Ramadan Fasting and Diabetes (2022): The Year in Review

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Abstract

Objectives The literature on the impact of Ramadan fasting (RF) on metabolic control and health in people with diabetes is widely spread in many journals making it not readily accessible to those interested in the subject. We aimed to provide a narrative overview of the global literature production in 1 year (2022) on diabetes and RF.

Materials and Methods It is a narrative, non-systematic review of the international literature from a single major medical online database (i.e., PubMed) in one calendar year (2022). Relevant literature was narrated in a concise thematic account.

Results Themes emerged from the review of the literature on RF published in 2022, including a couple of studies on the epidemiology of fasting in the real world by adults and children. Three studies involved some pathophysiological observations of metabolic and other biochemical markers. Several studies assessed the use and safety of different pharmacological therapeutic agents. Certain sulfonylureas, such as modified-release gliclazide, were considered safer than other sulfonylureas. Newer basal insulin analogs were studied in different geographical and socioeconomic settings (Gulf vs. South East Asia). The role of diabetes technology in Ramadan was the focus of several studies of insulin pumps and monitoring. Special themes were high-risk groups, pregnancy, acute complications, postbariatric surgery, and COVID-19 in Ramadan. Few studies examined the safety of sodium-glucose co-transporter-2 inhibitors as a class and individually during RF. Professional and patient perspectives released in 2022 included updated guidelines for adults and adolescents.

Keywords

► Ramadan fasting
► diabetes
► hypoglycemia
► epidemiology
► diabetic ketoacidosis
► patient perspectives
► healthcare professionals

Conclusion In 2022's medical literature, RF and diabetes continue to address epidemiology, the burden of diabetes care on fasting patients, and discussions of concerns of patients and healthcare professionals. Risk stratification and issues of high-risk patients are still in focus for children, adolescents, and adults. Approaches to effective management still gather evidence for newer pharmacological agents and diabetes technology.

Introduction

Ramadan fasting (RF) is observed by millions of Muslims around the world. It lasts for 1 month per the lunar calendar. RF entails abstinence from food, water, all oral substances, intravenous fluid therapy, and smoking between dawn and sunset.[1] Ramadan's impact on health and disease stems from the physiological effects of prolonged fasting during the daytime and possible overfeeding at night and its various social changes, such as changes in exercise and sleep patterns. The last three decades witnessed a rising interest in the research on RF in health and disease.[2] Diabetes is the most extensively studied single medical condition in connection with RF.[2,3]

Here, we provide a thematic overview of the global research work conducted during 2022 on the impact of RF on people with diabetes. We aimed to provide a concise bird's eye view of the literature published in a year. This may help catch up with the year's research production.

Materials and Methods

This is a narrative, nonsystematic review of the literature retrieved from one online database over a full calendar year (2022). The PubMed search engine of the National Center for Biotechnology Information (NCBI) at the US National Library of Medicine (NLM) was used. The search term ["Ramadan fasting" AND diabetes], with time filters from 1/1/2022 to 31/12/2022], was used to identify the relevant records. Seventy-two records were retrieved and examined for relevance, reviewed, and narrated thematically. Full-text research articles in English were included. No statistical analysis was conducted on the data included in the original articles, and detailed numerical presentations were avoided. Original articles, systematic reviews, and meta-analyses guidelines were included, but short narratives and statements were not included. The aim is to provide a concise but adequately representative theme surrounding RF.

Results

The various themes that emerged from the literature review are listed in ►**Table 1**. The results are presented following the same thematic flow.

Epidemiology

Two studies examined the demographic and clinical characteristics of people with diabetes who observe fasting during Ramadan in different age groups and geographical locations. A total of 485 outpatients with type 1 diabetes mellitus (T1DM) or type 2 diabetes mellitus (T2DM), followed at a university hospital in Algiers, Algeria, in 2021, were included in the study.[4] Just over half were females; 88.2% had T2DM, the mean age was 59.8 years, and the mean of diabetes duration was 12.8 years. Participants fasted a mean of 20.5 days (T1DM: 6.3 T2DM: 22.3). A feeling of well-being and religious convictions were the dominant fasting decision-making factors in people with a high-risk score. There was an increase in dietary and sugar intakes in 21.6 and 42.3% of the population, respectively, a reduction in sleep duration in 34.5%, and a lack of medical adjustment in most participants. The International Diabetes Federation and Diabetes and Ramadan (IDF-DAR) risk score was significantly lower in the nonfasting group than in the fasting group in the general population and within the high-risk category. No difference in the frequency of acute diabetes-related complications was found. People with diabetes who fast during Ramadan tend to be younger, predominantly males, and with a shorter diabetes duration compared with non-fasting people. The risk score remained

Table 1 Themes emerged from a review of the literature on Ramadan fasting published in 2022

Epidemiology of diabetes during Ramadan fasting in adults and children
Some observational studies on pathophysiological changes during Ramadan
The efficacy and safety of various pharmacological agents during: sulfonylureas, insulins, SGLT2 inhibitors)
The use of diabetes technology for management and monitoring of diabetes during Ramadan fasting
Diabetes and RF in special groups: (high-risk groups, pregnancy, acute complications, postbariatric surgery)
The impact of the interplay of Ramadan fasting and the COVID-19 pandemic on diabetes management and control
Professional and patients perspectives: (guidelines, professional perspectives; patients perspectives)

Abbreviations: COVID-19, coronavirus disease 2019; RF, Ramadan fasting; SGLT2, sodium-glucose co-transporter-2.

significantly higher in nonfasting participants compared with fasting participants within the same high-risk category. The authors concluded that acute diabetes-related complications do not appear to be more frequent in the fasting population. On the other hand, many children and adolescents choose to fast despite the exemption. In a real-world setting, glycemic control of children and adolescents with T1DM was compared between multiple daily injections (MDI) versus continuous subcutaneous insulin infusion (CSII) outcomes in the context of RF.[5] Children and adolescents with T1DM who decided to fast during Ramadan were enrolled in the CHOICE (carbohydrate, insulin, and collaborative education) educational program. Forty-two patients (age 13.5 years; 27 [64.3%] males; T1DM duration 4.9 years) fasted for 22 days; 23 patients were on MDI, and 19 were on CSII. No significant differences were seen in continuous glucose monitoring (CGM)/flash glucose monitoring (FGM) generated mean blood glucose levels before, during, and after Ramadan. Glycosylated hemoglobin A1c (HbA1c) and weight after Ramadan did not change significantly compared with baseline. Also, there was no significant difference between MDI and CSII groups in fasting days, frequency of hypoglycemia episodes, diabetic ketoacidosis (DKA) frequency, HbA1c level, and weight after Ramadan. Data showed no significant deterioration in indicators of overall glycemic control, which remained inadequate.

