



# Diabetes and Ramadan Fasting (2023): The Year in Review

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J Diabetes Endocrine Practice

## Abstract

### Keywords

- ▶ physiology
- ▶ health care professionals
- ▶ complications
- ▶ risk stratification
- ▶ patients' perspectives
- ▶ Ramadan fasting
- ▶ COVID-19

**Introduction** We aimed to provide an overview of the global literature production on diabetes and Ramadan in the past year (2023).

**Materials and Methods** This is a narrative, nonsystematic review of the international literature from two major medical online databases (PubMed and Google Scholar) in 2023. The search term “Diabetes AND Ramadan fasting” was used, and the relevant literature was narrated in a concise thematic account.

**Results** The publications spanned a vast array of topics related to diabetes and Ramadan fasting (RF), including physiology and nutrition, risk assessment stratification tools and their validation, assessments of safety and efficacy profiles of older and newer diabetes therapies, diabetes education, use of advanced technology for the treatment, and monitoring and impact on pregnancy. Some reports covered the interaction between Ramadan and COVID-19 concerning diabetes, pregnancy, complications, and unique characteristics of diabetes and fasting by young and older people.

**Conclusion** The current narration presents this year’s global scholarly production on the safety of fasting practices, care models, and patients’ experiences and perspectives.

## Introduction

Ramadan fasting (RF) is observed by adult Muslims worldwide. It entails abstinence from food, water, all oral substances, intravenous fluid therapy, and smoking between dawn and sunset during the ninth month of the Muslims’ lunar calendar.<sup>1</sup> Ramadan’s impact on health and disease stems from the physiological effects of prolonged fasting

during the daytime, possible indulgence in eating during the evening, and various social changes, such as reduced working hours and reversal of circadian rhythm. The last three decades witnessed a rising interest in research on the impact of RF on health and disease.<sup>2</sup>

Diabetes has been the most extensively studied single medical condition connected to RF.<sup>2</sup> A thematic overview of the global research work conducted in the realm of RF during

DOI <https://doi.org/10.1055/s-0044-1782672>.  
ISSN 2772-7653.

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2023 and its impact on people with diabetes (PWD) provides a concise bird's-eye view of the literature published in the past year to identify the evidence base that may guide clinical practices for years to come.<sup>3-8</sup>

## Materials and Methods

This is a narrative, nonsystematic review of the international literature from two major medical online databases (PubMed and Google Scholar) in 2023. The search term [Diabetes AND Ramadan] with a time filter from January 1 to December 31, 2023 was used to identify the relevant records. Eighty-five records were identified in PubMed and 72 in Google Scholar. The records were retrieved, pooled, and examined for relevance. Full-text research articles in English were included. Duplicates, abstracts only, and short narrations were removed, resulting in a total of 45 articles that were reviewed and narrated thematically.

One author drafted an initial manuscript. All other authors contributed to the intellectual content using a single version loaded online using Google Docs. We performed no statistical analysis on the data included in the original articles, and excessively detailed numerical presentations were avoided. The final product was refined through several multilateral rounds of discussion.

## Highlights of the Literature

The emerging themes from the literature review are listed in ►**Table 1**. They covered physiology and nutrition, risk stratification, education and lifestyle, antidiabetic medications, diabetes technology, fasting with diabetes in special circumstances, RF in the COVID-19 pandemic, and, finally, cultural, professional, and advocacy. The contents of these articles will be presented briefly in the following sections.

### Physiology and Nutrition

Several factors, including health status, and diet, influence fasting blood glucose (FBG). Some studies have reported a beneficial effect of RF on PWD. However, clinical observations have shown that glycemic deterioration can be exacerbated in some patients. In 2023, three studies addressed

glucose homeostasis; one investigated lipid metabolism, and the other evaluated changes in osmolality.

