular follow-up with HCP before, during and after Ramadan is necessary to ensure a safe and healthy fasting experience
Reappraisal of Strategy	Diabetes is a dynamic condition, and constant reappraisal is required during the current and next fasting period

HCP- health care provider

Pre-Ramadan Management of Diabetes

DM management in people planning to fast during Ramadan should ideally start six to eight or maximum 12 weeks before the first day of fasting (6, 29). Diabetes assessment and plan of care pre-Ramadan should ideally follow the flow chart shown in Figure 4 (6, 29).

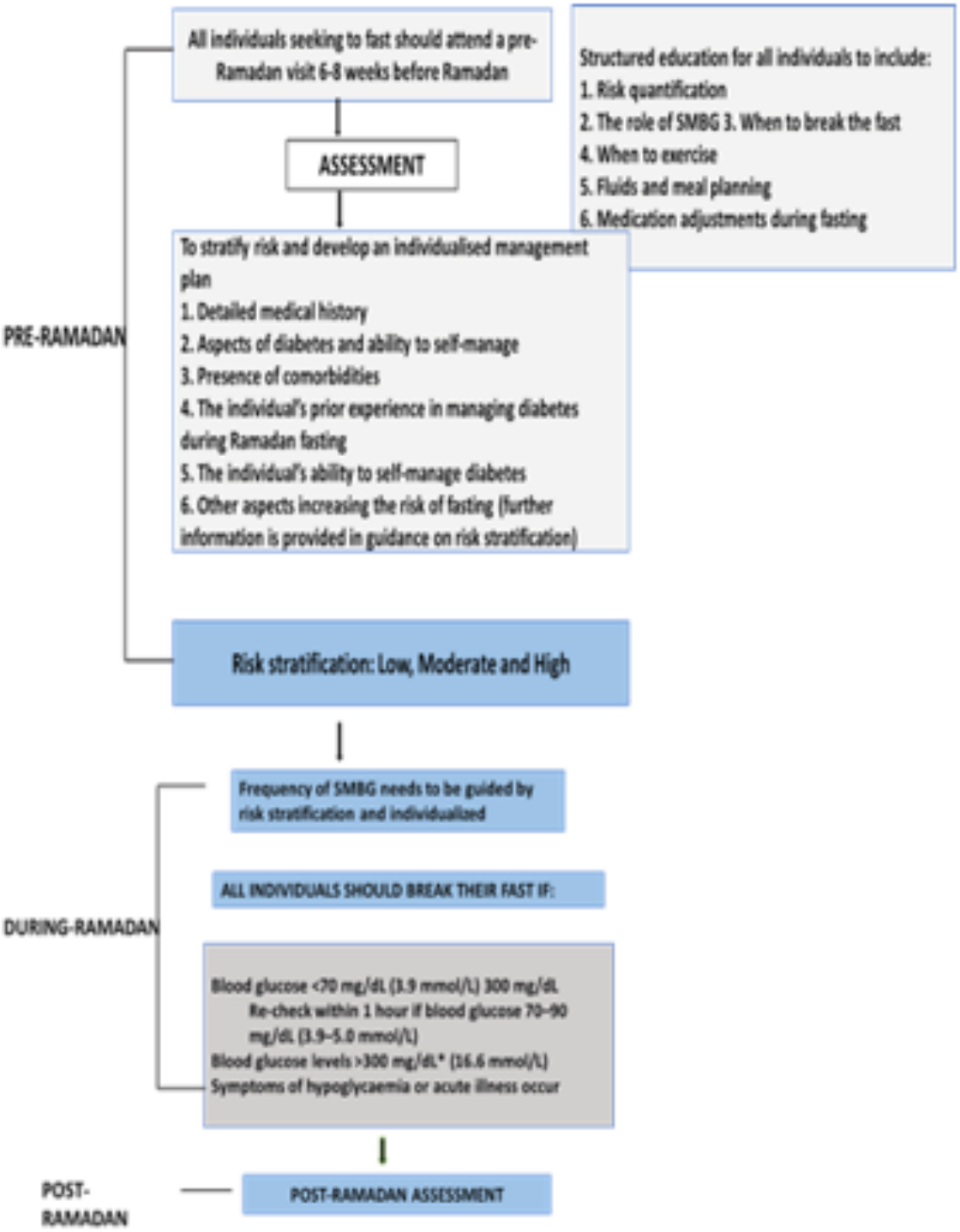

Figure 4. Diabetes assessment and plan of care pre-, during and post Ramadan (6, 29)

Patient education during this time-period is necessary because many patients follow a self-management approach of diabetes during Ramadan and do not appreciate the risks and implications of fasting on DM and its medications, and fast against medical advice (6, 19). Physicians need to be sensitized about this time-period for their Muslim patients as many may not realize the religious sensitivities associated with DM management during Ramadan (6).

PRE-RAMADAN EDUCATION

The pre-Ramadan diabetes education should cover:
Risk quantification, exemptions, and removing misconceptions

- Blood glucose monitoring
- Fluids and dietary advice
- Physical activity and exercise advice
- Medication adjustment
- When to break the fast
- Recognition of hypoglycemia and hyperglycemia symptoms

RISK STRATIFICATION OF PEOPLE WITH DIABETES

The pre-Ramadan time period should be used to understand the individual's risks associated with fasting, and develop an individualized treatment plan for the individual who falls in the lower risk category and can fast. The risk stratification is done based on several factors (6, 9, 10):

- Type and duration of diabetes
- DM treatment regime and polypharmacy with multiple glucose lowering drugs
- Level of glycemic control
- Risk or occurrence of hypoglycemia
- DM self-management capability including hypoglycemia awareness, motivation for self-monitoring blood glucose (SMBG), frailty, and cognition
- DM complications and comorbidities
- Ongoing/recent severe illness
- Renal impairment
- Social determinants affecting assess and adherence to treatment including economic and education level
- For those with T1D: access to continuous glucose monitoring (CGM) and advanced insulin technologies

The IDF-DAR Practical Guidelines 2021 stratify the individuals with DM who are going to fast during Ramadan into three risk categories, low, moderate and high (Figure 5) (29).