Pathophysiology

Three studies were published in 2022 on the pathophysiological changes during RF. The first was a prospective study including 55 T2DM patients on oral antidiabetic drugs who intended to observe RF in 2019.[6] All participants were evaluated before (T0), immediately after (T1), and 2 months after Ramadan (T2). Participants' mean age was 54.5 years, and the number of fasted days was 29.3 days. The mean daily calorie intake decreased significantly by 19% during Ramadan. A significant decrease in weight, waist circumference, and fat body mass was observed at T1. The weight loss correlated significantly with the number of fasting days and was maintained at T2. Serum fructosamine increased at T1 and returned to its baseline levels at T2. A significant decrease in insulin, fibrinogen, and high sensitivity C-reactive protein levels was observed at T1. Homocysteine level was significantly higher after Ramadan. However, no significant changes were found in blood pressure, fasting blood glucose, HOMA-IR, uric acid, lipids, and white blood cells count. The mean Framingham score decreased insignificantly after Ramadan. The second study addressed the postprandial hyperglycemia commonly observed after iftar.[7] They investigated whether D-allulose (a C-3 epimer of D-fructose), a rare sugar reported to have several health benefits, improves postprandial glucose in patients with T2DM during RF. They compared glucose levels at 5 days of control and 5 days of consumption. The primary outcome was postprandial peak glucose levels. During the consumption period, 8.5 g of D-allulose was consumed by the participants before the iftar meal. Postprandial glucose was measured using a CGM system. A total

of 12 participants completed the study. There were significantly lower postprandial glucose values. The study suggests that supplementation with D-allulose can potentially improve postprandial hyperglycemia in patients with T2DM after iftar. The third study determined the Haptoglobin (Hp) phenotype in RF.[8] Hp is a recognized multifaceted marker of inflammation that mediates the interplay between obesity, inflammation, and cardiometabolic dysfunction. One hundred fourteen subjects (aged 38.7 years, body mass index (BMI) 30.41 kg/m^2) were included. Hp2–2 and Hp2–1 were the predominant phenotypes (48.2 and 46.5%), respectively. Significant reductions were observed in serum Hp, interleukin-6 (IL-6), tumor necrosis factor-alpha (TNF-α), triglycerides (TG), total cholesterol (TC), low-density lipoprotein (LDL), BMI, and fat mass (FM), and a significant elevation was observed in serum CD163, high-density lipoprotein (HDL), and IL-10 at the end of Ramadan in the whole population. Furthermore, significant decreases in Hp, BMI, FM, TG, LDL, and TNF-α, with significant increases in HDL and CD163 levels, were observed among subjects with Hp2–2 and Hp2–1 phenotypes. A more pronounced reduction in FM was reported in subjects with Hp2–2 compared with Hp2–1.

Lifestyle Management

Three articles addressing different aspects of lifestyle management and patient education were published in 2022. The impact of virtual "pre-Ramadan" visits, used as an alternative option to the traditional (in-person) visits, on fasting experience and glycemic control during Ramadan was evaluated in 151 patients with T1DM.[9] The patients were categorized into three groups according to the type of "pre-Ramadan" visit that they attended in 2020: virtual ($n = 50$), in-person ($n = 56$), and no visit ($n = 45$). Patients who had a virtual "pre-Ramadan" visit were more likely to use CGM than those who had no visit (61.7 and 38.6%, respectively, $p < 0.05$). Attending a virtual "pre-Ramadan" visit was associated with the least number of days fast was broken compared with those who had no visit ($p < 0.01$) or in-person visit ($p = 0.02$). After adjusting for age, gender, pre-Ramadan A1c, and CGM use, the odds of fasting most days of Ramadan were highest in the virtual group (odds ratio [OR] 9.13) followed by the in-person group (OR: 3.02) compared with the no-visit group. Virtual "pre-Ramadan" visits are an effective alternative to in-person visits when managing people with T1DM who plan to fast during Ramadan. In another study, the practice of Muslims with diabetes mellitus in Singapore who intend to fast during Ramadan was assessed with particular attention to locally available evidence.[10] Adequate preparation for RF, including pre-Ramadan assessment, optimization of glycemic control, structured Ramadan-focused diabetes education, medication adjustment, glucose monitoring, and test fasting, can lead to improvements in metabolic control and reduced risk of fasting-related complications in people with diabetes mellitus. While there are ongoing efforts to reduce risk during this period, larger-scale national programs are needed to avert complications and assess the long-term effects of RF on the local population. Finally, a systematic

Table 2 Summary of the studies on the efficacy and safety of different pharmacological agents during Ramadan

Author (region) (ref)	Drugs	Acronym, setting and design	Conclusion
Soelistijo et al (Indonesia)[12]	Gliclazide-modified release	DIA-RAMADAN (a prospective observational study	Gliclazide MR is safe, well tolerated, and can maintain glycemic control effectively for Indonesian patients with T2DM who perform RF
Hassanein et al (UAE)[13]	Insulin Gla-300	The ORION study; South East Asian subgroup analysis	Gla-300 is effective, with a low risk of hypoglycemia, for managing T2DM during Ramadan in the South Asian and Arabian Gulf populations
Malik et al (Qatar)[14]		The ORION study; Gulf subgroup analysis	
Yousuf and Ahmedani (Pakistan)[15]	Empagliflozin versus SU and DPP-4Is.	Prospective observational study; 116 patients	Empagliflozin is safe and effective in fasting people with T2DM
Sheikh et al (Pakistan)[16]	63% on empagliflozin; 37% on dapagliflozin	Prospective, observational, controlled cohort study at Aga Khan University Hospital, (2021)	Safety of SGLT2i agents during Ramadan in the Pakistani population is established, recommending it as a treatment option in adults with T2DM, without any additional adverse events
Ahmed et al[17]	Empagliflozin with metformin (44) versus sitagliptin and metformin (88)	A multicenter prospective, observational study Pakistan (2021)	SGLT-2 inhibitors combined with metformin for patients with diabetes during Ramadan fasting is as effective, safe and well tolerated as DPP-4 combined with metformin
Goh et al (Malaysia)[18]	Empagliflozin	A prospective cohort study; single center	Empagliflozin use is safe and not associated with an increased risk; therefore, it is a viable option for T2DM care planning for RF
Pathan et al (Bangladesh)[19]	(Empagliflozin + metformin) $+/-$ DPP-4 inhibitor ($n = 274$) versus metformin $+/-$ DPP-4 inhibitor ($n = 219$)	Multicenter, open-label, two-arm parallel-group study (24 weeks)	Empagliflozin is efficacious and safe for treating adults with T2DM during Ramadan
Gameil et al (Egypt)[20]	Empagliflozin (87) or dapagliflozin (85) versus controls (73)	An observational noninterventional study, Mansoura University	Significant clinical and biochemical markers of dehydration were noticed among users of SGLT2i during the Holy Ramadan

Abbreviations: DPP-4, dipeptidyl peptidase inhibitor 4; MR, modified-release; RF, Ramadan fasting; SGLT2i, sodium-glucose cotransporter-2 inhibitors; SU, sulfonylurea; T1DM, type 1 diabetes mellitus; T2DM, type 2 diabetes mellitus.

review and meta-analysis of the literature aimed to determine the safety and efficacy of different classes of drugs and the importance of structured education during Ramadan.[11] Thirty-two articles were included in the review, and seven studies were for meta-analysis. Most studies demonstrated the importance of structured education as a group or a one-on-one session with healthcare professionals (HCPs) to prevent diabetes-related risks during Ramadan and suggested that structured education and counseling by HCP can effectively prevent complications associated with RF in people with T2DM.

