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The South Asian Health Foundation (UK) guidelines for managing diabetes during Ramadan

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ABSTRACT

Background: Fasting in the holy month of Ramadan is among the five pillars of Islam and is considered as a religious obligation by the Muslim population. People with diabetes observing the practice of fasts are at a higher risk of complications such as hypoglycaemia, hyperglycaemia and ketoacidosis due to changes in eating patterns and circadian rhythms. With the objective of mitigating these complications, the South Asian Health Foundation (UK) has developed the present guidelines based on robust evidence derived from epidemiological studies and clinical trials.

Methods: We have highlighted the role of pre-Ramadan risk stratification and counselling by healthcare professionals with emphasis on the need for advice on adequate dietary and fluid intake, blood glucose monitoring and awareness of when to break the fast.

Results: We reviewed the current literature and have given clinically-relevant recommendations on lifestyle modifications and glucose-lowering therapies such as metformin, sulphonylureas, dipeptidyl peptidase-4 inhibitors, sodium glucose co-transporter-2 inhibitors, thiazolidinediones, glucagon-like peptide-1 receptor agonists and insulin.

Conclusions: An individualised patient-centric treatment plan is essential to not only achieve optimal glycaemic outcomes but also enable people with diabetes to observe a risk-free month of fasting during Ramadan.

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1. Introduction

The prevalence of type 2 diabetes mellitus (T2DM) is on the rise globally, especially in emerging economies with large Muslim populations [1]. In 2019, T2DM was the most common type of diabetes, and accounted for nearly 90% of all diabetes globally. Nearly 463 million adults were living with diabetes, which is projected to rise to 700 million by 2045 [2]. The most recent World Bank data shows a global diabetes prevalence of 8.8% in the 20–79 years age-group who have type 1 diabetes mellitus (T1DM) or T2DM [3].

The Muslim population is expected to grow twice as fast as the overall global population, in absolute number in all regions of the world between 2010 and 2050. Worldwide, their number is projected to rapidly increase in the upcoming decades, rising from nearly 1.6 billion in 2010 to approximately 2.8 billion in 2050 [4]. The prevalence of diabetes in the adult Arab population rose from 2.4% to 25.4% between 1982 and 2015. By 2035, the number of people with diabetes in the Middle Eastern region is projected to rise by 96.2% [5].

In Europe, by 2050, Muslims are projected to make up to 10% of the overall population. The South Asia-Pacific region continues to remain the home of majority of the world's Muslims. By 2050, 53% of the global Muslims are expected to live in South Asia and the Pacific, and nearly 20% of the world's Muslim population is projected to live in the Middle East and North Africa. In sub-Saharan Africa, the Muslim population is predicted to rise from nearly 250 million in 2010 to almost 670 million in 2050. Likewise, the absolute number of Muslims is anticipated to intensify in regions with smaller Muslim populations including North America [4].

Fasting in the holy month of Ramadan is amongst the five pillars of Islam and considered a religious obligation for all Muslims, with some exceptions. Observing fast involves abstaining from eating and drinking from dawn (suhoor) to dusk (iftar); the duration of fasting might vary from 10 to 20 h depending on the geographical location and season. Although mandatory, religious exemptions to fasting include pregnancy, lactation, travelling, or any acute or chronic conditions wherein fasting might predispose to health-risks. Since diabetes is a metabolic disorder involving the risks of hypo- and hyperglycaemia, it is considered a risk state for people fasting during Ramadan [6]. However, most Muslim people with diabetes do not consider themselves to be unwell and therefore would wish to fast during Ramadan as an article of their faith and also a socio-cultural event to foster relationships with family and friends. As a result, many choose to fast despite contrary medical advice [7].

Members of the South Asian Health Foundation along with experts in the field of diabetes care, patient groups and Muslim religious leaders participated in a series of meetings and conferences to develop a guideline for the management of Muslim people with T1DM and T2DM intending to observe fasts during the month of Ramadan. The panel held discussions to review existing guidelines, formulate a search strategy to include publications from various databases, and finalise the relevant sections for the guideline. A comprehensive, focused literature review was conducted for newer studies related to diabetes and Ramadan fasting with special emphasis on randomised controlled trials and real-world evidence. Subsequent to final consensus' from all authors, evidence-based recommendations were developed to assist physicians in their daily clinical practice for managing people with diabetes during Ramadan.

2. Physiology of fasting during Ramadan in normal individuals

2.1. *Effects on glucose*

During Ramadan, minor changes in blood glucose is unlikely to have adverse effects in healthy subjects [8]. Ziaee V et al recorded a mean reduction of 7.3 ± 7.8 mg/dL (0.41 ± 0.43 m mol/L) in glucose levels before and after Ramadan in 81 students of Tehran University of Medical Sciences [9]. M'guil M et al found diabetes to be well-controlled (with diet and/or glucose-lowering agents) in terms of fructosamine, glycated haemoglobin (HbA1c), homeostasis model assessment for insulin resistance, C-peptide, and insulin-like growth factor 1 levels, with no severe adverse effects in people with T2DM observing fasts [10]. Another study noted a decrease in fasting glucose, insulin, and insulin resistance after 4 weeks of Ramadan fasting in healthy normal weight individuals with 1%–2% weight loss from baseline [11].

A *meta*-analysis by Kul S and colleagues that included 16 studies (n = 776) found a significant overall pooled standardised weighted mean difference of −1.10 (95% CI, −1.62 to −0.58; p = 0.001) for change in fasting blood glucose before and after Ramadan [12].

2.2. *Effects on body weight*

Various researchers have suggested intermittent fasting as an effective dietary intervention to ameliorate various metabolic risk factors, including fasting glucose and insulin levels, plasma lipids, insulin sensitivity, and some inflammatory cytokines [13], body weight [9,12], body mass index and waist circumference [14]. These beneficial effects may be mediated via metabolic switching and cellular stress resistance [15].

Even though the intermittent fasting in Ramadan does not entail energy restriction, there may be changes in body weight on account of the reduced frequency of food and fluid intake, and reduced physical activity. Ramadan fasting is the most common pattern of time-restricted eating that leads to transient weight loss with mixed evidence revealing enhancements in metabolic markers [16]. Weight changes during Ramadan are relatively small (−1.24 kg; 95% CI, −1.60 to −0.88 kg) and reversible after the month of fasting; structured and consistent lifestyle modifications are essential to achieve sustained weight loss [17].

2.3. *Changes in sleeping patterns and circadian rhythms*

Ramadan is associated with a number of changes to an individual's general activity and behaviour, meal times and patterns of nocturnal sleep and associated daytime somnolence [18–20]. Eating late at night is postulated to result in circadian desynchronisation and consequent disruption of

regular sleep patterns [16]. The evident concerns of daytime fasting are worsening energy levels due to absence of food intake and altered metabolic responses during the day.

Fluctuations in sleeping and eating schedules have been found to decrease morning cortisol levels and increase evening levels. In control settings, morning 08:00 h values were 3.84 times higher compare to those at 20:00 h, which was seen to reduce to 2.02 times during Ramadan [21]. Moreover, there are reports of decreased amplitudes and phase shifts in rhythms of body temperature and melatonin suggesting major chronobiological and behavioural changes during Ramadan fasts [22].