Risk Element	Risk Score
1. Diabetes type and duration	
Type 1 diabetes	1
Type 2 diabetes	0
2. Duration of Diabetes (years)	
A duration of ≥ 10	1
A duration of < 10	0
3. Presence of hypoglycaemia	
Hypoglycaemia unawareness	6.5
Recent Severe hypoglycaemia	5.5
Multiple weekly Hypoglycaemia	3.5
Hypoglycaemia less than 1 time per week	1
No hypoglycaemia	0
4. Level of glycaemic control	
HbA1c levels > 9% (11.7 mmol/L)	2
HbA1c levels 7.5–9% (9.4–11.7 mmol/L)	1
HbA1c levels < 7.5% (9.4 mmol/L)	0
5. Type of treatment	
Multiple daily mixed insulin injections	3.5
Basal Bolus/Insulin pump	2.5
Once daily Mixed insulin	2
Basal Insulin	1.5
Glibenclamide	1
Gliclazide/MR or Glimepride or Repeglanide	1.5
Other therapy not including SU or Insulin	0
6. Self-Monitoring of Blood Glucose (SMBG)	
Indicated but not conducted	2
Indicated but conducted sub-optimally	1
Conducted as indicated	0
7. Acute complications	
DKA/ HONC in the last 3 months	3
DKA/ HONC in the last 6 months	2
DKA/ HONC in the last 12 months	1
No DKA or HONC	0

Risk Element	Risk Score
8. MVD Complications/Comorbidities	
Unstable MVD	6.5
Stable MVD	2
No MVD	0
9. Renal Complications/Comorbidities	
A duration of < 10 0 eGFR < 30 mL/min	6.5
eGFR 30–45 mL/min	4
eGFR 45–60 mL/min	2
eGFR >60 mL/min	0
10. Pregnancy*	
Pregnant not within targets*	6.5
Pregnant within targets*	3.5
No pregnant	0
11. Frailty and Cognitive function	
Impaired cognitive function or Frail	6.5
> 70 years old with no home support	3.5
No frailty or loss in cognitive function	0
12. Physical Labour	
Highly Intense physical labour	4
Moderate Intense Physical Labour	2
No physical labour	0
13. Previous Ramadan Experience	
Overall negative experience.	1
No negative or positive experience	0
14. Fasting hours (location)	
≥ 16 hours	1
< 16 hours	0

DKA – Diabetic Ketoacidosis HONC – Hyperglycaemic Hyperosmolar Nonketotic Coma eGFR – Estimated glomerular filtration rate MVD – Macrovascular disease

*Pregnant and breastfeeding women have the right to not fast regardless of whether they have diabetes

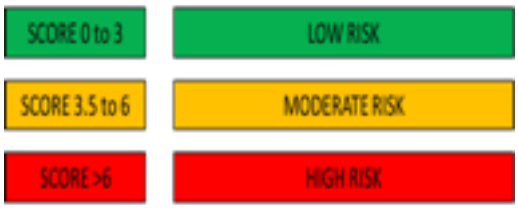

Figure 5. IDF-DAR 2021 Ramadan risk score and risk categories for fasting (2, 30)

DM patients who had a history of severe hypoglycemia ≤3 months before Ramadan, recurrent hypoglycemia, or of hypoglycemia unawareness are considered high risk (31). Young individuals and adolescents start fasting during Ramadan with the onset of puberty, and those with T1D are considered to be high risk for fasting and generally discouraged from fasting (9).

Many DM patients may need to be upgraded to high-risk category during the current coronavirus-2019 (COVID-19) pandemic and thus likely to fall under the 'advised not to fast' risk category (6).

Patients with high-risk scores are advised not to fast as fasting is not considered safe for these individuals (29). However, since fasting during Ramadan is a personal choice, the individuals deciding to fast despite being cautioned against it, should be monitored very closely during and after Ramadan (6, 19).

Individuals with low and moderate risk scores are educated about the risks and advised to fast with strict BG monitoring, and adjustments to diet/nutrition and medications (29). The individuals are closely monitored during Ramadan by their health care providers (HCPs) and advised to come for a post Ramadan follow-up. At this follow-up visit, the HCPs asses the glycemic control, and discuss the challenges faced to make the next Ramadan fasting more risk free. Pre-Ramadan risk assessment, education and advise is known to improve the fasting experience of individuals with DM (6).

Blood Glucose Monitoring

Self-monitoring blood glucose (SMBG) should be stressed upon and encouraged. Moderate to low-risk individuals with diabetes can monitor their BG once or twice daily but those at high risk of fasting should be encouraged to follow a 7-time-point guide for SMBG during Ramadan (Figure 6**)** (29). Additional BG check should be done if the individual experiences symptoms of hypoglycemia, hyperglycemia, or feel unwell (29).

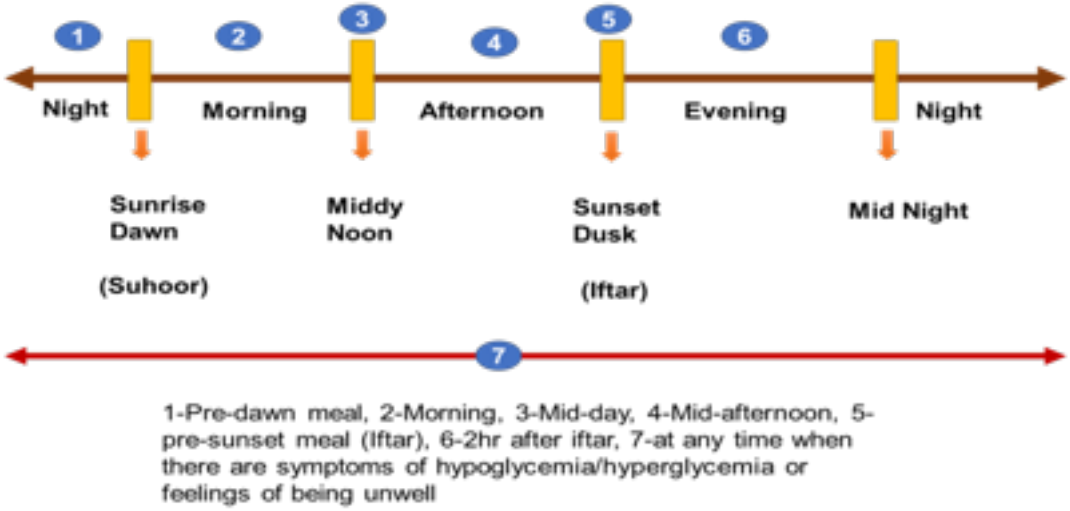

Figure 6. A seven time-point blood glucose monitoring guide for people with diabetes fasting during Ramadan (29)

Fluids and Dietary Advice

Detailed diet plan for Ramadan is provided through Ramadan specific medical nutrition therapy (MNT) and Ramadan Nutrition Plan (RNP) (29,32). Adequate fluid intake should be encouraged between sunset and dawn.