A cross-sectional study investigated the influence of RF on FBG levels by identifying factors associated with variations in FBG levels during RF among PWD. They monitored the FBG levels of 181 patients with type 2 diabetes (T2D) over 2 months, representing the Islamic lunar months of Shaban (8th month) and Ramadan (9th month).<sup>9</sup> Based on their findings, PWD was classified into three groups depending on the influence of RF on FBG levels: the positively affected group (44%) with lowering in average FBG levels; the neutral group (24%) with no change in the average FBG levels; and the negatively affected group (32%), whose average FBG levels increased during Ramadan compared to the previous month. Furthermore, they found that the positive effect of RF was more frequent among patients with obesity, nongeriatric, and male patients with diabetes. In contrast, the negative effect of RF was more frequent among patients who were not adhering to their medications. They concluded that RF affects FBG levels differently among PWDs. More studies are needed to identify the factors associated with interindividual variation in the response to RF and those who are suitable candidates for RF. In a different study, the effect of RF on interstitial glucose control and variability before, during, and after Ramadan in T2D patients receiving insulin therapy was investigated.<sup>10</sup> Participants received a flash glucose monitoring (FGM) system 1 week before Ramadan that was removed on the sixth or seventh day of Ramadan (pre- and early Ramadan periods) and a second FGM system 1 week before the end of Ramadan that was removed 1 week after the end of Ramadan (late and post-Ramadan periods). Fasting blood samples were collected during the pre-, early, and late Ramadan study visits and tested for glycosylated hemoglobin (HbA1c), serum creatinine, and plasma glucose levels. Thirty-four patients were prospectively included. The standard deviation and coefficient of variation of glucose concentrations were higher in the early Ramadan period than in the pre-Ramadan period. Still, they were similar in the late or post-Ramadan periods. Changes in the early Ramadan period were restricted to males and patients younger than 55 years. No significant changes were observed in the average glucose level, glucose management indicator,

**Table 1** The themes covered in the research on diabetes and Ramadan in 2023

Physiological and nutritional changes during Ramadan fasting
Validation and utilization of the IDF-DaR risk stratification scale
The role of Ramadan-focused education and lifestyle modification
Newer data on pharmacological therapy during Ramadan (insulins, SGLT2 inhibitors, etc.)
The impact of diabetes technology on enabling safe fasting with reduced complications
Ramadan fasting and diabetes in special groups: <i>diabetes in pregnancy, adolescents, and older adults</i>
Complications: <i>diabetic ketoacidosis and hypoglycemia, renal disease, cardiovascular disease, and mental health</i>
The interplay between diabetes, Ramadan, and COVID-19 infection
Some cultural, professional, and advocacy perspectives
IDF-Dar: International diabetes Federation-Diabetes and Ramadan international Alliance

time in range (TIR), time in hyperglycemia, or time in hypoglycemia at any time. RF in patients with insulin-treated T2D was associated with an initial increase in glucose variability that quickly returned to pre-Ramadan levels. RF was not associated with any significant changes in glycemic control measures. Sibarani<sup>11</sup> aimed to ascertain how serum lipid parameters were affected by RF. The study prospectively evaluated 19 patients with T2D during Ramadan who were not on statin therapy and had an average age of 57.2 years. At the end of RF, apolipoprotein B levels increased, and both small, dense low-density lipoprotein (LDL) size and mean body weight (BW) decreased. However, no changes were noted in the serum LDL cholesterol, high-density lipoprotein (HDL) cholesterol, and triglyceride levels. Keskinler et al<sup>12</sup> studied the changes in osmolality levels due to fasting in Ramadan among 52 T2D patients (22 females and 30 males), including fasting and nonfasting patients. The mean levels of morning serum osmolality were not different between the fasting and nonfasting groups. There was no difference in the nonfasting group between the morning and evening levels, whereas with fasting, evening serum osmolality was significantly lower than morning serum osmolality. Use of sodium-glucose cotransporter 2 (SGLT2) inhibitors was not associated with any biochemical signs of dehydration during fasting, and there was no significant difference between morning and evening serum osmolality.