Evidence suggests a reduction in the proportion of rapid eye movement sleep as the key change in sleep architecture during Ramadan fasting [20,23,24]. Though disturbance of normal sleep may have an effect towards the increased somnolence experienced on the subsequent day [21], some studies found no impact of intermittent Ramadan fasting on drowsiness and vigilance [25,26].

3. Effects of fasting during Ramadan in people with diabetes

3.1. *Hypoglycaemia*

The population-based, retrospective, transversal, Epidemiology of Diabetes and Ramadan (EPIDIAR) survey, was conducted in 13 countries (n = 12,243; T1DM = 1070; T2DM = 11,173) to examine the characteristics and care of patients with diabetes in countries with a sizable Muslim population and to study diabetes features and the effect of fasting during Ramadan. Compared with other months, significantly more frequent episodes of severe hypoglycaemia occurred during Ramadan (T1DM, 0.03 vs. 0.14 episode/-month, p = 0.0174; T2DM, 0.004 vs. 0.03 episode/month, p < 0.0001). This is an increase of 4.6 times in T1DM and 7.5 in T2DM. The authors emphasised a need to offer more intensive education to patients with diabetes before fasting, to disseminate guidelines, and recommended future studies evaluating the impact of fasting on morbidity and mortality [27]. Findings from the Multi-Country Retrospective Observational Study of the Management and Outcomes of Patients with Diabetes during Ramadan (CREED study; n = 3250) also suggests an association between having an episode of hypoglycaemia before and during Ramadan (OR, 7.80; 95% CI, 5.31–11.45) [28].

A recent cross-sectional study carried out in 378 adult patients with diabetes attending four primary healthcare centers during Ramadan recorded hypoglycaemia (defined as < 70 mg/dL [<3.9 mmol/L] or classical symptoms of hypoglycaemia that resulted in breaking the fast) in more than half (52%) of patients; most patients did not receive instructions regarding self-management immediately before or during Ramadan. The risk factors reported were young age, T1DM, long duration of diabetes and the use of insulin. The authors highlighted the importance of awareness of classical symptoms and appropriate action like self-blood glucose monitoring and immediate breaking of fasts in the event of hypoglycaemia during Ramadan [29]. The recent DAR-MENA study reported a significant increase in confirmed hypoglycemia before and during Ramadan (incidence: 4.9% vs. 10.4%, p < 0.001; adverse events: 0.11 vs. 0.22 events/month/participant, p < 0.001), which was dependent on treatment regimen, and that in the incidence of severe hypoglycemia before Ramadan (0.2%) than during Ramadan (0.9%) (p = 0.031) [30].

In order to reduce episodes of hypoglycaemia, individualised treatment and adequate Ramadan-specific diabetes self-management education must be specifically targeted towards patients with prior hypoglycaemia events [28].

3.2. *Hyperglycaemia*

During Ramadan, hyperglycaemia is most commonly encountered during the evening time probably due to extensive reduction in glucose-lowering agents and feasting at iftar [31]. The EPIDIAR study recorded a significant increase in the mean number of severe hyperglycaemia/ ketoacidosis events during Ramadan than the month preceding Ramadan (T1DM, 0.05 ± 0.08 vs 0.16 ± 0.51, p = 0.1635; T2DM, 0.01 ± 0.05 vs. 0.05 ± 0.35, p < 0.0001) [27]. This is an increase of 3.2 times in T1DM and 5.0 in T2DM. Elmehdawi RR et al interviewed 493 patients with diabetes at Benghazi Diabetes and Endocrine Center (BDEC) to assess the potential complications of fasting during Ramadan. They noted hyperglycaemia in a total of 11.2% (T1DM, 20.8%; T2DM, 10.7%), with severe hyperglycaemia in 10.9% treated with insulin and 9.9% with oral glucose-lowering agents; 1% of patients required admission due to hyperglycaemia [32].

Studies assessing continuous glucose monitoring system in patients with diabetes have reported higher rates of hyperglycaemia than hypoglycaemia during Ramadan fasting, especially around iftar time [33,34]. In another recent study that evaluated 52 adult patients with diabetes in the Oman Police Force, hyperglycaemia was a more common occurrence than hypoglycaemia (34.6% vs. 3.8%); no patients had a pre-Ramadan assessment or previous 3 months HbA1c [35].

Guidelines recommend frequent home blood glucose monitoring, particularly before iftar and 2 h afterwards, as well as before and 2 h after suhoor, in order to regulate insulin doses and prevent any hypoglycaemia and postprandial hyperglycaemia following feasting [36–38].

3.3. *Diabetic ketoacidosis*

Though most studies report higher hospitalisation rates due to diabetic ketoacidosis in Ramadan [39–41], a recent critical reappraisal highlighted that these episodes could be precipitated by factors unrelated to fasting. Retrospective, prospective and database studies could not document any increase in observed diabetic ketoacidosis during Ramadan [42]. However, as a result of long-lasting starvation, euglycaemic diabetic ketoacidosis has been reported in people with T1DM fasting during Ramadan [43].

Risks for diabetic ketoacidosis associated with Ramadan fasting in people with diabetes include unwarranted reduction of insulin dosages due to assumed reduced food intake, increased blood viscosity secondary to dehydration increasing the risk of thrombosis, moderate-to-severe hypergly-

caemia before the fast, renal insufficiency, advanced micro- and macrovascular complications and other comorbid conditions, and dose reduction in acute infection (deficient to meet stress demands induced by elevated catecholamines and steroids) [44].

3.4. *Dehydration and thrombosis*

Patients with diabetes and nephrotic syndrome regardless of their estimated glomerular filtration rate (eGFR) and HbA1c should be considered as high risk for fasting during Ramadan in view of the increased risk of thrombosis specifically during prolonged fasting relatively decreasing volume and dehydration resulting in negative and harmful consequence [45].

Dehydration can worsen in hot and humid climates, increased length of fasts, and in people with occupations involving hard physical labour, i.e. conditions that lead to excessive perspiration. Furthermore, hyperglycaemia could give rise to osmotic diuresis and add to depletion of volume as well as electrolytes [44].

Chronic inflammation and endothelial dysfunction could potentially exacerbate cardiovascular risk with severe hypoglycaemia, particularly in patients with longer duration of diabetes, preexisting cardiovascular disease, and severe autonomic neuropathy [46]. Intravascular contraction and volume depletion might also predispose a hypercoagulability state, with an increased incidence of thrombosis.

Researchers have also suggested a possible role of dehydration in the increased incidence of retinal vein thrombosis during Ramadan [47]. Although previous studies reported no profound effect of fasting during Ramadan on physiological intraocular pressure, refractive error or visual acuity [48], others have highlighted detailed impact of dehydration on ocular tissue during Ramadan fasting, such as increased tear osmolarity, anterior chamber depth, and retinal thickness, and decreased intraocular pressure, axial length, central corneal thickness, and lens thickness [49,50].

Taking into consideration these detrimental effects on health, especially in hot climates, education programs must focus on the need for adequate water intake during the non-fasting hours in Ramadan.

A recent large-scale systematic review evaluating the effects of Ramadan fasting on cardiovascular events (5 studies) and risk factors (17 studies) in patients with T2DM reported lack of substantial evidence showing increased or reduced incidence of cardiovascular events during the fasting period; however, there was a signal of increased risk of stroke [51].