Physical Activity and Exercise Advice

Individuals with diabetes who are fasting should be encouraged to carry out their normal physical activity (29). Taraweeh prayers, which involve activities such as bowing, kneeling, and rising, can be considered as part of daily exercise activities (29). Rigorous exercise/activity during the fasting period should be avoided as this can increase the risk of hypoglycemia and dehydration, especially during the last few hours of fasting (29).

Medication Adjustment

All medications (diabetes and non-diabetes) should be reviewed in the pre-Ramadan period to see which medications need a dose and time adjustment. The change should be made well before Ramadan and monitored through appropriate clinical and laboratory evaluation (29). Patients on insulin should be taught self-titration of units based on SMBG values (10).

When to Break the Fast

This is an essential component of Pre-Ramadan education. All individuals with diabetes who are fasting during Ramadan should be advised to break their fast if:

- Blood glucose <70 mg/dL (3.9 mmol/L)
- Advise to re-check within 1 hour if BG is between 70–90 mg/dL (3.9–5.0 mmol/L)
- Blood glucose >300 mg/dL (16.6mmol/L)
- Symptoms of hypoglycemia, hyperglycemia, dehydration or acute illness occur

Recognizing Symptoms of Hypoglycemia and Hyperglycemia

All individuals with diabetes who are fasting during Ramadan and their caregivers should be taught to recognize symptoms of hypoglycemia and hyperglycemia (Figure 7) (29). If they recognize these symptoms, they should be advised to break their fast.

Figure 7. Symptoms of hypoglycemia and hyperglycemia (29)

The Medico-Religious Interplay in Ramadan

Muslims believe that Ramadan is a blessed month, and see fasting during the holy month of Ramadan as a deeply meaningful and spiritual experience (1, 30). A significant number of individuals with diabetes fast during Ramadan, even against medical advice and despite the religious exemptions available to the sick (1, 30, 33). This population also includes adolescents with T1D, who fast against medical advice (9). Individuals with diabetes who fast during Ramadan are more likely to avoid consulting their doctors (12).

International Diabetes Federation (IDF) and Diabetes and Ramadan (DAR) International Alliance collaborated to form the IDF-DAR Practical Guidelines 2021 to help healthcare providers (HCPs) better manage diabetes in patients fasting during the month-long holy period of Ramadan (2).

It is important to make these individuals with diabetes who cannot fast due to their medical condition understand that they are equally blessed even if they do not fast (30). Many individuals with diabetes who fast prefer to take fasting related advice from their holy leader (*Imam*). Hence, the right message and education should be disseminated by both the HCPs and the religious leaders (Table 3) (30). HCPs should avoid medical jargons, and counsel patients from a religious standpoint; and religious leaders should integrate into their counseling the value and significance of exemptions in context with the medical advice.

Table 3. Medical and Religious Risk Score Recommendations (30)		
Risk score	**Medical recommendations**	**Religious recommendations**

LOW RISK 0-3 points	Fasting is probably safe. Ensure 1. Medical Evaluation 2. Medication adjustment 3. Strict monitoring	1. Fasting is obligatory 2. Advice not to fast is not allowed except if patient is unable to fast due to: - Physical burden of fasting - Has to take medication or food or drink during the fasting hours on medical advice
MODERATE RISK 3.5-6 points	Fasting safety is uncertain Ensure: 1. Medical Evaluation 2. Medication adjustment 3. Strict monitoring	1. Fasting is preferred but patients may choose not to fast if they are concerned about their health after consulting the doctor and taking into account the full medical circumstances and patient's own previous experiences 2. If the patient does fast, they must follow medical recommendations including regular blood glucose monitoring
HIGH RISK >6 points	Fasting is probably unsafe	Advise against fasting

Medical Nutrition Therapy (MNT) and Ramadan Nutrition Plan (RNP) for People with Diabetes

MNT is an essential component of diabetes management and includes both meal plans and diabetes education, aimed at improving lifestyle and diabetes related behavior (4). MNT helps achieve the desired glycemic control and helps the overweight and obese individuals with T2D improve their lifestyle and lose weight (4). MNT should be appropriate and accurate for the patient's age, comorbidities, lifestyle requirements, and other medical needs. MNT should be easily absorbed; affordable, easily accessible, acceptable (through right aroma and consider taste preferences), and attractive (visually appealing) (4). This improves adherence to the MNT (4).

An MNT plan for individuals with diabetes is essential for safe fasting during Ramadan (32). Structured Ramadan-specific MNT (34) has shown to improve fasting BG and triglyceride levels and pre-dawn and pre-bed SMBG values compared to patients with T2D receiving standard care (34).