Pharmacological Therapy

Several studies assessed the use and safety of different pharmacological agents during Ramadan. These included nine original research articles and three systematic reviews

and meta-analyses. The original research covered certain sulfonylureas such as modified-release (MR), newer basal insulin analogs, sodium-glucose co-transporter-2 inhibitors (SGLT2is; ►**Table 2**), and the systematic reviews addressed SGLT2is, insulins, and the safety of antidiabetic drugs during RF at large.

Research Studies

Sulfonylureas (SUs) have been widely used in many countries for T2DM treatment. Gliclazide is one of the SUs with the lowest risk of hypoglycemia; however, the safety and effectiveness of gliclazide MR during Ramadan have not yet been reported in Indonesia. The study evaluated the safety, efficacy, and tolerability of gliclazide-MR during RF by analyzing data from the DIA-RAMADAN study.[12] Subjects had been treated with gliclazide MR for at least 90 days prior to the

study. They were examined for their BMI, fasting plasma glucose (FPG), and HbA1c levels 6 to 8 weeks before Ramadan (V0) and 4 to 6 weeks after the end of Ramadan (V1). Out of 198 subjects participating in the study, only two subjects (1.0%) reported symptomatic HEs (either confirmed or not confirmed), and no severe HEs had been reported. There were no significant changes in HbA1c and FPG levels ($p > 0.05$). Interestingly, there was a reduction in body weight (-0.4kg) from pre- to post-Ramadan ($p < 0.001$). Almost no subjects reported discontinuation of gliclazide MR throughout the study; however, one subject reported a change of diabetic treatment to diet only.

The ORION study was a real-world, prospective, observational, noncomparative study conducted across 11 countries in people with T2DM treated with Gla-300 during pre-Ramadan, Ramadan, and post-Ramadan periods. The primary endpoint was the percentage of participants experiencing more than or equal to 1 event of severe and/or symptomatic documented hypoglycemia with self-monitored plasma glucose (SMPG) less than or equal to 70 mg/dL during Ramadan. Secondary endpoints were changes in HbA1c, FPG, SMPG, insulin dose, and adverse events (AEs). In 2022, two subgroup analyses of the ORION study were published.[13,14] The first subgroup analysis included participants from the South Asia region (India and Pakistan).[13] It included 106 participants with a mean age of 51.3 years and a mean number of 29.8 fasting days. The number of severe and/or symptomatic documented hypoglycemia events was low in the pre-Ramadan (SMPG ≤ 70 mg/dL: 1 event [0.9%]; SMPG < 54 mg/dL: 1 event [0.9%]) and Ramadan periods (SMPG ≤ 70 mg/dL: 1 event [0.9%]; SMPG < 54 mg/dL: 0 events), and none in the post-Ramadan period. One participant reported severe hypoglycemia (any time of the day) throughout the pre-Ramadan period. A reduction in HbA1c and FPG levels was seen during the pre- to post-Ramadan period; however, a slight increase in SMPG levels was reported during this same period. Gla-300 daily dose was reduced from 21.6 to 20.2 U from pre-Ramadan to Ramadan. The incidence of AEs was 1.9%. The second subgroup analysis included 222 participants from the Gulf region (Kuwait, Saudi Arabia, UAE, and Qatar).[14] The primary endpoint was reported in one (0.5%) participant. The incidence rate of symptomatic documented hypoglycemia (SMPG ≤ 70 mg/dL) decreased from the pre-Ramadan (3.2%) to the Ramadan period (0.5%). No severe hypoglycemia events were reported during the study. Reductions were observed in HbA1c (0.51%), FPG (13.9 mg/dL), and SMPG (6.1 mg/dL). No significant changes were observed in body weight or the Gla-300 dose. AEs were reported in 11 (5.0%) participants.

SGLT2is are considered safe with a low risk of hypoglycemia. Several research studies on the subject were published in 2022.[15–20] In one study, the efficacy and safety of empagliflozin in people with T2DM during RF were determined.[15] People with T2DM who took empagliflozin and sulfonylurea with or without metformin and dipeptidyl peptidase inhibitors (DPP-4) were recruited a month before Ramadan. HbA1c and estimated glomerular filtration rate (eGFR) were recorded pre- and post-Ramadan. The partic-

ipants were given a predesigned diary to track their glycemic status during Ramadan. The proportion of the people who had hypoglycemia or any AE related to the study drug was assessed after Ramadan. A total of 116 participants completed the study. Symptomatic episodes of hypoglycemia were increased among people who used sulfonylurea. Genitourinary infections and volume depletion events were recorded more in people on empagliflozin. A significant reduction in BMI and HbA1c was noted among people on empagliflozin post-Ramadan. A significant reduction in eGFR was noted only in people taking empagliflozin in combination with metformin. Another study examined the safety and efficacy of SGLT2-i in patients with T2DM in a real-life setting during Ramadan.[16] Of the 102 participants recruited, 82 completed the study. Most (52%) were males, with a mean age of 52.2 years and an average duration of T2DM of 11.2 years. Six documented symptoms of hypoglycemia. However, no episode of severe hypoglycemia, hyperglycemia, dehydration, DKA, hospitalization, or discontinuation of SGLT2i was reported. HbA1c and body weight changes were insignificant, whereas eGFR decreased minimally (mean: 94–88, $p < 0.001$). Another study compared the efficacy and safety of empagliflozin with sitagliptin during Ramadan (2021).[17] The study included 132 patients, 88 on metformin and sitagliptin, and 44 on metformin and empagliflozin. Patients of the SGLT-2i group experienced similar symptomatic hypoglycemic episodes (15.9%) as the sitagliptin group. There was an improvement in body weight, blood glucose levels, and HbA1c after Ramadan on SGLT-2i compared with sitagliptin. There were no cases of urinary tract infection in the empagliflozin group. Three studies reported on the differences in outcomes of T2DM fasting patients on empagliflozin compared with those not on the drug.[18] In the first study, the empagliflozin group was on the study drug for at least 3 months. For the control group, subjects not receiving SGLT2 inhibitors were recruited. They recruited a total of 98 subjects. Baseline anthropometry, blood pressure, and renal parameters were similar in the two groups. No significant changes in blood pressure, weight, urea, creatinine, eGFR, or Hb levels during Ramadan were found in either group. Likewise, no difference was detected in blood ketone levels (empagliflozin vs. control, 0.17 mmol/L vs. 0.13 mmol/L, $p = 0.304$) or hypoglycemia indices (empagliflozin vs. control, 19.1 vs. 16%, $p = 0.684$). RF resulted in weight loss and reduced eGFR levels in patients with T2DM. The second investigated the efficacy and safety of empagliflozin in patients with T2DM while fasting during Ramadan in a 24 weeks, multicenter, open-label, two-arm parallel-group study.[19] HbA1c reduction was significant in the empagliflozin arm (-0.49% vs. -0.12%); [$p < 0.001$]). Significant weight reduction was seen in the Empagliflozin arm (1.4 vs. 0.09 kg; $p < 0.001$). There was no significant increase in hypoglycemia or volume depletion in either arm. There was no need for hospital admission. There was no report of serious AEs, discontinuation, or reduction in prescribed doses of empagliflozin during Ramadan. Finally, the hydration status was assessed in adult Muslims with T2DM who

used SGLT2i during Ramadan.[20] Participants in each group were well-settled on their medications for more than 3 months before the onset of Ramadan. They noticed a higher prevalence of orthostatic dizziness and postural hypotension among SGLT2i users than non-SGLT2i users. The mean arterial blood pressure decreased significantly among users of SGLT2i than non-SGLT2i users. Moreover, patients who used SGLT2id exhibited significantly higher values of urine specific gravity, serum osmolality, and blood urea nitrogen/creatinine ratio than non-SGLT2i users.