Furthermore, Elmajnoun et al<sup>13</sup> performed a systematic review and meta-analysis to investigate the impact of RF on glycemic control in patients with T2D in relevant studies (January 2000–December 2021). Observational studies that examined the changes in BW and glucose parameters (HbA1c and FBG) before and after RF among different age groups with T2D were included in the systemic review and meta-analysis. Effect sizes for the tested outcomes were calculated as weighted mean difference (WMD). Quality assessment was examined using the National Heart, Lung, and Blood Institute (NHLBI) tool. Of the 1,592 identified records, 12 studies conducted in the Middle Eastern and Asian countries were eligible and included in the quantitative analyses. The quality of the retrieved studies was evaluated and found to range between fair (83%) and good (17%). These 12 studies included 5,554 participants, of whom 54% were males and 46% were females. Their pooled analysis demonstrated that the HbA1c and FBG levels significantly decreased after RF when compared to the prefasting levels. However, the difference in BW in fasting patients after RF versus the prefasting stage was nonsignificant. Although young patients with T2D were enrolled in the 12 selected studies, the investigators did not find any studies that solely focused on this group. The impact of RF on adults with T2D was associated with favorable outcomes. However, future studies should evaluate data from young adults separately. In addition, it is essential to identify the effects of the number of fasting days (level of exposure), diet, level of physical activity, and sleeping patterns on optimal glycemic control. Medical professionals could utilize this information as a nonpharmacological therapeutic method for managing diabetes in patients willing to practice fasting during Ramadan and other months of the year.

### Risk Stratification

Several studies in 2023 evaluated the potential challenges and values of using the 2021 IDF-DAR (International Diabetes Federation-Diabetes and Ramadan Alliance) risk stratification tool (**– Table 2**).<sup>14–18</sup>

The original creators of the tool investigated its validity using two different approaches. In the first study, they performed a prospective, survey-based study before and after Ramadan (2021) to explore the ability of the new IDF-DAR risk stratification tool to predict the probability of fasting and complications risk.<sup>14</sup> A total of 659 participants had a pre-Ramadan assessment; 647 (98.2%) answered the post-Ramadan follow-up questionnaire. The mean age was 53.5 years and 47.9% were females. Six hundred and three patients (91.5%) had T2D, while 56 patients (8.5%) had type 1 diabetes (T1D). Using the IDF-DAR risk tool pre-Ramadan, 51.4% were categorized as low risk, 26.3% as moderate risk, and 22.3% as high risk. The percentage of patients who fasted the full 30 days constituted 94.3, 81.1, and 76.9% in the low-, moderate-, and high-risk groups, respectively ( $p < 0.0001$ ). Any hypoglycemia was reported in the low-, moderate-, and high-risk groups, and severe hypoglycemia was reported by 2.1% patients in the high-risk group, 3 (1.8%) patients in the moderate-risk group, and none (0%) in the low-risk group. Hyperglycemia ( $>250$  mg/dL) was reported in the low-, moderate-, and high-risk groups by 2.7, 13.0, and 23.8% patients, respectively. The investigators concluded that the IDF-DAR risk assessment tool reliably predicted both the ability to fast during Ramadan and the likelihood of hypoglycemia or hyperglycemia. A second approach to determining the validity of the risk score examined the variability among physicians in risk stratification for PWD during RF.<sup>15</sup> A twenty-six clinical scenario questionnaire was developed. Cases were prescored using the proposed risk calculator. The survey was sent to 350 practicing physicians with expertise in managing patients with diabetes. The survey sought expert opinions on patients' risk classification during RF. The responses of 312 participants were analyzed. A wide variation in evaluating patients' risk was evident, particularly in moderate-risk cases. Overall, responses to case scenarios were classified correctly, with a 33 to 85% variation in the correct response. Geographical and interspecialty differences were noted.

Two other groups from Sudan and Bangladesh evaluated the risk scale independently.<sup>16,17</sup> The first group assessed the scale using a cross-sectional hospital-based study that recruited 300 individuals with diabetes (79% have T2D) from diabetes centers in Sudan.<sup>16</sup> Risk scores were distributed as low risk (13.7%), moderate risk (24%), and high risk (62.3%). There was a significant difference in the mean risk score by sex, duration, and type of diabetes. One-way analysis of variance (ANOVA) revealed a significant difference in the risk score by age group. Logistic regression revealed that the odds of being in the 41- to 60-year age group had a lower probability of being categorized in the moderate-risk group of fasting rather than in the low-risk group by 4.3 times than being in the group of patients older than 60 years ( $p = 0.008$ ). The odds of being in the age group of 41 to 60 years lower the