4. Pre-Ramadan assessment and screening

4.1. *Healthcare professional training and increasing awareness*

Spirituality, personal beliefs, and religiosity affect patients' health behaviours and treatment adherence. There are a number of sociocultural and religious issues specific to South Asian Muslim societies that focus on the need for individualisation of care for people with diabetes. Healthcare providers must understand the effect of Ramadan fasting on the health of their Muslim patients, specifically those with chronic medical conditions, and how to help them accomplish safe fasting. Health care professionals must be knowledgeable and culturally competent about the basics and exemptions of Ramadan fasting, and the treatments and procedures that invalidate fasting [52–55].

A comprehensive survey by the Middle East and North Africa (MENA) Endocrine Research Group in the UAE demonstrated variable levels of knowledge amongst physicians' about care of patients with diabetes during Ramadan and recommended annual continued education, mentoring and support schemes with regular assessments before the month of Ramadan [56]. A scoping review by Almansour and colleagues, involving 14 studies, found a wide variation in the knowledge of participating healthcare professionals pertaining to managing diabetes in patients who intended to observe fasts during Ramadan. While most healthcare professionals agreed to offer healthcare services, they had suboptimal knowledge of the method to provide such services, and most were keen to receive training regarding their role in managing diabetes during Ramadan [57].

A number of researchers have highlighted the need for a variety of awareness strategies to educate people with diabetes about glucose monitoring, modifications to medication, diet and lifestyle during Ramadan fasting. People with diabetes must receive pre-Ramadan assessment at least 1–2 months before Ramadan and be counselled by healthcare providers. Educating the family or caregivers of people with diabetes who wish to fast is also imperative [35,37,58,59,60].

In order to warrant safe fasting during the month of Ramadan, healthcare professionals should work together with religious scholars and communities to reach out and educate their patients with diabetes to provide patient-centered care [7,53]. Initiatives such as the 'A Safer Ramadan' by DESMOND (The Diabetes Education and Self-Management for Ongoing and Newly Diagnosed) [61,62], and 'New Safer Ramadan eLearning module' by the EDEN (Effective Diabetes Education Now)[63] programmes provide support towards training and raising awareness of safer fasting to healthcare professionals, in addition to the local community and patients.

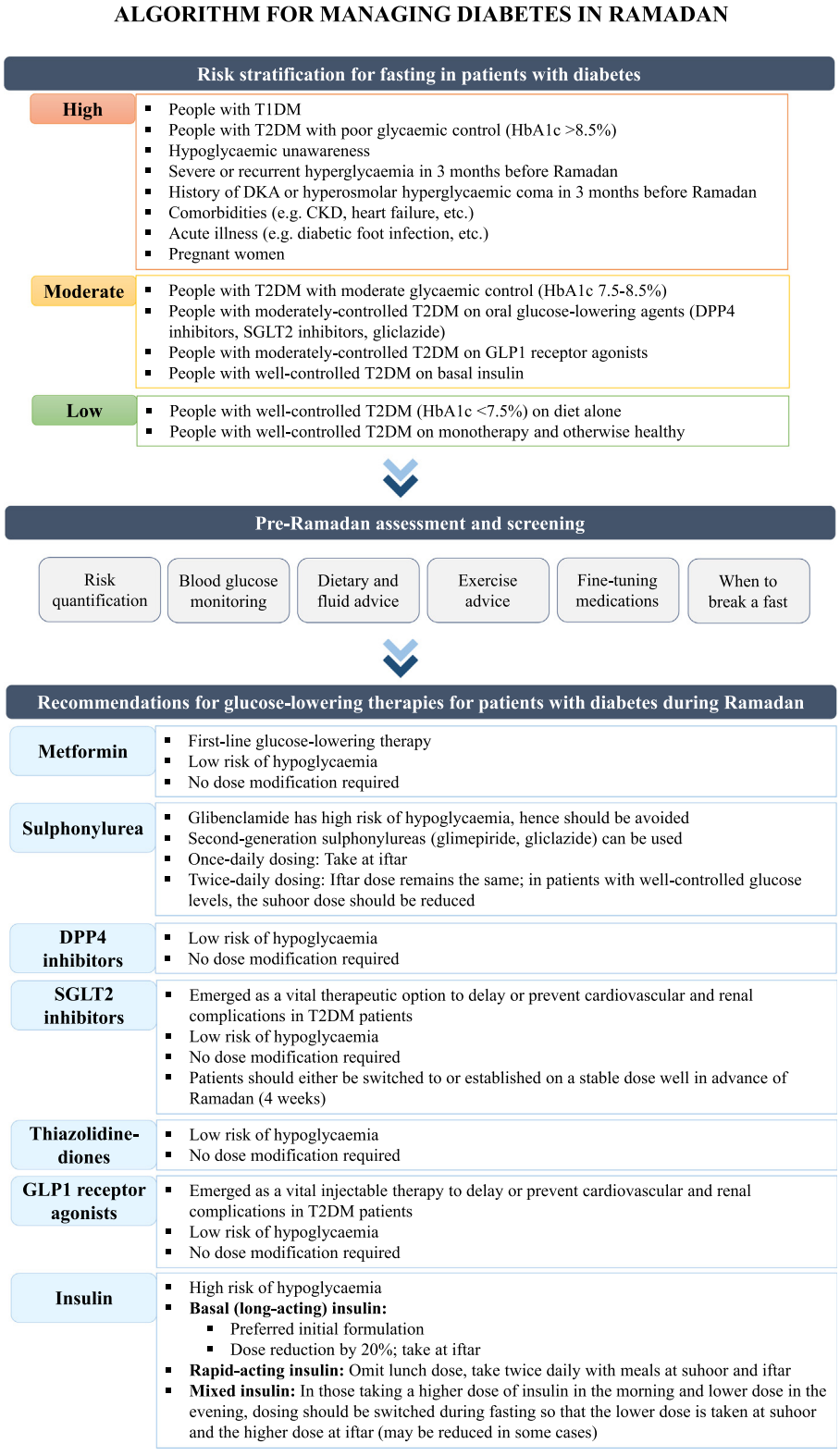
4.2. *Risk quantification and stratification*

Healthcare professionals consistently discourage fasting during Ramadan for people with ill-health, which include those with diabetes as a result of increased potential risk of complications [64]. In order to provide optimal care to people with diabetes observing fasts, awareness of risks associated with fasting among healthcare professionals is of utmost importance so as to quantify and stratify the risks for each patient individually. Factors to be considered for risk quantification include type of diabetes, treatment regimen, risk of hypoglycaemia, comorbidities or existing complications, previous Ramadan experience, and individual work and social circumstances [37,64].

There are suggestions that young adults can fast safely if they are stable, otherwise healthy, have good hypoglycaemic awareness and comply with their personalised management plan under medical supervision [65]. The risk stratification

for people with diabetes who fast during Ramadan are illustrated in Fig. 1.

During pregnancy, increased levels of blood glucose and HbA1c are associated with an increased risk for major congenital malformations. Fasting during pregnancy would have



Abbreviations: CKD, chronic kidney disease; DKA, diabetic ketoacidosis; DPP4, dipeptidyl peptidase; GLP1, glucagon-like peptide; HbA1c, glycosylated haemoglobin; T1DM, type 1 diabetes mellitus; T2DM, type 2 diabetes mellitus.