Systematic Reviews

Three systematic reviews were published on SGLT-2is and insulin therapy. The first evaluated the effects of RF on patients with T2DM treated with SGLT-2i.[21] A total of five studies were included in this meta-analysis. During Ramadan, there was a significant reduction in glycated Hb ($p < 0.00001$) and diastolic blood pressure ($p = 0.006$), with a non-significant trend for a weight reduction ($p = 0.44$) and systolic blood pressure ($p = 0.67$). The number and severity of hypoglycemic episodes were lower in patients with T2DM treated with SGLT-2i compared with SUs. There was no significant change in the eGFR, β-hydroxybutyrate, bicarbonate, or anion gap. However, they identified considerable heterogeneity among studies and a lack of head-to-head studies with structured outcome reporting on the risks and benefits of SGLT-2i during Ramadan. The study showed that patients with T2DM treated with SGLT2i's during Ramadan have an improvement in HbA1c, less hypoglycemia, and no major adverse effects. The second evaluated whether insulin dosing recommendations will likely reduce hypoglycemic events and improve glycemic control during RF for this high-risk group.[22] A comprehensive search was performed for studies assessing which types of insulin and/or dosing recommendations reduce hypoglycemic events and improve glycemic control during Ramadan. They excluded studies focusing mainly on oral antihyperglycemic medications, T1DM, persons with insulin pumps, and studies older than 20 years. Hypoglycemic event rates, pre- and post-iftar blood glucose levels, overall average blood glucose, and HbA1c were analyzed, and a narrative synthesis was performed. Out of 1,101 collected articles, 14 eligible studies, including 2,969 participants with an average age of 54.8 years, found that insulin dose reduction may prevent hypoglycemia without causing subsequent hyperglycemia. Rapid-acting insulin analogs may improve post-iftar and overall blood glucose without incurring hypoglycemia. Finally, a systematic review and meta-analysis aimed to determine the safety and efficacy of different classes of drugs[11] in T2DM patients who fast during Ramadan. The newer class of glucose-lowering agents appears to lower the risk of hypoglycemia compared with sulfonylureas, while gliclazide is relatively safe among sulfonylureas. The meta-analysis indicates that DPP-4 inhibitors would significantly reduce the risk of hypoglycemia compared with sulfonylurea (OR = 0.38; $p < 0.00001$). The review suggested that the safest class of oral glucose (OG)-lowering drugs preferred during RF in T2DM patients is DPP-4 inhibitors.

Diabetes Technology in Ramadan

There was a large interest in studies involving technology during Ramadan fasting.[9,23–29] These studies are summarized in ►Table 3. The highlights of these studies are discussed briefly below.

Validated glycemic data from people with T1DM who observed fasting during Ramadan in 2019 and 2020 using automated insulin dosing systems were reviewed and analyzed.[23] Six profiles met the inclusion criteria. The average age was 33.7 years, diabetes duration was 23.5 years, BMI was 23.6 kg/m^2, and glycated Hb was 6.3%. The average glucose during Ramadan was 7.0 mmol/L, coefficient of variation was 28.5%. The percentage of time in the range (TIR) of 3.9 to 10 mmol/L was 88.8%, and the percentage of time less than 3.9 mmol/L was 2.5%. The number of fasting days was 27.3, and the number of days where fasting was broken due to diabetes was one per participant. No significant differences in glycemic outcomes were noted between Ramadan and non-Ramadan periods. The efficacy of self-administered subcutaneous mini-dose glucagon (MDG) to treat fasting-induced hypoglycemia in T1DM was evaluated in a 4-week randomized, controlled crossover trial of 2-week MDG or 2-week OG tablets (control) involving 17 adults with T1DM during Ramadan.[24] Compared with OG, MDG demonstrated a significantly greater change in blood glucose from baseline to 30 minute ($\Delta\Delta t30$, $p < 0.001$) and 1 hour ($\Delta\Delta t60$, $p = 0.02$). The efficacy of MDG was preserved following more than or equal to 8 hour fasting with significantly higher $\Delta\Delta t30$ in MDG ($p = 0.01$). Over the entire 2 weeks, the MDG period had increased time in 70 to 180 mg/dL ($p = 0.009$) and less time less than 70 mg/dL ($p = 0.04$). MDG use resulted in faster fast food completion than OG ($p < 0.001$). The impact of RF on ambulatory glucose profile among patients with T1DM was evaluated using an FGM system.[25] A comparative study of 87 patients with T1DM was included, whose health status permitted them to fast, based on the risk stratification. Besides the demographic data, other data connected with the glycemic profile, such as the mean TIR, mean time above range (TAR), mean time below range (TBR), mean glucose level, HbA1c, glucose variability (GV), and glucose monitoring indicator (GMI %), were recorded at three specific periods; namely, pre- (prior to), during and post-Ramadan. The mean age of the study population was 21.3 years, and 52.9% of this population was female. Compared with the pre-Ramadan data, no significant alterations ($p > 0.05$) were noted in terms of the low glucose events, percentage of glucose level below 70 mg/dL, the average duration of hypoglycemic events, and percentage of glucose level below 54 mg/dL, from the values observed during and post-Ramadan. In comparison with the pre-Ramadan data, no significant changes appeared ($p > 0.05$) concerning the GV, average glucose, GMI, percentage within target, TAR (181–250 mg/dL), and percentage >250 mg/dL, for the periods during and post-Ramadan, except scanning of FreeStyle Libre ($p = 0.042$) during Ramadan month compared with pre-Ramadan. CGM has been increasingly used in recent years to evaluate glycemic control and variability in individuals with diabetes observing RF.