Structured Ramadan-specific MNT includes (32, 34):

1. Pre-Ramadan nutrition education
2. Individualized energy and balanced macronutrient prescriptions for non-fasting period (sunset to sunrise) to prevent hypoglycemia during fasting state
3. Well distributed carbohydrate intake to prevent post meal hyperglycemia
4. At least one serving/day of diabetes-specific formula to be taken during Suhoor and/or pre-bed snack.
5. Diet plan should consider other comorbidities.
6. Ramadan toolkits:

- Ramadan flip chart
- 14-day menu plan
- Ramadan Nutrition Plate (RNP)
- Festive season nutrition plan (Syawal nutrition plan)

RNP "is a mobile and web-based application designed to help healthcare professionals (HCPs) individualize medical nutrition therapy (MNT) for people with diabetes" who are fasting during Ramadan (32). A well designed and customized RNP is a prerequisite to safe and confident fasting during Ramadan (32). Apart from nutrition, the platform also provides education regarding safe fasting during Ramadan. It helps individuals to safely fast who have no access to HCPs during Ramadan. Several RNPs have been developed for different countries to suit their regional customs, beliefs, and preferences. HCPs can use their country specific RNP, Ramadan Nutrition plate, and well-balanced meal (Table 4) (4, 32) as a guide to individualize the MNT during Ramadan (32).

Table 4. Macronutrient Meal Composition for Ramadan (4, 32)

<table>
<tr><th>Macronutrient</th><th>Recommended amount</th><th>Recommended sources</th><th>Sources not recommended</th></tr>
<tr><td>Carbohydrate</td><td>≤130 g/day
Accounts for 40-45% of total caloric intake
Adjust as per cultural setting and individual preferences
<table>
<tr><th>Meal</th><th>Calorie %</th><th>Carbohydrate exchange*</th></tr>
<tr><td>Suhoor</td><td>30-40</td><td>3-5</td></tr>
<tr><td>Iftar snack</td><td>10-20</td><td>1-2</td></tr>
<tr><td>Iftar meal</td><td>40-50</td><td>3-6</td></tr>
<tr><td>Healthy snack (if required)</td><td>10-20</td><td>1-2</td></tr>
</table></td><td>Low glycemic index and glycemic load carbohydrates: whole grains, legumes, pulses, temperate fruits, green salad, and most vegetables</td><td>Foods rich in sugar, refined carbohydrate, processed grains, or starchy foods: sugary beverages, traditional desserts, white rice, white bread, low fiber cereal, and white potatoes</td></tr>
<tr><td>Fiber</td><td>20-35g/day (or 14g /1000 kcal)</td><td>High fiber foods: unprocessed food, vegetables, fruits,</td><td>-</td></tr>
</table>

		seeds, pulses, and legumes Fiber helps to provide satiety during Iftar and to delay hunger after Suhoor	
Protein	≥1.2g/kg of adjusted body weight Accounts for 20-30% of the total caloric intake. Protein enhances satiety and gives sensation of fullness. Also helps to maintain lean body mass	Fish, skinless poultry, milk and dairy products, nuts, seeds, and legumes (beans), low fat milk and milk products	Protein with a high saturated fat content such as red meat (beef, lamb) and processed meats (increase CVD risk)
Lipids	Between 30–35% of the total calorie intake. The type of fat is more important than the total amount of fat in reducing CVD risk. Limit saturated fat to < 7%. PUFA and MUFA should comprise the rest of the fat intake. • Limit dietary cholesterol to < 300 mg/day or < 200 mg /day if LDL cholesterol > 2.6 mmol/L	Consume fat from PUFA and MUFA (e.g., olive oil, vegetable oil, or blended oil (PUFA and Palm oil)). Oily fish (e.g., such as tuna, sardines, salmon, and mackerel) as a source of omega 3-fatty acids	Minimize saturated fat, including red meat (beef and lamb), ghee, and foods high in trans-fats (e.g., fast foods, cookies, some margarines).

* 1 Carbohydrate exchange = 15 g Carbohydrates; CVD, cardiovascular disease; MUFA, Monounsaturated fatty acids; PUFA, Polyunsaturated fatty acids

Medical Management of Diabetes During Ramadan

Diabetes assessment and plan of care during and post Ramadan should ideally follow the flow chart shown in Figure 4 (6,29).

MEDICAL MANAGEMENT OF T1D DURING RAMADAN IN ADOLESCENTS AND YOUNG INDIVIDUALS

TID is treated with insulin replacement therapy. After the Pre-Ramadan risk stratification, adjustments are made to the patient's dosing, timing, and type of insulin regime based on the patient's risk level.

Insulin Regimens

There is no conclusive evidence supporting efficacy and safety of a particular insulin regime over another in adolescents with T1D who are fasting during Ramadan. The insulin regime is therefore based on affordability, access to treatment (medication,

specialist and advanced technology), and cultural preferences (9).

Changing the insulin regime just before Ramdan is likely to result in dose errors and increase the risk of hypoglycemia. Hence, every effort should be made to continue the same regime, but with proper dose modifications and comprehensive counseling covering diet, lifestyle, physical activity, SMBG, and self-titration of insulin dose (10).

The most commonly used insulin regimens in adolescents are (9):

1. Basal-bolus regimens –multiple dose injections (MDI) adjusted according to meal (preferred option)
2. Conventional twice daily neutral protamine Hagedorn (NPH)/regular short acting (human) insulin
3. Continuous subcutaneous insulin infusion (CSII) with or without sensors
4. Premixed insulins (generally not recommended for T1DM)

Of these, MDI and CSII are closer to providing the physiological insulin secretion pattern.

Table 5 gives guidance on dose modifications of different insulin regimes.[9] SMBG should be encouraged and the patients or their caregivers taught to self-titrate the insulin dose based on the BG levels (Table 6) (10).

Table 5. Insulin Dose Adjustments During Ramadan (10,35)

Insulin	Dose modification	Timing	Glucose monitoring
MDI (basal bolus) with analogue insulins	Basal insulin 30-40% dose reduction	Take at Iftar	5–7-point glucose monitoring*
MDI (basal bolus) with analogue insulins	RAI Suhoor dose reduced 30-50% Skip pre-lunch dose Iftar dose to be adjusted according to the 2hr post Iftar BG levels	Take at Iftar and Suhoor	5–7-point glucose monitoring*
MDI (basal bolus) with conventional insulins	NPH insulin No dose modification at *Iftar* 50% dose reduction at *Suhoor*	Take at Iftar and Suhoor	5–7-point glucose monitoring or 2-3 staggered readings throughout the day*
MDI (basal bolus) with conventional insulins	Regular insulin Suhoor dose reduced by 50% Skip pre-lunch dose Iftar dose unchanged	Take at Iftar and Suhoor	7-point glucose monitoring or 2-3 staggered readings throughout the day*

	unless needs to be adjusted according to the 2hr post Iftar BG levels		
Premixed (analogue or conventional) once daily	No dose modification	Take at Iftar	At least 2-3 daily Readings*
Premixed (analogue or conventional) twice daily	No dose modification at *Iftar* 50% dose reduction at *Suhoor*	Take at Iftar and Suhoor	At least 2-3 daily Readings*
CSII / Insulin Pump	Basal rate adjustment 10-30% increase for the initial few hours of I*ftar* 20-40% decrease for the final 3-4 hours of fast Bolus doses Same ICR and ISF principles as followed prior to Ramadan Reduce the dose post-*Suhoor* by 20%		CGM