Fig. 1 – Algorithm for Managing Diabetes in Ramadan.

a higher risk of morbidity and mortality to the foetus as well as the mother [66]. Even though pregnant women are exempt from fasting during Ramadan, many choose to fast. Pregnant and lactating women should utilise this exemption as it may impact their own health and that of their offspring.

4.3. *Patient education*

Studies have demonstrated that individualised education and diabetes treatment programs help people with T2DM lose weight, improve glycaemic control and achieve a safer fast during Ramadan [67–69].

The International Islamic Fiqh Academy advocates pursuing education and guidance for all people with diabetes who intend to fast during Ramadan because of the risks from complications on the health of patients and their lives. Education in the form of sermons in mosques and media can increase level of awareness, improve the preparedness to deal with it, thus significantly reduce negative effects and aid in accepting medical advice for treatment [70].

The Ramadan Education and Awareness in Diabetes (READ) programme was conducted to assess the impact of Ramadan-focused education observed that not only did Ramadan-focused education in diabetes empowered people to change their lifestyle, but also reduced the risk of hypoglycaemic events and prevented weight gain, with a potential advantage of metabolic control [67].

The Ramadan Prospective Diabetes Study performed in 110 fasting individuals (3946 readings) with T1DM or T2DM suggested that the composite effect of active glucose monitoring, alteration of drug dosage and timing, dietary counselling and patient education in people with diabetes can help patients observe fasts during Ramadan without major complications [71].

The novel educational intervention, “A Safer Ramadan” is designed to meet the specific needs of Muslim people with diabetes who observe Ramadan fasts, and additionally targets healthcare providers and the community [62].

The fundamental components of pre-Ramadan education include risk quantification, blood glucose monitoring, dietary and fluid advice, exercise advice, fine-tuning of medications and information regarding when to break the fast (Fig. 1). Healthcare professionals are crucial in educating their people with diabetes, increasing their awareness regarding the risks involved and establishing guidelines to reduce any negative effects associated with intermittent fasting [72]. Continuous multidisciplinary support with suitably structured educational programs help achieve optimal outcomes in people with diabetes planning to fast during Ramadan [29,73].

4.4. *Blood glucose monitoring*

Self-monitoring of blood glucose using glucometers (capillary blood glucose values) is being universally used for many years to moderate the potential risk of hyperglycaemia, hypoglycaemia, and ketoacidosis. However, this invasive method is painful to children and adolescents, particularly if monitoring is required multiple times a day [74]. Some people with diabetes may also refrain from performing finger pricking during Ramadan as they may perceive it as an interference with the act of fasting. For cultural reasons, there are concerns of religious implications of self-monitoring blood glucose (SMBG), but most religious scholars advocate SMBG as it involves a minimal amount of blood and does not invalidate religious fast [37,75].

Real-time continuous glucose monitoring offers constant 24-hour recording displaying episodes of hypo- and hyperglycaemia and improving patients’ safety during fasting [76,77]. It was found that children and adolescents with T1DM who used flash glucose monitoring during Ramadan could fast without the risk of life-threatening episodes of severe hypoglycaemia or diabetic ketoacidosis [74]. Flash glucose monitoring may be a valuable tool in clinical practice during Ramadan avoiding multiple painful finger-pricks in addition to potential of unlimited monitoring times [78]. However, recent evidence highlights a high rate of asymptomatic hypoglycaemia, which is not detected by flash glucose monitoring [79] as compared to SMBG and for long duration even in people without T1DM; in addition to being expensive, these limitations of the flash glucose system monitoring cannot be ignored.

The use of glucose monitoring, adequate education and good glycaemic control prior to Ramadan are important strategies to achieve better glycaemic outcomes.

4.5. *When to break the Ramadan fast*

Despite serious health concerns, most Muslim people with T2DM may resist breaking their fast. Patients must be educated of the risks of fasting and the symptoms of hypoglycaemia, dehydration, and hyperglycaemia, and advised on the situations in which they must break their fast [59]. They should be advised to break their fast when they have symptoms of hypoglycaemia, hyperglycaemia, dehydration or acute illness occurs or when blood glucose level is < 70 mg/dL (<3.9 mmol/L) or exceeds > 300 mg/dL (16.6 mmol/L) [37]. If the patient is taking insulin or insulin secretagogues (e.g. sulphonylurea), they must be instructed to break the fast if the morning blood glucose is < 70 mg/dL (<3.9 mmol/L) at suhoor [80].

5. Managing T1DM

Fasting is contraindicated in people with poorly controlled T1DM, including patients with a history of severe hypoglycaemia and/or diabetic ketoacidosis at least 3 months before Ramadan [81], and guidelines recommend that people with T1DM (even well-controlled) should not fast [37,38,59,75,82]. Taking into account the risks of poor glycaemic control, people with T1DM, on a four times daily basal bolus regimen, must be discouraged from fasting during the month of Ramadan. Nevertheless, if patients still choose to fast, they should be made aware of carbohydrate counting. If capillary blood glucose level is ≤ 126 mg/dL (≤7 mmol/L), patients should be recommended a 20% decrease in background insulin [83], and indeed all patients will need to omit their lunchtime insulin altogether as they will not be eating lunch at all.

Muslim patients with uncontrolled T1DM who observe fasts during Ramadan experience an extensive variability in

glucose levels between fasting and eating hours, demonstrating a higher tendency for hyperglycaemia [33]. A recent systematic review and *meta*-analysis reported reduction in residual hypoglycaemia risk during Ramadan with appropriate patient selection in combination with intensive glucose monitoring and regular, supervised fine-tuning of basal insulin rates. In suboptimally-controlled young people with T1DM observing Ramadan fasts, treatment with continuous subcutaneous insulin infusion was found to be associated with reduced events of severe hypoglycaemia, hyperglycaemia and ketosis, but with an increased frequency of non-severe hypoglycaemia compared to those who did not receive the infusion [84].

A retrospective study found that patients on insulin pump could fast during Ramadan without incidences of severe hypoglycaemia or ketoacidosis by close blood glucose self-monitoring and weekly follow-up with their healthcare professionals [85].

6. Managing T2DM

Most guidelines and recommendations currently advocate that healthcare professionals should make patients aware about the potential risks and benefits of fasting. Pre-Ramadan risk assessment and medical counselling are essential to assist patients in their decision to fast. One such potential risk and an important management challenge during Ramadan is the occurrence of increased risk of hypoglycaemia.

6.1. *Nutrition & lifestyle*

The pre-Ramadan visit should include an assessment of patient nutrition wherein the healthcare professional should advise their people with diabetes about the essential dietary modifications to be adopted while fasting during Ramadan [37], as compared to other months of the year, dietary patterns for fasting Muslims are significantly modified [27]. Consuming large meals at iftar (>1500 calories or significant portions of highly processed carbohydrates and sugar) might result in severe and prolonged postprandial hyperglycaemia and weight gain. Eating suhoor early (specifically during longer fasting hours) could lead to hypoglycaemia before iftar. Therefore low glycaemic index foods should be encouraged, generally at all times, but especially during Ramadan. Moreover, consuming large amounts of high glycaemic index carbohydrates at suhoor can lead to postprandial hyperglycaemia [86,87]. There may be an increase in the consumption of fried foods with *trans*-fat margarine or oils rich in saturated fat. Changes in sleeping patterns and physical activity can alter metabolism and contribute towards weight gain [88].