Table 3 Summary of studies on the use of technology in managing diabetes during Ramadan published in 2022

Authors, region (Ref)	Aims	Technology	Conclusion
Aldibbiat et al (Kuwait, UAE, KSA)[23]	Review and analysis of glycemic data from people with T1DM who observed RF (2019 & 2020)	Automated insulin dosing systems	Automated insulin dosing systems showed a safe and effective management strategy of RF in T1DM
Algeffari et al (KSA)[24]	Treatment for hypoglycemia in T1DM during RF	Home use of MDG versus oral glucose	MDG is effective for preventing and treating hypoglycemia
Al Hayek et al (KSA)[25]	Evaluating the impact of RF on AGP among patients with T1DM	A comparative study to evaluate the impact of RF on AGP in T1DM using FGMS	RF was achievable in T1DM patients with adequate counseling and support
Hasbullah et al (Malaysia, Switzerland, USA)[26]	Effects of structured RNP on glycemic control and variability	Continuous glucose monitoring in individuals with T2DM	Utilizing CGM to monitor glycemic excursions during RF is important
Elbarbary and Ismail (Egypt)[27]	Glycemic control during RF in adolescents and young adults with T1DM	MiniMed 780G advanced hybrid closed-loop system	Glycemic targets during RF achieved by reducing hypoglycemia without compromising safety with minimal user input
Teoh et al (Malaysia)[28]	Comparison of glycemic changes using CGM metrics among 32 children and adolescents with T1DM before and during RF	CGM iPro2 (Medtronic) complemented by SMBG	T1DM youths can fast safely with the provision of focused education and regular SMBG
Motaib et al (Morocco)[29]	Predicting poor glycemic control during Ramadan among non-fasting patients with diabetes	Artificial intelligence-based machine learning models	Thresholds for each predicting factor for poor glycemic control were proposed

Abbreviations: AGP, ambulatory glucose profile; CGM, continuous glucose monitoring; FGMS, flash glucose monitoring system; MDG, mini-dose glucagon; OG, oral glucose; RF, Ramadan fasting; RNP, Ramadan Nutrition Plan; SMBG, self-monitoring of blood glucose; T1DM, type 1 diabetes mellitus; T2DM, type 2 diabetes mellitus.

However, the effectiveness of the Ramadan Nutrition Plan (RNP) in individuals with T2DM using CGM-derived measures has yet to be investigated. As mentioned above, CGM was employed to evaluate the effects of structured RNP versus standard care in individuals with T2DM.[26] Regarding technology, participants wore CGM 5 days before Ramadan and during Ramadan. CGM-derived measures of glycemic variability were calculated using Glyculator version 2.0. CGM data showed the sRNT group had significantly lower average sensor glucose, peak sensor value, estimated A1c, percentage, and duration of TAR, J-index, mean amplitude of glycemic excursion, and continuous overall net glycemic action, and a significantly higher percentage of TIR. The structured RNP significantly improved clinical outcomes, glycemic control, and variability in individuals with T2DM. MiniMedTM 780G is the most advanced insulin pump system approved for treating T1DM. Hypoglycemic events are a serious complication associated with T1DM management during RF. A prospective study assessed the safety, effectiveness, and optimization of an advanced hybrid closed loop (AHCL) system on glycemic metrics and the level of hypoglycemia in T1DM patients who wished to fast Ramadan.[27] Forty-two T1DM patients (mean age 15.2 years) using the AHCL system were divided into two groups (each $n = 21$): the intervention group who adjusted AHCL settings and the control group who kept the same settings as before Ramadan. The most aggressive system settings among the control group consisting of a 100 mg/dL glucose target, active insulin time of 2 hour, and bolus increment maintained exceptional glycemia with TIR reaching 82.0%, TAR more than 180 mg/dL of 12.1% without an increase in hypoglycemia (TBR 3.0%), all of which were nonsignificant in comparison to the intervention group. Overall time spent in closed loop (SmartGuard) by users averaged 98.7% in auto mode and involved only 1.0 exits per week, indicating confidence in the system's performance. There were no severe hypoglycemic or DKA events during the study. As discussed above, the CGM was utilized to examine virtual "pre-Ramadan" visits, as an alternative option to the traditional (in-person) visits, on fasting experience and glycemic control during Ramadan in people with T1DM.[9] CGM metrics were retrospectively compared across the groups. Patients who had a virtual "pre-Ramadan" visit were more likely to use CGM than those who had no visit (61.7 and 38.6%, respectively, $p < 0.05$). CGM TIR during Ramadan was the highest in those who had virtual "Pre-Ramadan" visits compared with those who had no visit or in-person visits (59, 44, and 47%, respectively). CGM was used to study glycemic changes among 32 children and adolescents with T1DM before and during RF.[28] The study was conducted in two tertiary centers in Malaysia (May 2020). Patients were given Ramadan-focused education. CGM iPro2 (Medtronic) was used before and during Ramadan, complemented by

self-monitoring of blood glucose (SMBG). The majority (91.7%) were on MDI, while only 8.3% were on CSII. All fasted in Ramadan without acute complications. Retrospective CGM analysis revealed similar results in TIR, time in hyperglycemia, and time in hypoglycemia before and during Ramadan, indicating no increased hypoglycemic or hyperglycemic events related to fasting. Glycemic variability before Ramadan, as measured by the low blood glucose index (LBGI), high blood glucose index (HBGI), and mean average glucose (MAG), was similar to values during Ramadan. Machine learning models were used to predict poor glycemic control during Ramadan among non-fasting patients with diabetes.[29] First, they conducted three consultations, before, during, and after Ramadan, to assess demographics, diabetes history, caloric intake, and anthropometric and metabolic parameters. Second, machine learning techniques were trained using the data to predict poor glycemic control among patients. Then, they conducted several simulations with the best-performing machine learning model using variables that were found as main predictors of poor glycemic control. The prevalence of poor glycemic control among patients was 52.6%. The extra tree classifier was the best-performing model for glycemic deterioration (accuracy $= 0.87$, area under the curve $= 0,87$). Caloric intake evolution, gender, baseline caloric intake, baseline weight, BMI variation, waist circumference evolution, and TC serum level after Ramadan were selected as the most significant for predicting poor glycemic control. The authors proposed thresholds for each predicting factor, among which this risk is present.

Special Themes

Risk Stratification

Risk assessment is a fundamental step in determining patients' safety in fasting. An evidence base for the risk factors for major complications during RF in people with diabetes grouped according to the IDF-DAR risk categories.[30] This prospective observational multicenter study was conducted by the Baqai Institute of Diabetology and Endocrinology in April-June 2019. People with diabetes having the intention to fast were recruited. Demographic data collection and risk categorization were done; structured education was given on a one-on-one basis to each study participant. Assessment of complications was done during the post-Ramadan visit. A total of 1,045 people with diabetes participated with near equal gender distribution. Two-thirds of the study population were grouped into high- and high-risk categories. Frequencies of major hypoglycemia, major hyperglycemia, hospitalization, and need to break the fast were 4.4, 10.8, 0.8, and 3.1%, respectively. On multivariate analysis, the risk factors found for major hypoglycemia during Ramadan were male gender, use of sedatives and antidepressants and having T1DM, history of DKA/HHS during last 3 months for significant hyperglycemia or hypoglycemia and hospitalization for breaking of fast, while older age, acute illness, and major hypoglycemia were identified factors for hospitalization. In this prospective study, evidence-based risk factors for fasting-related major complications were identified in peo-

ple with diabetes. It is imperative to recognize these factors during pre-Ramadan risk assessment visits.