* And whenever any symptoms of hypoglycemia/hyperglycemia develop or feeling unwell
ICR- Insulin Carbohydrate Ratio; ISF- Insulin Sensitivity Factor; RAI- rapid analogue insulin

Table 6. SMBG Guided Dose Titrations for Different Types of Insulin During Ramadan (10)

Fasting/pre-*Iftar*/pre-*Suhoor* blood glucose	**Basal insulin**	**Short-acting insulin**	**Premixed insulin**
	pre-*Iftar*	**pre-*Iftar**/post-*Suhoor***	**pre-*Iftar* insulin modification**
<70 mg/dL (3.9 mmol/L) or symptoms	Reduce by 4 units	Reduce by 4 units	Reduce by 4 units
<90 mg/dL (5.0 mmol/L)	Reduce by 2 units	Reduce by 2 units	Reduce by 2 units
90-126 mg/dL (5.0-7.0 mmol/L)	No change	No change	No change
>126 mg/dL (7.0 mmol/L)	Increase by 2 units	Increase by 2 units	Increase by 2 units
>200 mg/dL (16.7	Increase by 4 units	Increase by 4 units	Increase by 4 units

mmol/L)			

*Reduce the insulin dose taken before *Suhoor*; **Reduce the insulin dose taken before *Iftar*

Recommendations for Insulin Regimes

1) T1D management during Ramadan should be individualized according to patient's need, preference, affordability, acceptability, and access to treatment (9).

2) The basal-bolus regime is the preferred regime and consists of a long-acting insulin analogue (basal insulin) and a premeal rapid acting insulin analogue (bolus insulin) (9).

3) Associated with a lower risk of hypoglycemia when compared to conventional, twice-daily, insulin regimens

4) The bolus insulin dose should be dependent on the carbohydrate count of the meal. It should ideally be given 20 minutes before the meal for better post-prandial BG control.

5) Boluses covering *Suhoor* and *Iftar* should be based on Insulin Carbohydrate Ratio (ICRs) and Insulin Sensitivity Factor (ISFs)

Approximately 70% of hypoglycemia occur during the last six hours of fasting. Hence, the type of basal insulin used, reduction in basal insulin dose and modification of insulin timing are the tools used to avoid hypoglycemia:

1) Ramadan fasting should be started with a reduction of basal insulin-starting with 20% and individualizing up to 40% as required
2) Basal insulin can be administered earlier in the day to minimize insulin exposure during the last few hours of fasting when BG levels are low.
3) Basal insulin can also be taken at *Iftar* or earlier in the evening
4) First-generation basal insulin analogues (such as glargine U-100) are more likely to cause hypoglycemia than the second generation, long-acting insulin analogues (glargine U-300 and degludec). However, the choice of insulin should be individualized based on risk of hypoglycemia.
5) Long-acting insulin analogues are preferred over intermediate acting (NPH/human insulin) as they provide a steady fall of BG towards normal levels by sunset time (9).
6) Twice daily regimens are more likely to be associated with hyperglycemia (9).
7) Twice daily regimens are usually not preferred during Ramadan, but if they are the only choice available to the patient, their timing and dose needs to be more closely monitored depending on the timing, portion size and carbohydrate content of meal (9).
8) Premixed twice daily insulin regimes are not recommended during Ramadan period as they require fixed carbohydrate intake at fixed timing, and this may be difficult for adolescents to follow (9).
9) There is emerging evidence that T1D patients can fast during Ramadan with fewer complications with the help of newer technologies such as insulin pump therapy, CGM and hybrid closed-loop systems (6).
10) CSII with insulin pumps in adolescents help achieve the targeted glycemic control with reduction in hyperglycemia and severe hypoglycemia, and provides more flexibility, improved quality of life and decreased risk of complications like diabetic ketoacidosis (9).

- CSII allows for easier management of DM and reduces risk of complications than MDI (9)
- The basal and bolus doses are adjusted through algorithms on the pump or through sensors and mobile applications (in more advanced versions)

- Basal insulin is reduced by 20-35% in the last 4-5 hours before Iftar and increased by 10-30% after *Iftar* up to midnight
- Prandial insulin bolus calculation is based on usual ICR and ISR
- Bolus doses can be delivered in three different ways:
- Standard dosing: Immediately before meals
- Extended or square dosing: gradual dosing over a certain time period
- Combo or dual wave bolus: combination of standard and extended
- High fat content diet as seen during *Iftar* is likely to benefit from extended or combo bolus dosing (9).
- Insulin pumps augmented with CGM provide better glycemic control and reduce complications considerably in adolescents with T1D. These sensor-augmented pumps are of two types (9):
- Low Glucose Suspend (LGS) function pumps: The high-risk BG threshold for HE is pre-set in these pumps. The insulin administration can be automatically suspended for ≤2 hours when sensors detect BG levels below the pre-set threshold
- Predictive Low Glucose Suspend (PLGS) pumps: Insulin administration is automatically suspended before BG reaches hypoglycemic levels (70 mg/dL [3.9 mmol/L]).
- Automated insulin delivery (closed loop): These can suspend or increase insulin delivery based on sensor-based BG values. Thus, closed loops help increase time in range (TIR) and minimize hypoglycemia and hyperglycemia.
- Types: Hybrid closed-loop automated insulin delivery systems; Do-It-Yourself Artificial Pancreas Systems (DIY APS)
- However, CSII is a costly technology, has limited access in many countries, and therefore is not widely available due to cost and accessibility constraints (9).