**Table 2** Summary of the recent studies on IDF-DaR risk stratification scoring system

Study	Population	Study design	Outcome measures	Conclusions
Mohammed et al <sup>14</sup>	659 patients who intended to fast in Ramadan; 98.2% participated; 91.5% with T2D and 8.5% with T1D	A prospective, study before and after RF (2021)	To explore the ability of the new IDF-DaR risk stratification tool	The tool reliably predicts the ability to fast during Ramadan and the likelihood of hypoglycemia or hyperglycemia
Afandi et al <sup>15</sup> (multicountry)	Established physician with experience in managing diabetes in RF	A survey with 26 clinical scenarios	Physicians' variation in risk stratification.	A wide variation in evaluating patients' risk, particularly in moderate-risk cases
Noor et al <sup>16</sup> (Sudan)	300 individuals with diabetes (79% have T2D) from diabetes centers in Sudan	A cross-sectional hospital-based study	Risk score and its relationship with sex, type, and duration of diabetes	Most patients have a high risk of fasting during Ramadan. An IDF-DAR risk score is significant in assessing individuals with diabetes for RF
Kamrul-Hasan et al <sup>17</sup> (Bangladesh)	1,328 adults with T2D	A prospective study in the peri-Ramadan period of 2022	Categorization by IDF-DAR risk stratification tool, risk-based counseling, patient practice, and outcomes	The new IDF-DAR risk scoring system seems conservative in the risk categorization of T2D patients in predicting complications
Shaltout et al <sup>18</sup> (Egypt)	Not applicable	Consensus development	Risk assessment scoring	The risk is based on several factors (DM type, presence, severity of complications, fasting hours, socioeconomic factors)

Abbreviations: AHCL, advanced hybrid closed-loop; DM, diabetes mellitus; IDF-DaR, International Diabetes Federation-Diabetes and Ramadan International Alliance; RF, Ramadan fasting; SGLT2i, sodium-glucose cotransporter 2 inhibitor; T1D, type 1 diabetes; T2D, type 2 diabetes.

probability of being categorized in the high risk of fasting rather than low risk by eight times more than being in the age group more than 60 years. The second group performed a prospective study in the peri-Ramadan period in 2022, evaluating adults with T2D and categorizing them using the IDF-DAR 2021 risk stratification tool.<sup>17</sup> Counseling on fasting according to the risk categories was made, and their intention to fast was recorded. Among 1,328 participants (age: 51.1 years; females: 61.1%), only 29.6% had a pre-Ramadan HbA1c level less than 7.5%. According to the IDF-DAR risk category, the frequencies of participants in the low-risk group (should be able to fast), moderate-risk group (not to fast), and high-risk group (should not fast) were 44.2, 45.7, and 10.1%, respectively. Most (95.5%) patients intended to fast, and 71% fasted the full 30 days of Ramadan. The overall frequencies of hypoglycemia (3.5%) and hyperglycemia (2.0%) were low. Hypoglycemia and hyperglycemia risks were 3.74- and 3.86-fold higher in the high-risk group than in the low-risk group. The first study noted that most patients had a high risk of RF and that the IDF-DAR risk score was significant in assessing individuals with diabetes for RF. However, the second study included a small percentage of high-risk patients and concluded that the new IDF-DAR risk scoring system was conservative in risk categorization of T2D patients in predicting complications as it found fasting to be safe for patients in the high-risk group.

Furthermore, another diabetes group based in Egypt released a consensus statement to provide further insights into risk stratification in PWD intending to fast during Ramadan based on the three-step modified Delphi method.<sup>18</sup> The panel comprised senior adult and pediatric endocrinologists and other experts in relevant specialties affiliated with academic institutions in Egypt. The group developed a new risk assessment tool based on several factors, including the type, presence, and severity of complications, the number of fasting hours, and certain socioeconomic factors. Patients were classified into four categories (high, high, moderate, and low risk) according to their risk factors. The tool contained some items included in the IDF-DAR tool but did not depend on a scoring system. Further research is needed to validate this new risk assessment tool.