Fasting with Chronic Kidney Disease

There is growing literature on guidelines regarding RF for chronic kidney disease (CKD) patients. However, most studies only consider the impact of fasting on renal function. Additionally, factors influencing RF in patients with CKD were evaluated in a prospective before and after cohort study.[31] CKD patients were counseled regarding fasting and followed up post-Ramadan for renal function status, actual fasting behavior, and other relevant outcomes. Of the 360 patients who attended the pre-Ramadan consultation, 306 were reachable after Ramadan (67.1% reported that they had fasted, 4.9% had attempted to fast but stopped, and 28% still needed to fast). Of these, 74 have a postfasting kidney test. Of the patients, 68.1% had stage 3A CKD, 21.7% had stage 3B, 7.9% had stage 4, and only 2% had stage 5. Of those who fasted, 11.1% had a drop in the eGFR of 20% or more. Those who did not fast (16.7%) presented a similar drop. Conversely, among the few who attempted to fast and had to stop, half showed a drop in eGFR of more than 20%. In linear regression, fasting was not associated with post-Ramadan eGFR when controlling for age and baseline eGFR. There were 17 (5.6%) significant events, including one death. More significant events occurred among the group who fasted some of Ramadan days; 26.7% of the subjects experienced an AE, while 4.7% of the group who did not fast had a significant AE compared with 4.4% among those who fasted all of Ramadan.

Acute Complications

In the fasting state, there is the danger of the blood glucose levels becoming too high when the usual medications are not taken. The risk of diabetic emergencies, including DKA, is thought to be higher during RF due to metabolic changes and alterations in food habits. The incidence of DKA during Ramadan, pre- and post-Ramadan, was examined in a retrospective study involving all adults admitted with DKA to King Saud Medical City in Riyadh, Saudi Arabia.[32] They explored the relationship of admissions to Ramadan and compared it to the month before (Sha'aban) and the month after (Shawwal). During the study, 51 patients with DKA were admitted to the hospital. Nineteen patients in Ramadan (37.3%), eight patients in Sha'aban (15.7%), and twenty-four patients in Shawwal (47%) showed a significant increment in Ramadan compared with Sha'aban and more increment in Shawwal ($p = 0.019$). The most common precipitating factor for DKA during Ramadan and Sha'aban was missing insulin doses, while infections were considered the main stimulating agent in Shawwal. There was an increase in the incidence of DKA episodes in Ramadan compared with the preceding month. However, fewer DKA events than Shawwal might indicate that RF is a potential risk factor for DKA.

Fasting in Pregnancy

Despite being exempted, many pregnant Muslim women with diabetes still choose to fast during Ramadan. Two studies were published in 2022 on diabetes and pregnancy

during Ramadan.[33,34] The association of Ramadan with maternal and neonatal outcomes among pregnant women with gestational diabetes mellitus in a retrospective cohort study. A total of 345 Muslim women with singleton pregnancies who attended a major Sydney teaching hospital from 1989 to 2010 were included.[33] Exposure to Ramadan was stratified by the whole pregnancy days exposed to Ramadan, duration (hours) of daily fasting, and trimester of exposure. Maternal and neonatal outcomes were examined by exposure status, and never exposed pregnancies were comparators in all three analyses. They found no significant effect of Ramadan exposure on mean birth weight, macrosomia, and maternal outcomes. However, they found a significant trend for increased neonatal hyperbilirubinemia with increasing Ramadan days exposure and later trimester exposure ($p \leq 0.02$ for both), with adjusted OR (AOR): 3.9 ($p = 0.03$) for those with more than or equal to 21 days exposure to Ramadan and AOR 4.3 ($p = 0.04$) for third-trimester exposure. Conversely, longer Ramadan exposure and late trimester exposure were independently associated with a lower prevalence of neonatal hypoglycemia (AOR: 0.4 and 0.3 for more than or equal to 21 days and third-trimester exposure, respectively). Furthermore, neonatal hypoglycemia decreased for the fasting period of more than 15-hour group (AOR 0.2, $p = 0.01$). Also, different glycemic markers as an indicator for diabetes control in fasting pregnant women were investigated in another prospective observational study.[34] A total of 89 pregnant diabetes women were recruited. Blood glucose was self-monitored in all pregnant women using a glucose monitoring device at home. They measured the fructosamine and HbA1c levels before, during, and after Ramadan. Pregnant women with T1DM were 14, T2DM were 21, and gestational diabetes were 21. The mean fructosamine level decreased during and after Ramadan in gestational diabetes pregnant women compared with T2DM and T1DM pregnant women subjects ($p = 0.009$). This study indicates that pregnant women with diabetes could fast during Ramadan, and their fructosamine levels were reduced during fasting. Utilization of fructosamine for short-term monitoring of glycemic control, in addition to home glucose monitoring in pregnant women with diabetes, will provide a good index of glycemic control.

Fasting after Bariatric Surgery

Fasting during Ramadan is mandatory for all adult healthy Muslims. International studies found that most Muslims with diabetes mellitus fast during Ramadan. The main risk factors are hypoglycemia, hyperglycemia, DKA, and dehydration during fasting. Therefore, stratification of the risks for severe acute diabetes complications needs to be considered for each individual, and strategies personalized to avert these complications.[35] The advent of new diabetes medications, which are effective yet with a better safety profile and monitoring of blood glucose levels during the day, is important to reduce the risk of untoward effects of hypoglycemia and hyperglycemia during RF. Here they reviewed the safety and effectiveness of the newer diabetes medications for RF and whether it is safe to perform fasting after bariatric

surgery. The newer diabetes medications such as GLP-1 agonists, DPP-4 inhibitors, SGLT-2 inhibitors, and new Insulin therapy are considered safe and effective during fasting during Ramadan. These medications are associated with a reduction in HbA1c, body weight, systolic blood pressure, and risk of hypoglycemia during RF. However, further studies with larger sample sizes are needed to confirm the efficacy and safety of these newer medications during RF. Individuals with bariatric surgery should seek advice and approval to fast from the bariatric dietician, physician, and surgeon before the beginning of the month of Ramadan.

COVID-19-Ramadan Interplay

A strict lockdown was enforced during the coronavirus disease 2019 (COVID-19) pandemic in many countries. The lockdown period overlapped with RF and its drastic lifestyle changes, including meal timings. Muslim people may have been discouraged from fasting during the COVID-19 pandemic, as diabetes has emerged as a significant risk factor for adverse outcomes of COVID-19 infection. Several studies investigated the interplay between the COVID-19 pandemic and lockdown with RF (►**Table 4**). These studies will be highlighted briefly below. Helal et al reported the impact of the COVID-19 lockdown (2020) on glucose control pre- and post-lockdown and during Ramadan in patients with T1DM and T2DM on insulin therapy. Twenty-four patients (19 men, 6 women) who monitored their glucose levels using FGM and remotely connected to a diabetes clinic in UAE were included.[36] CGM metrics were calculated for each period: 30 days before lockdown, 30 days into lockdown and pre-Ramadan, and 30 days into lockdown and Ramadan. MAG remained steady before and during the lockdown. No significant differences were observed in TIR, time in hypoglycemia, and LBGI between pre-lockdown and lockdown periods. However, there was a significant difference in GMI and percentage of time in hyperglycemia between Ramadan and pre-Ramadan during the lockdown period. The percentage of TIR was significantly lower in Ramadan than pre-Ramadan MAG and HBGI. HBGI were significantly higher in Ramadan compared with the pre-Ramadan period. There was no significant difference in the percentage of time in hypoglycemia and LBGI between Ramadan and pre-Ramadan periods. Alamoudi et al compared Saudi Arabia with other countries regarding patient attitudes toward fasting during Ramadan during the COVID-19 pandemic.[37] Data was collected from Saudi Arabia and 12 other mostly Muslim-majority countries via physician-administered questionnaires within post-Ramadan 2020. One thousand four hundred eighty-five T1DM patients were analyzed; 47.5% were from Saudi Arabia versus 52.5% from other countries. About 71.1% fasted during Ramadan; 90.2% were Saudi patients versus 53.8% from other countries. Experiencing Ramadan during the COVID-19 pandemic did not affect the Saudi T1DM patients' decision to fast, while it significantly influenced their decision in other countries (1.4 vs. 9.9%, $p < 0.001$). More Saudi patients needed to break the fast due to diabetes-related complications than in other countries (67.4 vs. 46.8%, $p \leq 0.001$). The mean number of days fasted in Saudi and other countries was