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MEDICAL MANAGEMENT OF ADULTS WITH T1D DURING RAMADAN

Patients advised to self-monitor BG at 7-time-point points: when fasting; post-breakfast; pre-lunch; post-lunch; pre-dinner; post dinner; and midnight (9).

Dose adjustments for the different insulin regimes should start during the pre-Ramadan period and every attempt should be made to attain the desired glycemic goal but at low risk for hypoglycemia.

Short acting insulin analogues (glulisine, lispro, or aspart) are associated with less hypoglycemia and better improvement in postprandial glycemia than regular insulin. Premixed insulins are generally not preferred during Ramadan (9).

Table 5 provides guidance on dose modifications of different insulin regimes (9). SMBG should be encouraged and the patients taught to self-titrate the insulin dose based on the BG levels (Table 6) (10).

MEDICAL MANAGEMENT OF T2D DURING RAMADAN

Medical management of Ramadan in patients with T2D varies with wide variety of oral and injectable glucose lowering drugs (GLDs) used during Ramadan as shown in Table 9**.** Patients may be on one or more oral GLDs or a combination of oral and injectable GLDs

Table 9. Different Types of Glucose Lowering Drugs Used by Patients with T2D During Ramadan (1,10)	
Oral glucose lowering drugs	**Injectable glucose lowering drugs**
Sulfonylurea (gliclazide, glipizide, glimepiride, glibenclamide, or glyburide)	Long/intermediate basal insulins (insulin glargine, insulin detemir, insulin degludec or NPH) Insulin: insulin pump, multiple daily injections, insulin lispro, insulin glargine, soluble human insulin, insulin detemir, and biphasic insulin
Biguanides (Metformin)	Bolus prandial rapid or short-acting insulins (lispro, glulisine, aspart or regular human insulin)
Thiazolidinediones (pioglitazone)	Premixed insulins (fixed ratio combinations of short and intermediate acting insulins)-usually not recommended during Ramadan
DPP-4 inhibitors (sitagliptin, saxagliptin, linagliptin, alogliptin, vildagliptin)	GLP-1 RA (lixisenatide, exenatide, liraglutide, dulaglutide, semaglutide)
SGLT2-I (dapagliflozin, canagliflozin, empagliflozin, and ertugliflozin)	
Alpha-glucosidase inhibitor (acarbose, voglibose)	
Short-acting insulin secretagogues (repaglinide and nateglinide)	
Oral GLP-1 RA (semaglutide)	

DPP-4, dipeptidyl peptidase 4; GLP-1 RA, Glucagon-like peptide-1 receptor agonists (GLP-1 RAs); NPH, neutral protamine Hagedorn; SGLT2-I, Sodium/glucose cotransporter-2 inhibitors

After the Pre-Ramadan risk stratification, adjustments are made to the patient's GLDs. Some patients may need a change of medications too depending on their risk level. Preference is given to GLDs with better glycemic control and lower risk of hypoglycemia.

Oral Glucose Lowering Drug Adjustments During Ramadan

- In general, non-sulfonylureas GLDs are superior in lowering hypoglycemia incidence than sulfonylureas (1).
- Metformin is the most commonly used first line oral GLD, and has minimal risk of hypoglycemia (10).
- Sulfonylureas are the most commonly used second line oral GLDs after metformin, especially in resource limited settings (10).

- Short-acting insulin secretagogues can be useful GLDs during Ramadan because of their short duration of action and low risk of hypoglycemia (10).
- DPP4 inhibitors are well tolerated during fasting and have a low hypoglycemia risk (10).
- SGLT2 inhibitors are the newest class of oral GLDs used in T2D. They have demonstrated effective glycemic control during Ramadan even in patients with cardiovascular diseases/chronic kidney disease, and have low risk of hypoglycemia (10, 36).
- An individual should be started on a SGLT2 inhibitor at least 2-4 weeks before Ramadan for the BG levels to stabilize during the fasting time.
- Of the thiazolidinediones, only pioglitazone is widely approved for T2DM, has low hypoglycemia risk, but clinical data on its use during Ramadan is limited (10).

Table 10. Oral Glucose Lowering Drugs Used During Ramadan: Dose Modifications and Timing Adjustments in Individuals with Type 2 Diabetes (10)

Oral GLD	Dose modification	Timing
Metformin once daily	No dose modification	Take at Iftar
Metformin twice daily	No dose modification	Take at Iftar and Suhoor
Metformin thrice daily	No modification to morning dose. Afternoon dose to be combined with evening dose	Take morning dose before Suhoor and evening dose at Iftar
Prolonged release metformin	No dose modification	Take at Iftar
Sulfonylureas once daily	Reduce dose in patients with well controlled BG levels	Take at Iftar
Sulfonylureas twice daily	In patients with well controlled BG levels Iftar dose remains the same. Suhoor dose is reduced	Take at Iftar
Older sulfonylureas (e.g., glibenclamide)	Avoid and replace with 2nd generation SUs such as glicazide, glicazide MR, and glimepiride	
Short-acting insulin secretagogues thrice daily dosing	Reduce or re-distribute to two doses	Take before Iftar and Suhoor
DPP4 inhibitor once daily	No dose modification	Take at Iftar
DPP4 inhibitor twice daily (vildagliptin)	No dose modification	Take at Iftar and Suhoor
SGLT2 inhibitors	No dose modification	Take at Iftar
Thiazolidinedione	No dose modification	Take at Iftar

BG, blood glucose; DPP-4, dipeptidyl peptidase 4; MR, modified release; SGLT2-I, Sodium/glucose cotransporter-2 inhibitors; SU, sulfonylurea

Injectable Glucose Lowering Drug Adjustments During Ramadan

- Most patients with long-standing T2D eventually need insulin to manage their BG levels. Various insulin regimes are used in T2D (table 9) (1, 10) and in general, the use of insulin increases the risk of hypoglycemia during Ramadan.
- Insulin can be given as single daily injection, MDI or as CSII through insulin pumps. The insulin regime is therefore based on affordability, access to treatment (medication, specialist and advanced technology), and cultural preferences (9).
- Changing the insulin regime just before Ramdan is likely to result in dose errors and increase risk of hypoglycemia. Hence, every effort should be made to continue the same regime, but with proper dose modifications and comprehensive counseling covering diet, lifestyle, physical activity, SMBG, and self-titration of insulin dose (10).
- Table 5 shows the various insulins and how their doses and timing are adjusted during Ramadan.
- SMBG guided dose titrations for different insulin types are shown in Table 6.
- GLP-1 RAs can be safely used with other GLDs including metformin and insulin. They have low hypoglycemia risk, but the risk could be higher if given with insulin or sulfonylureas. However, dose needs to be titrated at least 2-4 weeks prior to Ramadan (10).