The role of appropriate nutrition and lifestyle management is vital during Ramadan to achieve optimum diabetes control [59,67]. There is a need for an individualised nutrition plan for people with diabetes during Ramadan fasting.(Fig. 2) Dietary recommendations for those fasting during Ramadan should be personalised to the patients' age, lifestyle requirements and comorbidities [89,90]. The chief objectives of medical nutrition therapy during Ramadan fasting are to ascertain adequate calorie consumption (with balanced macronutrient proportions) during the non-fasting period in order to avoid hypoglycaemia during the fasting period, allocate equal amounts of carbohydrate among meals to minimalise postprandial hyperglycaemia, keeping in mind comorbidities like dyslipidaemia and hypertension [37].

For people with T2DM, appropriate nutrition during Ramadan fasting can help reduce severe hyperglycaemia (after each main meal), hypoglycaemia (particularly during the late period of fasting before iftar), electrolyte imbalance, dehydration (mainly in countries with hot climates and prolonged fasting hours), significant weight gain (due to reduced physical activity and increased caloric intake), and acute renal failure in individuals susceptible to severe dehydration (especially in patients with impaired kidney function and the elderly) [37,67].

There is a decline in the level of physical activity in individuals observing fasts during Ramadan, which tends to return to normal after the completion of the month. Prioritisation and adherence to socio-religious practices during Ramadan tend to result in changes in the normal routine thereby reducing the time for physical or recreational activities. On the other hand, general feelings of malaise, mood swings and lethargy during the daytime are related to Ramadan fasting, and are possibly the leading causes for decline and/or avoidance in participation of physical activities during this period [91]. The recent international, multicenter, prospective, observational Diabetes and Ramadan - Middle East and North Africa (DAR-MENA) study reported reduction in physical activity levels in 53% patients during Ramadan [30].

For people with T2DM fasting during Ramadan, performing exercises in the morning is better but should be avoided a couple of hours before iftar; blood sugars should be checked if unwell during or after exercise.

6.2. *All drug classes*

Blood glucose profile during Ramadan is characterised by important glycaemic excursions [76]. During Ramadan, glucose-lowering agents are generally taken either just before or after the main meal, and might contribute to iftar glucose excursions; moreover, hormonal changes could be another factor as a result of prolonged fasting. In certain cultures, iftar comprises of a small snack, followed by evening prayers, and is then succeeded with the main evening meal. Such a practice may perhaps be more suitable for those with diabetes taking their medications at iftar [34].

Since Muslim people with T2DM might still decide to fast during Ramadan, fasting must be made as safe as possible for this population. For healthcare professionals, this means lesser time and resources in treating complications of hypo- and hyperglycaemia, a safer alternative to accomplish glycaemic targets, and, eventually, cost reduction [92].

Individualisation of therapy is the best approach for the management of diabetes and minimise the risk of drug-induced hypoglycaemia and other undesirable effects during Ramadan. A statistically significant 0.3% mean HbA1c reduction was observed during Ramadan fasting in patients with

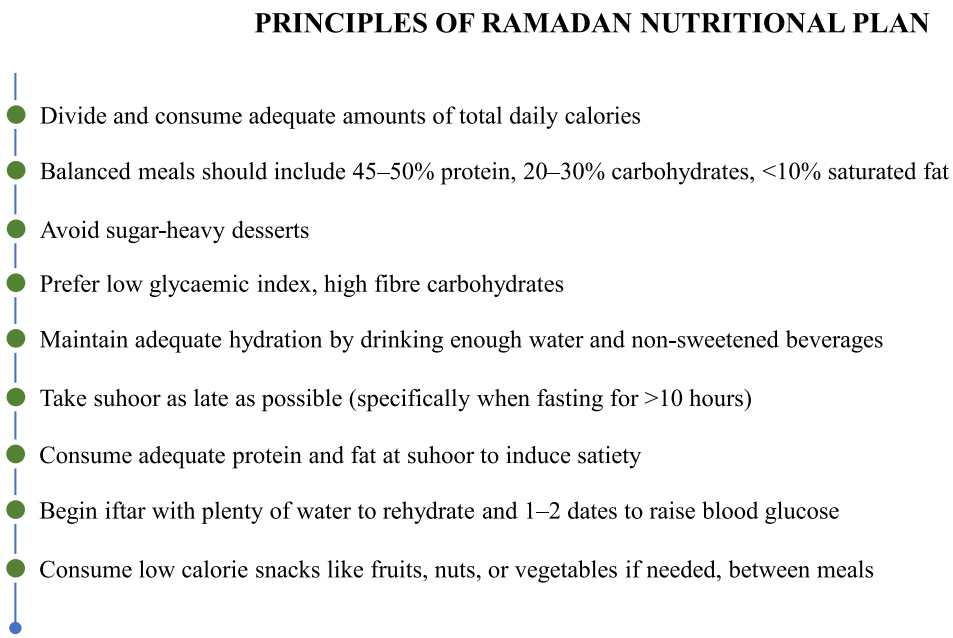


Fig. 2 – Principles of Ramadan Nutrition Plan.

dose adjustments to glucose-lowering agents made during Ramadan, although it was associated with a 25% rate of minor hypoglycaemia. It is worthwhile to note that this rate of hypoglycaemia was comparatively lower than in non-fasting people with T2DM [93].

6.2.1. *Metformin*

Metformin is universally recommended as the first-line glucose-lowering therapy. To date, there is a dearth of studies exploring the rate of hypoglycaemia during fasting with metformin alone. Nevertheless, the hypothetical risk of severe hypoglycaemia is low, as metformin enhances insulin sensitivity and not insulin secretion [59]. In well-controlled people with T2DM on oral glucose-lowering therapy especially metformin, the risk of fasting is very low and patients may safely fast in Ramadan [94].

We thereby recommend no dose modification for metformin during Ramadan fasting; the lunchtime dose should be taken at iftar.

6.2.2. *Sulphonylureas*

The mechanism of action of sulphonylureas involves stimulating insulin secretion, even at low blood glucose levels, resulting in an increased risk of hypoglycaemia [95].

The open-label, prospective, observational study, Glimepiride in Ramadan (GLIRA), examined the effect of the changes in nutritional habits and drug administration schedule during Ramadan on the control of T2DM in 332 patients (100 newly diagnosed and 232 already-treated with glimepiride). During Ramadan, 3% newly diagnosed patients and 3.7% already-treated patients reported hypoglycaemic episodes. The authors concluded that Muslim people with T2DM taking glimepiride (and normally well-controlled) can fast during Ramadan with careful dietary management and a change in the time of drug administration from morning to evening, without affecting glycaemic control [96].