Table 4 Summary of the impact of the interplay of Ramadan with COVID-19 and COVID-19 lockdown on diabetes control

First author, (region)	Study objectives	Methods	Conclusion
Helal et al (UAE)[36]	The effect of COVID-19 and the overlapping RF on glucose control	25 Insulin-treated DM (19 men, 6 women)	No significant effect on markers of glycemic control. RF was associated with changes (e.g., increase in GMI, HBGI, and glycemic variability)
Alamoudi et al (Saudi Arabia)[37]	Comparison of KSA with 12 other countries regarding patient attitudes toward RF and complications related to fasting during the COVID-19 pandemic	Data from 13 countries by post-Ramadan 2020. 1,485 T1DM (705 from KSA); 1,056 (71.1%) fasted; 90.2% of KSA patients versus 53.8% of other countries	Observing RF is extremely common among Saudi T1DM patients compared with other Muslim countries and was not affected by the COVID-19 pandemic. It was associated with more hypoglycemia and hyperglycemia
Zabeen et al (Bangladesh)[38]	The experience of young patients with diabetes who fasted during Ramadan 2020 at the time of the COVID-19 pandemic time lockdown	A post-Ramadan survey of young patients who observed RF during the pandemic	Higher HbA1c was observed in young people with diabetes who fasted during the COVID-19 pandemic lockdown of 2020 Ramadan
El Toony et al (Egypt)[39]	Impact of pre-Ramadan education on glycemic control in T2DM during COVID-19	A prospective study; 316 T2DM	Education positively decreased the risk of symptomatic hypoglycemia in elderly diabetic patients
Sultana et al (Bangladesh)[40]	Prevalence and correlates of diabetes distress and depressive symptoms among individuals with T2DM during RF	A cross-sectional study amid COVID-19	Psychosocial support in RF should be examined to promote mental health and well-being of individuals with T2DM

Abbreviations: COVID-19, coronavirus disease 2019; GMI, glucose monitoring indicator; HBGI, high blood glucose index; HbA1c, hemoglobin A1c; HCP, healthcare professionals; RF, Ramadan fasting; T2DM, type 2 diabetes mellitus.

24 and 23 days, respectively. Hypoglycemic events were more common among Saudi patients during Ramadan compared with other countries, 72% and 43.6% ($p < 0.001$), respectively. There was a significant difference in timing; the largest peak for Saudi Arabia patients was after dawn (35 vs. 7%, $p < 0.001$), while it was pre-sunset for the other countries (23 vs. 54%, $p = 0.595$). Daytime-hyperglycemia was also more common among Saudi patients (48.6 vs. 39%, $p < 0.001$); however, it was a less likely cause of breaking the fast (25.6 vs. 38.3%, $p < 0.001$). Zabeen et al reported the experience of young patients with T1DM, T2DM, and other types of diabetes who fasted during Ramadan 2020 at the time of the COVID-19 pandemic time lockdown. A post-Ramadan survey was designed for young patients who fasted during Ramadan in 2020 during the COVID-19 pandemic time.[38] The study was conducted to compare the basal characteristics and other parameters in children and adolescents (<18 years) with young adults (≥18 years) with diabetes at Pediatric Diabetes Center in BIRDEM in Bangladesh. Among the study participants, a significantly higher number of participants were in the older age group who fasted for more than 15 days ($p = 0.045$). A considerable proportion (30.7%) of patients developed mild hypoglycemia, and only eight (2.6%) developed moderate-to-severe hypoglycemia. Both groups had a significant post-Ramadan basal insulin dose reduction ($p = 0.001$). Although increased bolus insulin dose requirements were observed in the older age group, a decreased requirement was observed in the younger age group during Ramadan ($p = 0.001$). Post-Rama-

dan median HbA1C in both groups was increased with a nonsignificant increase in the older age group compared with the younger age group, though it did not reach statistical significance ($p = 0.239$). The COVID-19 pandemic had a minor impact on fasting during Ramadan in the cohort. They could fast safely with fewer complications during Ramadan. The data supports Ramadan-focused diabetes education with great self-care. Young people with diabetes can fast safely during Ramadan. El Toony et al evaluate the impact of pre-Ramadan education in reducing the risk of hypoglycemia and achieving glycemic control in the elderly.[39] A prospective study was performed in outpatient clinics at Assiut university hospital, including 316 T2DM patients who intended to fast. They were grouped into less than 65 years and more than or equal to 65 years patients. The patients received pre-Ramadan individual education sessions. A semi-structured questionnaire was used to collect the data from stratifying the risk of fasting. The study was performed in three phases. Assessment of hypoglycemia and biochemical parameters after the education was the primary outcome. Fasting blood glucose decreased during and after Ramadan in the elderly significantly ($p = 0.0001$). The patients who achieved fasting blood glucose of less than eight mmol/L increased from 29.3 to 46.6% after Ramadan in elderly patients. HbA1c decreased significantly after Ramadan ($p = 0.001$). The main cause of breaking fast was hypoglycemia in both groups; 9 versus 7.7% in patients less than 65 and more than or equal to 65 years, respectively. The waist circumference significantly decreased in patients 65 or older ($p = 0.05$). TC and LDL

increased with no statistical significance in patients more than or equal to 65 years ($p = 0.512$, 0.470). Both groups showed improved HDL cholesterol during and after Ramadan ($p = 0.0001$). Psychological concerns relating to "diabetes distress" (DD) and depressive symptoms (DS) in individuals with T2DM may negatively impact adherence to medical treatments and overall mental health. Sultana et al investigated DS and DD about fasting during Ramadan.[40] A cross-sectional survey was conducted among 735 patients with T2DM in 2021. DD and DS were measured by the Problem Areas in Diabetes scale and Patient Health Questionnaire-9, respectively. More than one-third of the participants (41.2%) had DD and DS (36.9%). DS was significantly higher in participants who did not fast ($p = 0.027$). Participants with higher dietary diversity were less likely to have DD ($p = 0.004$) and DS ($p = 0.001$). Females (AOR = 1.89) and those who lived alone (AOR = 1.89) were more likely to have DS. Participants with diabetes-related complications were more likely to experience DS (AOR = 2.17) and DD (AOR = 3.46). DD was also associated with being younger ($p = 0.003$), having hypertension ($p = 0.030$), having heart disease ($p = 0.012$), and taking insulin ($p = 0.010$). Individuals with T2DM who were not fasting experienced more mental health concerns. Psychosocial support and other interventions from health professionals should be examined, and practical interventions should be implemented to promote the mental health and well-being of individuals with T2DM.