Individuals on Multiple Antidiabetic Therapy

Individuals on multiple GLDs are at higher risk of hypoglycemia during Ramadan (18). The risk of hypoglycemia is highest if they are on ≥4 GLDs or on a combination of metformin, DPP4I and basal insulin (37).

In individuals on multiple GLDs, the risk of hypoglycemia is dependent on several factors such as type and number of GLDs, duration of diabetes, pre-Ramadan glycemic control, renal function, and presence of other comorbidities (10).

Individuals on ≥3 GLDs who are fasting during Ramadan should receive comprehensive counseling and advice before the start of Ramadan, and it should cover diet, lifestyle, physical activity, SMBG, and dose and time modifications of GLDs (10).

Individuals on a combination of insulin and SUs are at highest risk of hypoglycemia and require a dose reduction GLDs (approximately 25-50% reduction in insulin dose) during Ramadan.

Flash glucose monitoring, CGM, activity monitoring, risk stratification, dose adjustments, and use of artificial intelligence-based algorithms that cover one or more of these aspects are the various tools that are likely to help high-risk patients with T2D fast with fewer hypoglycemia and hyperglycemia related complications (6, 10).

MANAGEMENT OF DIABETES IN SPECIAL POPUATIONS DURING RAMADAN

As discussed, individuals who are considered high risk for fasting during Ramadan need special pre-Ramadan risk stratification, counseling, dose modification, and need to follow strict SMBG during Ramadan, and those on insulin should be capable of

self-titrating their insulin dose based on their BG values.

This is especially true for special population considered high risk due to a high probability of harm caused by fasting during Ramadan (5). This special population of high-risk individuals with diabetes includes pregnant women, elderly, and people with CVD or CKD. All these individuals are usually advised not to fast, but many do decide to fast against medical advice (5).

Management of Diabetes/Gestational Diabetes During Ramadan

Even in healthy pregnant women, fasting during Ramadan results in biochemical changes that almost mimic the effects of prolonged fasting (35). Ramadan fasting results in an increase in triglycerides (TG), free fatty acids (FFA), and ketones in healthy pregnant women along with a decrease in glucose and insulin (35). However, data on physiological and biochemical changes caused by fasting during Ramadan in pregnant women with diabetes is largely lacking.

Pregnancy is an exemption from fasting. However, many pregnant women choose to fast during Ramadan. A detailed discussion regarding the potential risks of fasting must be held with them.
While healthy pregnant women can generally fast safely with no maternal or fetal risk, those with hyperglycemia need to strictly monitor their BG levels to prevent hyperglycemia, hypoglycemia, and adverse maternal and fetal outcomes (35).

- Pre-Ramadan assessment should begin months before Ramadan, and apart from risk stratification, should focus on breaking general myths like 'finger-prick testing for BG levels breaks their fast', encourage SMBG, and educate about the maternal and fetal risks of both hypoglycemia and hyperglycemia (35).
- Pregnant women with diabetes should maintain normal physical activity while fasting. The *Taraweeh* prayer they offer should be considered as exercise for which insulin doses should be adjusted as required (35).
- Fiber rich food and drinking 2-3 liters of water a day should be encouraged. Suhoor should be taken as late as possible (35).
- Insulin and/or metformin are the treatment of choice in pregnancy with diabetes. Though glibenclamide is also used in some patients, its use should be discouraged during Ramadan. Some women with gestational diabetes may be managed on diet and/or metformin too.
- The metformin dose may not need any change during pregnancy but the dose of insulin should be modified as discussed in Table 5 (10, 35). Insulin dose titration should be guided by SMBG as shown in Table 6.
- SMBG should be carried out as guided in Figure 6. Pregnant women with diabetes should strictly monitor and maintain their BG levels as follows (35):
  - ✓ Fasting between 70-95 mg/dL (3.9 – 5.3 mmol/L).
  - ✓ Post-prandial < 120 mg/dL (6.7 mmol/L).
- Pregnant women with diabetes should break their fast if (35):
  - ✓ BG levels < 70 mg/dL (3.9 mmol/L) during fasting hours.
  - ✓ Feel unwell.
  - ✓ Feel reduced fetal movement.
- Pregnant women with diabetes should carry out regular SMBG at the following time points (35):
  - ✓ Before the sunset meal.
  - ✓ 1-2 hours after meals

✓ Once during the day while fasting, particularly in the afternoon.
✓ Anytime they feel unwell.

Management of Diabetes in Elderly with Diabetes Fasting During Ramadan

Older age (≥ 65 years) by itself can be considered a high risk for fasting during Ramadan in individuals with diabetes, even though many elderly fast successfully during Ramadan (38). Older individuals with diabetes are less likely to fast than younger ones (DAR 2020 survey: 71.2% of ≥ 65 years intended to fast compared to 87.3% of those < 65 years) (39). However, fasting during Ramadan being a personal choice, many older adults with diabetes do choose to fast during Ramadan. The DAR Global Survey (2020) also showed that the elderly were more motivated to fast with 69% of those aged ≥ 65 years fasting for 30 days compared to 60% of those < 65 years (39).

Elderly (≥ 65 years) with diabetes were significantly more likely to break their fast than younger (<65 years) individuals with diabetes (17% vs. 11.5%; P<0.001) (39). Similarly, they were significantly more likely to break their fast due to hypoglycemia than their younger counterparts (67.7% vs.55.4%; P=0.02).