Aravind SR and colleagues conducted a five-country observational study to evaluate the incidence of hypoglycaemia in sulphonylurea-treated (with or without metformin) Muslims with T2DM (n = 1397) who expressed their intention to fast during Ramadan. The highest incidence of symptomatic hypoglycaemia was noted in patients treated with glipizide (27.6%), followed by glibenclamide (25.6%), glimepiride (16.8%) and gliclazide (14.0%); 7% patients treated with glibenclamide had severe (episodes requiring non-medical or medical assistance) hypoglycaemia [97]. Another pilot, observational study conducted in well-controlled patients with T2DM (n = 17) reported an increase in the risk of hypoglycaemia with the addition of sulphonylurea during Ramadan [94].

We therefore recommend that long-acting sulphonylureas like glibenclamide should be avoided while fasting during Ramadan; second-generation sulphonylureas (glimepiride, gliclazide) can be used. Long-acting sulphonylureas, such as glibenclamide, are more likely to induce hypoglycaemia than their shorter-acting counterparts (glimepiride, gliclazide). Once-daily dose should be taken at iftar. In people with well-controlled glucose levels taking sulphonylurea twice-daily, the suhoor dose should be reduced while the iftar dose should remain the same.

In the Western hemisphere countries where the duration of fasting during summer months can be as long as 20 h, all sulphonylureas should be used with caution. Appropriate pre-Ramadan education should be given with regards to hypoglycaemia, when to break the fast and appropriate dose adjustments.

6.2.3. *DPP-4 inhibitors*

The advantage of treatment with DPP-4 inhibitors is their glucose-dependent effect of GLP-1 on insulin secretion and glucagon inhibition with minimal hypoglycaemia [98].

Real-world studies comparing vildagliptin and sulphonylureas (as monotherapy or as an add-on to metformin) have demonstrated treatment with vildagliptin to be associated with reduced HbA1c, lower incidence of hypoglycaemic events, good treatment adherence and no effect on body weight during Ramadan fasting. On the contrary, regardless of pre-Ramadan dose adjustments, there was a high incidence of hypoglycaemia, non-significant increase in HbA1c and weight, and poor adherence in those receiving sulphonylureas [92,99–103].

The STudy Evaluating vildAgliptin compareD to gliclazide in patients with T2DM FASTing during Ramadan (STEADFAST) conducted at 69 sites in 16 countries with 557 patients previously treated with metformin and any sulphonylurea to receive either vildagliptin (50 mg twice daily) or gliclazide (80–320 mg/day) plus metformin. The relative risk (vildagliptin vs. gliclazide) of patients with hypoglycaemic events during the Ramadan fasting period was 0.72 (95% CI, 0.38–1.36; p = 0.307) for any hypoglycaemic events and 0.46 (95% CI, 0.20–1.06; p = 0.059) for confirmed hypoglycaemic events; 3.0% patients in the vildagliptin group vs. 7.0% patients in the gliclazide group reported confirmed hypoglycaemic events (p = 0.039; one-sided test) [104].

Loh HH et al performed a systematic review and *meta*-analysis of studies comparing the use of DPP4 inhibitors against sulphonylureas among Muslim people (n = 4276) with T2DM who fast in Ramadan. In Ramadan, DPP4 inhibitors showed similar efficacy to sulphonylureas in reducing HbA1c levels and weight change. Compared to insulin secretagogue, patients on DPP4 inhibitors had a lower risk of hypoglycaemia; risk of symptomatic hypoglycaemia reduced by nearly 50% in those on DPP4 inhibitors, and that of severe hypoglycaemia by almost 80%. The authors advocated DPP4 inhibitors to be more suitable especially in patients at high risk of hypoglycaemia (including the elderly, those with renal impairment, erratic food intake or those with history of hypoglycaemia while on sulphonylureas) [105].

The Ramadan Study Group conducted an open-label, randomised trial to evaluate the incidence of hypoglycaemia in fasting Muslim people with T2DM (n = 1066) from six different countries, treated with sitagliptin or a sulphonylurea during Ramadan. There was a reduction by almost 50% in the risk of symptomatic hypoglycaemia with sitagliptin than sulphonylurea. Moreover, in the Per-Protocol analysis, there was a 67% reduction in the risk of symptomatic hypoglycaemia with sitagliptin [106]. In a multicenter, pragmatic, randomised study comparing the incidence of symptomatic hypoglycaemia between sitagliptin (n = 421) and sulphonylurea (n = 427) in Muslim people with T2DM who fasted during Ramadan, 848 patients were recruited from clinical centers in India and Malaysia. Compared to sulphonylurea, patients treated with sitagliptin had a 48% relative reduction in risk of symptomatic hypoglycaemia during fasting; total number of symptomatic hypoglycaemic events was lower in those on sitagliptin compared to those taking sulphonylurea [107]. The results from both the studies suggested switching antihyperglycaemic treatment from a sulphonylurea to sitagliptin to reduce the risk of symptomatic hypoglycaemia by nearly 50% for Muslim people with T2DM who fast during Ramadan [106,107].

Another study suggested change from sulphonylurea to DPP-4 inhibitor as an appropriate strategy in some patients, that could be commenced at the pre-Ramadan consultation [34]. Considering the low risk of hypoglycaemia with DPP-4 inhibitors, we recommend no dose modification in people with diabetes during Ramadan fasts.

6.2.4. *SGLT2 inhibitors*

SGLT2 inhibitors can be considered a vital therapeutic option to delay or prevent complications due to high risk of cardiovascular diseases as their cardiovascular safety and superiority are well recognized [108]. Lower risk of hypoglycaemia is a major advantage of SGLT2 inhibitors over older therapies such as certain sulphonylureas and insulin; additional advantages being reductions in weight and blood pressure. As an add-on to metformin, SGLT2 inhibitors are equally efficacious as sulphonylureas for glycaemic control establishing its role in initial dual therapy along with metformin especially during Ramadan fasts [109]. Unlike insulin secretagogues, which enhance insulin secretion, SGLT2 inhibitors decrease glucose reuptake in the proximal tubules in an insulin-independent manner without affecting the counter-regulatory mechanisms leading to a lower risk of hypoglycaemia [110].

Significant improvement in glycaemic control, minimal break in fasting and no significant change in the kidney function after Ramadan in high-risk people with T2DM were some of the benefits detected in a study that assessed its use along with insulin during Ramadan, using FGMS under optimal care [109].

The EPIDIAR and CREED studies, as well as others, have highlighted the most-encountered risks of fasting in people with diabetes. Dehydration during Ramadan is a greater concern in hot climates especially the Middle East, as well as with prolonged fasts. Ramadan also poses risks of hyperglycaemia and DKA due to change in habits such as intake of more sweet foods, late-night eating and elimination or adjustment of diabetes medications. Stable patients with no increased risk of dehydration, hypotension and with normal kidney function may safely continue using the SGLT2 inhibitors therapy [111]. The FDA Drug Safety Communication warns healthcare practitioners about the risk of ketoacidosis with SGLT2 inhibitors [112]. It may be prudent that higher risk patients be observed carefully and any decision concerning SGLT2 inhibitors is taken on an individual basis. Table 1 summarises the concerns and practical tips on the use of SGLT2 inhibitors during Ramadan fasting in people with T2DM.