Professional Perspectives

Guidelines
Two updated sets of clinical practice guidelines were published in 2022.[41,42] The IDF and DAR International Alliance have substantially updated the previous guidelines.[41] This update includes key information on fasting during Ramadan with T1DM, the management of diabetes in people of elderly ages and pregnant women, the effects of Ramadan on one's mental well-being, changes to the risk of macrovascular and microvascular complications, and areas of future research. Also, the International Society for Pediatric and Adolescent Diabetes (ISPAD) updated its clinical practice consensus guidelines on Ramadan fasting. Moreover, they also included another religious fasting by young people with diabetes.[42] These guidelines seek to improve the awareness, knowledge, and management of diabetes during Ramadan and to provide real-world recommendations to health professionals and the people with diabetes who choose to fast.

Professional Matters
The approaches adopted by Iraqi physicians for the management of diabetes during Ramadan were evaluated in a cross-sectional online survey based (2021).[43] The participants were specialist doctors from different regions in Iraq who were directly involved in managing people with diabetes. Most participants were family physicians, followed by internists and endocrinologists. Among the respondents, 94.3% reported advising their patients regarding RF; 84.3% of this advice was

based on several factors. Pre-Ramadan education is provided by 75% of the participants. A minority (14.3%) allow patients with T1DM to fast, and 32.1% allow those with T2DM on insulin to fast. Recent DKA and severe hypoglycemia were the main reasons to advise against fasting. Regarding treatment modification during fasting, 56.4% of physicians changed the frequency of administration, and 67.8% scored well in the questions reflecting knowledge of the international guidelines. Also, the implementation and evaluation of an online module targeting pharmacy students to improve participants' knowledge, communication, and self-efficacy concerning proper care for patients with diabetes during Ramadan were described.[44] An online module with pre- and post-assessments was implemented over two semesters. The average score in the self-efficacy section increased (1.5 to 3.5; $p < 0.001$), and the average score in the knowledge section also increased (14 to 22; $p < 0.001$). The qualitative analysis provided insights into how participants perceived the module design, content, and its impact on practice. Participants described the module as informative, addressing a much-needed issue they had not been exposed to before. They emphasized how the module addresses the cultural needs of patients in their communities. They particularly appreciated seeing instructor videos depicting real-life scenarios and the focus on their communication skills, but some preferred learning about this topic through live sessions.

Patients' Perceptions and Advocacy
The level of diabetes knowledge and its association with diabetes self-management practices during RF were evaluated among patients with T2DM.[45] A cross-sectional study was conducted involving a sample of Malaysian patients with T2DM. Patients aged 18 years and above and attending an outpatient diabetic unit of a government hospital were recruited between February and April 2021. A self-administered questionnaire was utilized to assess diabetes knowledge and diabetes self-management practices. A total of 306 participants completed the questionnaire. Most were females (54.2%) and above 55 years old (75.1%). Resultantly, knowledge of diabetes was considered average among 52% of the participants. Only 9.5% of them avoided consuming sweet foods during the iftar. Practicing late suhoor ($p = 0.012$) and SMBG ($p = 0.026$) during Ramadan were significantly associated with a better diabetes knowledge score. Education level ($p = 0.000$), working status ($p = 0.030$), and monthly income ($p = 0.000$) were significantly associated with participants' knowledge level of diabetes. A higher proportion (72.2%) of the participants completed fasting for a month during Ramadan 2020. Meanwhile, hypoglycemia was the main reason (38.8%) for incomplete fasting. These findings reflect the need to improve patients' knowledge of diabetes and diabetes self-management practices, especially during Ramadan. Such objectives could be achieved by considering the associated factors identified in this study. In another study, how Muslims with diabetes decide whether to fast during Ramadan was evaluated in a qualitative study of 15 focus groups with Muslims with diabetes within a constructivist paradigm.[46] Convenience sampling was used.

All focus groups were transcribed verbatim and analyzed using Braun and Clarke's reflexive thematic analysis. Four themes were found to be important in the decision on whether to fast: (1) values and beliefs concerning Ramadan, (2) experiences and emotions concerning Ramadan, (3) the perception of illness, and (4) advice from HCPs, imams, and family. Many participants indicated fasting against medical advice and trusting their subjective assessments on whether they could fast. Moreover, three main stages in the decision-making process for eventually refraining from fasting were identified: (1) the stage where positive experiences with fasting dominate, (2) the stage where one encounters challenges but their determination to fast prevails, and (3) the stage where one decides to refrain from fasting after experiencing too many physical difficulties with fasting. Muslims with diabetes experience autonomy in their decisions on RF. Refraining from fasting often resulted from a difficult and dynamic decision-making process and was often made after participants reached their physical limits. These findings highlight the importance of shared decision-making to empower patients to make well-informed decisions on RF and pre-Ramadan diabetes education to help people with diabetes have a safe Ramadan. Lastly, the feelings, difficulties, attitudes, and spiritual coping status of Turkish patients with T2DM toward fasting during Ramadan were explored.[47] This descriptive qualitative study sample consists of 14 patients diagnosed with T2DM. They determined two main themes and relevant sub-themes. The first was "the feelings and difficulties experienced due to diabetes mellitus" with the sub-themes of "negative emotions" and "difficulties in fasting." The second theme was identified as "religious and spiritual coping," with the subthemes of "believing the disease comes from God," "having difficulty in adhering to disease-specific practices while fasting," and "feeling that fasting facilitates coping and provides relief." In conclusion, it was determined that the patients continued to fast despite the difficulties and that fasting facilitated coping and provided relaxation.

Final Remarks

We provide a narrative overview of the global literature production in 1 year (2022) on diabetes and RF. Themes emerged from a review of the literature on Ramadan fasting published in 2022. Ramadan fasting and diabetes continue to be seen addressing epidemiology, the burden of diabetes care on fasting patients, and discussions of concerns of patients and HCPs. Risk stratification and issues of high-risk patients are still in focus for children, adolescents, and adults. Approaches to effective management still gather evidence for newer pharmacological agents and diabetes technology. All are welcome to help build an evidence base for good clinical practice during Ramadan. It is comforting to see most of these studies coming from Muslim-majority regions such as the Middle East, North Africa, and South East Asia and that this work is recognized in impactful medical journals. Translating the evidence to clinical practice guidelines is para-

mount. Through this concise summary of the 2022 literature, we hope to contribute to this cause.

Compliance with Ethical Principles
No ethical approval is required. To the best of our abilities, we presented our perception of the published work in good faith. Original authors cannot be held responsible for any misrepresentation.

Authors' Contribution
S.A.B. proposed the study, performed the literature searches, and drafted the manuscript. All authors reviewed the whole document for intellectual content. All authors approved of its final version.

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