Fasting during Ramadan in elderly with diabetes needs special consideration and attention because:

• Diabetes related complications are higher in elderly and they need careful BG monitoring and GLD dose adjustments, which should be started well before Ramadan (38).

• Fasting related complications likely to be seen in elderly with diabetes can be due to both hyperglycemia and hypoglycemia, and also include impaired renal function, impaired postural balance, poor attention, and volume depletion. The risk increases with the number of days fasted (38).

• The DAR 2020 survey showed that hypoglycemia was significantly higher in elderly as compared to younger population (17.4% vs.15.2%; P<0.001) (39).

• 9.9% of those aged ≥ 65 visited the emergency department compared to 4.3% of individuals aged < 65

• Elderly were also more likely to get hospitalized due to hypoglycemia

• While 31.5% reduced their GLD dosing, 17% made no change to their medication dose

• The use of SUs and insulin increases risk of hypoglycemia. 32.7% of elderly need insulin, probably due to long standing diabetes.

• The DAR 2020 survey also showed that significantly greater number of elderly with diabetes who are fasting had hyperglycemia (BG levels > 16.6 mmol/L or 300 mg/dL) during Ramadan (19.3% vs. 15.6%; P=0.006) (39). 8.4% of the elderly had to attend the emergency department due to hyperglycemia related complications.

• The DAR 2020 survey showed that the majority (80%) do not break their fast even if they have hyperglycemia, and 20% do not change their behavior (food intake, medication change), 25% reduced their food intake, and 21% increased their medication dose (39).

• In the DAR 2020 Global Survey, 21% of participants with T2DM aged ≥ 65 years checked their BG levels once or less than once a week. Only around 10% checked their BG levels 3–4 times a day. There was no change in SMBG behavior during Ramadan (39).

• Research on elderly fasting during Ramadan is largely lacking.[38] Landmark trials in Ramadan like the EPIDIAR study which was used to formulate many recommendations for individuals with diabetes fasting during Ramadan, did not include the elderly.[7]

- The elderly population is growing fast, and therefore there will be more individuals with diabetes who are ≥ 65 years and intend to fast (40)
- The risk of fasting is much higher in elderly than in younger population with diabetes (38). This is because the elderly have more comorbidities (hypertension, hyperlipidemia, CVDs, CKD etc.) than the younger population (38, 39).
- Elderly with diabetes and impaired renal functions, CVD, dementia, frailty, and/or those with risk of falls are at higher risk for complications during fasting than elderly without comorbidities (38). Therefore, risk stratification of elderly with diabetes who decide to fast during Ramadan should be based not only on age, but also on their comorbidities, functional capacity, and ability to manage medications and carry out SMBG, cognition, and social circumstances (38).

Hence, the elderly with diabetes are a high-risk category for fasting during Ramadan. They need proper Pre-Ramadan risk stratification, education, and support to ensure that they can fast safely with proper SMBG and medication monitoring.

Table 11 covers the basic recommendations for elderly who intend to fast during Ramadan.

Table 11. Basic Recommendations for Elderly who Intend to Fast During Ramadan
MEDICATIONS AND REGIMENS
Choose medications that have a lower hypoglycemia risk • Make dose adjustments to lower the risk of hypoglycemia • For individuals on SUs, gliclazide and glimepiride should be used instead of glibenclamide SGLT2 inhibitors doses should be reviewed for benefit vs risks of adverse events especially in elderly with impaired renal function or those on diuretics Insulin: dose titration based on SMBG should be taught and dose modifications carried out based on the insulin type
SMBG
• Increase frequency to a 5-point time scale • Use CGM if available and feasible
DIET AND PHYSICAL ACTIVITY
• Individualized diet and activity plan • Started before Ramadan and adhere during fasting days • Medication doses and timings adjusted according to diet and physical activity level • Adequate nutrition should be stressed and education provided • Hydration ensured through proper planning
SOCIAL SUPPORT
Given that elderly may have cognition, memory, and physical deficits, adequate support should be ensured pre-Ramadan to ensure SMBG, adherence to diet and physical activity plan, insulin dose titration, and oral GLD dose modification

AWARENESS OF RISK OF COMPLICATIONS
• Discuss and document symptoms and events to increase awareness and recognition of complications • Both patient and caregiver should be educated to recognize the symptoms of complications

CGM, continuous glucose monitoring; GLD, glucose lowering drugs; SMBG, self-monitoring of blood glucose

Other Concerns Regarding Management of Diabetes During Ramadan

MANAGEMENT OF COMORBID HYPOTHYROIDISM

Hypothyroidism is commonly seen in patients with diabetes. Usually, thyroxine is taken half an hour before breakfast. However, during Ramadan, the breakfast time is shifted to pre-dawn. This is a time of rush and individuals may find it difficult to time the thyroxine dose half an hour before *Suhoor*. Similarly, if thyroxine is pushed to evening, then taking it half an hour before Iftar is usually difficult as usually this meal is taken with rest of the family and by *Iftar* time hunger score is high. Hence, thyroxine may be taken late (after a 4-hour gap) at night as long as no heavy meal is taken between *Iftar* and late night (12).

BARIATRIC SURGERY

Diabesity (co-existing diabetes and obesity) is of pandemic proportions across the world (4). Bariatric surgery is commonly performed in individuals with diabesity. Bariatric surgery poses certain concerns regarding fasting during Ramadan as these individuals cannot consume large meals and therefore absorb certain macronutrients (12).

GAPS AND WAY FORWARD

The last few decades have contributed immensely to the growing knowledge and clinical experience of health care providers regarding the clinical and metabolic complications of fasting, pre-fasting assessment, risk stratification and initiation of changes in medication dose and timing and dietary/lifestyle modifications during Ramadan (1). However, greater efforts are required to improve communication between the medical experts and religious scholars in order to ensure that medical guidance regarding safe fasting during Ramadan is best received by the public (30). Further well-designed clinical trials are required to assess the best treatment options for adolescents and adults with diabetes who fast during Ramadan. Artificial intelligence, use of RNP and other such tools need to be integrated to ensure safe fasting during Ramadan.

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