The role of SGLT2 inhibitors in people with T2DM during Ramadan has been investigated in several studies. The Canagliflozin in Ramadan Tolerance Observational Study (CRATOS) study was conducted in the Middle East during Ramadan with fasting times of average 15 h/day and ambient temperature up to 50 °C. The adjusted OR was 0.273 (95% Wilson CI, 0.104–0.719; p = 0.009) for hypoglycaemic events and 3.5 (95% Wilson CI, 1.3–9.2; p = 0.011) for volume depletion events, indicating a lower risk of hypoglycaemia but a higher risk of volume depletion with canagliflozin compared to sulphonylureas; however, the volume depletion did not make patients uncomfortable enough to discontinue treatment or miss many fasting days. In fact, lower number of missed fasting days and no change in dose was noted in those treated with

Table 1 – Concerns and practical tips on the use of SGLT2 inhibitors during Ramadan fasting in people with T2DM.

Concerns	Practical tips
• Volume depletion (due to osmotic diuresis) • Dehydration (due to abstinence from fluid intake) • Hypotension • Euglycaemic diabetic ketoacidosis • Mycotic fungal genital infections	• Appropriate patient selection • Review the need and decide on continuation/resumption/discontinuation • Ensure absence of contraindications like severe renal impairment, end-stage renal disease, or dialysis • Consider temporary discontinuation in settings of reduced oral intake or fluid losses in patients with acute kidney injury and impairment in renal function • Monitor for hydration status (volume and colour of urine) and maintain adequate fluid intake • Monitor for hypotension, particularly in patients on loop diuretics, elderly patients, or patients with impaired renal function (eGFR < 60 mL/min/1.73 m^2) • Assess patients who present with signs and symptoms of metabolic acidosis for ketoacidosis • Evaluate patients for signs and symptoms of urinary tract infections and treat promptly, if indicated • Consider lowering the dose of insulin secretagogue or insulin to reduce the risk of hypoglycaemia • Avoid commencement of SGLT2 inhibitors less than one month before the start of Ramadan

canagliflozin [113]. Dapagliflozin administered in Muslim people fasting during Ramadan found a 76% relative risk reduction of hypoglycaemia compared to sulphonylurea. Additionally, a greater reduction in reported symptomatic hypoglycaemia, from 24.1% to 3.4%, was observed when patients were switched from sulphonylurea to dapagliflozin [110]. In the Malay-Muslim population in Singapore, patients receiving stable dose of SGLT2 inhibitors prior to Ramadan, there was no increase in the risk of ketonaemia, hypoglycaemia or dehydration with no significant change in plasma β-hydroxybutyrate level than those not on SGLT2 inhibitors during the period of fasting [114].

A physicians' survey found that majority felt SGLT2 inhibitors were generally appropriate and safe during Ramadan but should be discontinued in selected patients. Most respondents would advise taking an SGLT2 inhibitor with the iftar, while only a minority advised taking them before suhoor [115].

A healthcare practitioner-initiated proactive information sharing about the potential risk of volume depletion including advice on how to avoid such an event is essential with all patients taking SGLT2 inhibitors [113]. Such advice is especially important in patients with higher risk of volume depletion such as reduced renal function, elderly patients on diuretics or medications that interfere with the renin-angiotensin-aldosterone system and patients with low systolic blood pressure [116].

SGLT2 inhibitors have emerged as an important therapeutic option to delay or prevent cardiovascular and renal complications in people with T2DM. This class of glucose-lowering therapy are considered safe in people with T2DM who wish to fast during Ramadan on account of their low risk of hypoglycaemia. We advocate appropriate patient selection and no dose modification for SGLT2 inhibitors, however patients should either be switched to or established on a stable dose of SGLT2 inhibitors well in advance of Ramadan (4 weeks).

6.2.5. *Thiazolidinediones*

Thiazolidinediones are generally considered safe during Ramadan as they are not directly associated with hypoglycaemia, but may increase the risk caused by other glucose-lowering agents when used in combination, in addition to increasing appetite and causing unwanted weight gain [59].

A multicenter, double-blind, randomised controlled trial found pioglitazone, in combination with other glucose-lowering agents, to be safe and efficacious in lowering blood glucose during Ramadan fasting, with no significant difference in the number of hypoglycaemic events in both groups [117]. Nevertheless, since the glucose-lowering benefits of thiazolidinediones take nearly 2–4 weeks to come into effect, they are not a good alternative as an immediate pre-Ramadan switch [59].

We recommend no modification in dose of thiazolidinediones in people with T2DM who fast during Ramadan.

6.2.6. *GLP-1 receptor agonists*

GLP–1 receptor agonists are considered a relatively safe treatment regime during Ramadan, owing to their glucose-dependent mechanism of action and low hypoglycaemic profile [59]. The advantages of therapy with GLP-1 receptor agonists in Ramadan include good HbA1c reduction, good fasting and postprandial glycaemic control, low risk of hypoglycaemia, no risk of dehydration or infection, low injection frequency, increased satiety levels (resulting in reduced binge eating at night and avoidance of unnoticed nocturnal hyperglycaemia and unwanted weight gain), no requirement of frequent SMBG, and minimal dose titration [118]. However, being relatively novel therapies, there is limited evidence on their use in Ramadan [59].

The Treat 4 Ramadan and the LIRA-Ramadan Trials were conducted during Ramadan in people with T2DM. Liraglutide showed similar improvement in glycaemic control, fewer hypoglycaemic events and better body weight reduction compared to sulphonylurea. The results of both trials provided evidence towards liraglutide as a safe and effective treatment strategy for people with T2DM in Ramadan [119,120].

The recent LixiRam study was a phase IV, randomised, open-label, 12–22-week study in people with T2DM insufficiently controlled with sulphonylurea together with basal insulin and one oral glucose-lowering agent to assess the safety of lixisenatide, as an add-on to basal insulin, who intended to observe fasts during Ramadan. Those administered lixisenatide had fewer $\geq$ 1 documented symptomatic hypoglycaemia event (3.3% vs 8.9%; OR, 0.34; 95% CI, 0.09 to 1.35; proportion difference, −0.06; 95% CI, −0.13 to 0.01) than those on sulphonylurea; the difference was statistically significant for 'any hypoglycaemia' (lixisenatide + basal insulin [4.3%] vs. sulphonylurea + basal insulin [17.4%]; OR, 0.22; 95% CI, 0.07 to 0.68; proportion difference −0.13, 95% CI −0.22 to −0.04) [121].

GLP-1 receptor agonists have emerged as an important injectable therapy to delay or prevent cardiovascular and renal complications in people with T2DM, with added benefit of weight loss. Due to the additional advantage of low inherent risk of hypoglycaemia, we recommend no dose modifications of the drugs belonging to this class during Ramadan.

6.2.7. *Insulin*

The primary advantage of insulin preparations over other glucose-lowering agents is the dose-dependent reduction in glucose levels to almost any glycaemic target. Hypoglycaemia is the most important disadvantage, others being weight gain, need for injection, frequent titration for optimal efficacy and glucose monitoring. Basal insulin is the preferred initial insulin while short- and rapid-acting insulins (administered at mealtime) are generally used to intensify basal insulin therapy in patients not meeting glycaemic targets (see Table 2).

During Ramadan, considering the higher risks of hypoglycaemia, insulin doses must be adjusted and individualised (on the basis of baseline glycaemic control, diet, exercise, occupation and blood glucose monitoring) [59], particularly in the elderly population. Studies have been conducted assessing the use and safety of insulins in people with T2DM fasting in Ramadan.

During Ramadan, people with T2DM treated with insulin lispro Mix25 had significantly improved daily average glucose level along with better pre- and post-iftar blood glucose control than human insulin 30/70 [122]. The Ramadan Study Group conducted an open label, multi-centre, cluster ran-

Table 2 – Future research priorities.

- Impact on physiological parameters and occurrence of emergent complications.
- Effects of ethnicity and socioeconomic factors on various health parameters across geographical areas.
- Formulate culturally appropriate strategies on patient education.
- Impact of combined involvement of community leaders alongside healthcare professionals in patient care.
- Effects of glucose lowering therapies in continuous glucose monitoring-based studies.
- Real world evidence demonstrating the safety of SGLT2 inhibitors, GLP-1 receptor agonists, DPP-4 inhibitors and newer insulin analogs in larger patient populations with wider inclusion criteria.
- Studies demonstrating the safety of combination therapies.
- Patient satisfaction questionnaires.

domised study to evaluate the effect of addition of insulin detemir and biphasic insulin (soluble insulin aspart/protamine-crystallised insulin aspart in the ratio 70/30) (n = 127) versus standard care (premixed or intermediate-acting insulin twice daily) (n = 118) on glycaemic control and quality of life of Muslim people with T2DM during Ramadan fast. The authors reported non-inferiority of treatment between interventional and standard care groups (155 ± 30.7 6 mg/dL vs. 159 ± 33.24 mg/dL, 8.6 ± 1.7 mmol/L vs 8.3 ± 1.8 mmol/L); p = 0.269), but with fewer adverse events (0.04 ± 0.06 vs. 0.07 ± 0.11; p = 0.010) [123].

Hassanein M et al conducted a phase 3, multicentre, international, open-label, randomised, treat-to-target trial to analyse the efficacy and safety of insulin degludec/insulin aspart (n = 131) compared with biphasic insulin aspart 30 (n = 132) in people with T2DM fasting during the month of Ramadan. Despite achieving significantly lower pre-iftar plasma glucose (estimated treatment difference: –0.54 mmol/L; 95% CI, –1.02 to –0.07; p = 0.0247) with similar overall glycaemic efficacy, IDegAsp showed significantly lower overall and nocturnal hypoglycaemia rates compared to BIAsp 30 [124].

A recent study by Bashier et al and colleagues evaluated the impact of optimum diabetes care on the safety of fasting in Ramadan in adult people (n = 67) with T2DM on insulin therapy. The authors found no increased safety risks in patients treated with insulin when provided with Ramadan-focused education, flash glucose monitoring sensor before and during Ramadan and medical advice for treatment adjustment [125]. Another recent study showed better results in post main meal control during Ramadan when switching from human insulin mix 30:70 to analog insulin mix 50:50, without increasing the incidence of hypoglycaemia or affecting HbA1c [126].

The use of insulin pumps provides different type of boluses, variable basal rate and related calculators that assist educated patients to pre-programme a reduced basal rate throughout the day. This mode of delivery ascertains avoiding hypo- and hyperglycaemia and enhances confidence during fasting [77].

Owing to the higher risk of hypoglycaemia with insulins, we recommend individualising treatment in people with T2DM who fast during Ramadan. Basal insulin is the preferred initial formulation. For long acting insulins, the dose should be reduced by 20% and taken at iftar. The lunch dose of rapid-acting insulin should be omitted and the remaining two doses should be taken with meals at suhoor and iftar. In patients on mixed insulin, taking a higher dose of insulin in the morning and lower dose in the evening, the dosing should be switched during fasting so that the lower dose is taken at suhoor and the higher dose at iftar, in some cases, the higher dose may be reduced.

6.2.8. *Inter-class evidence*

The limited time-frame to conduct studies and difficulties in recruitment may lead to the scarcity of studies during Ramadan. A *meta*-analysis found that changes in drug class was one of the most common approach employed by healthcare professionals to reduce the risk of hypoglycaemia during Ramadan [127]. Newer class of drugs such as SGLT2 inhibitors and some GLP-1 receptor agonists have consistent atherosclerotic cardiovascular disease benefits and improve glycaemic control without an increased risk of hypoglycaemia offering favourable effects during fasting in Ramadan.

A systematic review and *meta*-analysis observed that the use of liraglutide was associated with a significant weight loss (-1.81 kg; 95% CI, −2.91 to −0.71; p = 0.001) compared to sulphonylureas while pioglitazone was associated with a significant weight gain compared to placebo (3.48 kg; 95% CI, 2.82 to 4.14; p < 0.0001) [128].

Although studies were few, DPP-4 inhibitors were associated with a lower incidence of hypoglycaemia compared to sulphonylureas [127]. Similar observations were made in another *meta*-analysis which noted that the DPP4 inhibitors (vildagliptin and sitagliptin), sulphonylureas (gliclazide and glimepiride), longer acting insulin analogues (glargine and detemir), as well as premixed insulin analogues were relatively safer with a lower risk of hypoglycaemia in fasting during Ramadan. Glibenclamide was associated with a higher risk of hypoglycaemia and should be avoided [129].

The recent DAR-MENA study did not find any major safety concerns in fasting during Ramadan in people with T2DM. The authors found a higher rate of confirmed hypoglycaemia during Ramadan in people receiving oral glucose-lowering drugs with sulphonylurea or insulin (with or without sulphonylurea), and not amongst those receiving oral glucose-lowering drugs without concomitant sulphonylurea therapy. In this study, patients taking all types of sulphonylureas were included; there were no subgroup analyses reporting the higher rate of hypoglycaemia with any specific sulphonylurea [30].

Another recent systematic review showed similar or better efficacy for glycaemic and weight control, and lower risk of hypoglycaemia with SGLT2 inhibitors, incretin mimetics and the newer insulin analogues compared to sulphonylurea (except gliclazide). In patients requiring insulin, the newer premixed insulin formulations were better than the previous insulin formulations, particularly at the time of breaking fast [6]. Among insulins, intermediate acting insulin preparations had a lower propensity to cause hypoglycaemia [127].

The recommendations of the South Asian Health Foundation (UK) Guidelines for glucose-lowering therapies for people with diabetes during Ramadan are elucidated in Fig. 1.

7. Barriers to guideline implementation

There are a number of barriers to guideline implementation across Muslim communities, and span across patients, healthcare professionals, healthcare systems to larger communities.

Guidelines should primarily be completely understood to facilitate implementation of practical responses. Many barriers may perhaps be overcome by providing comprehensive diabetes education to both patients as well as healthcare professionals. Integrating targeted education with improved communication, skills training, use of individualised care-plans, resource management and instituting support networks amongst health and services communities can promote the foundation for effective guideline implementation via robust patient-doctor relationships. Additional strategic

solutions to overcome such barriers include increasing awareness among healthcare professionals of the key issues involving management of diabetes during Ramadan, and offering effective, socio-culturally sensitive patient education. Moreover, technology can be significant in disseminating diabetes management advice and guideline recommendations [37].

The present guidelines from the South Asian Health Foundation (UK) are based on robust evidence derived from epidemiological and clinical trials. However, gaps still exist in the management of diabetes during Ramadan, which could be the focus for future research.

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