### Education and Lifestyle Modification

A previous study analyzed the impact of applying recommendations from the American Diabetes Association and the European Association for the Study of Diabetes (ADA/EASD) on management of T2D during Ramadan.<sup>19</sup> A multinational, randomized controlled trial (RCT) was conducted in five Muslim-majority countries. Six hundred and sixty participants were approached. However, nearly a quarter of them declined to participate later for various reasons. In total, 506 participants were enrolled and were randomized to receive

Ramadan-focused education with diabetes treatment adjusted per the 2020 ADA/EASD recommendations or the control group that involved usual care. At the end of the study, data for 231 participants in the intervention group and 221 participants from the control group were available. The total number of hypoglycemic episodes in the intervention group was less than that in the control group. The intervention group also had a significantly lower severe hypoglycemia than the controls, with an odds ratio of 0.2. In both groups, the HbA1c levels were significantly reduced compared to baseline, but the improvements were significantly greater in the intervention group. While BW reduced and HDL cholesterol increased with the intervention, these changes were not significantly different from usual care. The authors affirmed that a pre-Ramadan assessment of people with T2D coupled with pre-Ramadan education and an adjustment of glucose-lowering treatment can prevent acute complications by reducing the risk of hypoglycemia, improve metabolic outcomes, and allow safer fast for these patients.

Access to and engagement with diabetes education is variable and its digitization may provide high-quality education at a low cost. Two Ramadan-focused massive open online courses (MOOCs) were developed and delivered for Ramadan 2023: one for health care professionals (HCPs) in English and another for PWD in English, Arabic, and Malay.<sup>20</sup> A user-centered iterative design process was adopted. The MOOCs featured interactive elements, videos, patient stories, and live multilingual question-and-answer sessions. Promotion occurred through diabetes organizations and health authorities. The evaluation included platform usage analysis and mixed-methods evaluation of user surveys. In total, 1,531 users registered for the platform from more than 50 countries; 809 (549 HCPs and 260 patients) started a course, and 387 completed a course. HCPs worked in mostly (60%) nondiabetes specialist roles; 55% identified as Muslim, and most self-reported high baseline levels of diabetes and Ramadan awareness. Users found the course to be informative and useful. In the HCP MOOC, users reported improved post-MOOC Ramadan awareness, associated diabetes knowledge, and ability to manage diabetes during Ramadan. A model used in developing an educational booklet consists of four stages: define, design, develop, and disseminate.<sup>21</sup> The feasibility of growing media was analyzed by the content validity index (CVI) using the item-level content validity index (I-CVI) and the scale content validity index (S-CVI) to assess whether an item was relevant or not relevant to the index (CVI > 0.80). The patients' CVI was assessed using the I-CVI and S-CVI. The average value of I-CVI was 0.875, and the average value of S-CVI was 0.875, meaning that all parts of the content were relevant in providing information about healthy eating for diabetes during RF. The investigators proposed that the booklet can be used as an educational medium for pre-Ramadan education.

### Pharmacological Therapy

Seven studies investigated various pharmacological agents, including insulin (2), DDP-4 inhibitors (1), and SGLT2 inhibitors (4); ▶ **Table 3**.<sup>22–28</sup> A Cochrane review was also pub-

lished on the effects of various interventions during RF.<sup>29</sup> They will be discussed briefly below.

A prospective, observational, noncomparative, multicenter study investigated the safety and clinical outcomes of patients with T2D treated with Glargine U-300 during Ramadan.<sup>22</sup> The study included patients from four countries who had T2D and were currently treated with Glargine U-300 who planned to fast during Ramadan. The mean HbA1c decreased during the study period from 7.9% pre-Ramadan to 6.9% post-Ramadan. The overall HbA1c target value was 6.9%, achieved by 29 patients (21.9%). The mean FBG decreased from baseline post-Ramadan by  $-0.09$  mmol/L. Only five patients had symptomatic documented hypoglycemia during Ramadan, and none were considered to have severe hypoglycemia. The study showed that insulin Glargine U-300 maintained the glycemic control of T2D patients who decided to fast during Ramadan with less insulin dose required and without increasing the risk of hypoglycemia. The same group also evaluated the safety and effectiveness of the combination of insulin glargine/lixisenatide (iGlarLixi) in adults with T2D fasting during Ramadan in a multinational, prospective, single-arm, real-world observational study.<sup>23</sup> Among the 409 eligible participants who were followed during Ramadan, the vast majority fasted for  $\geq 25$  days, and 92.4% did not break fasting during Ramadan. Only four participants broke their fast due to hypoglycemia. Minimal adjustments were seen in antihyperglycemic therapies from before to during Ramadan. The investigators concluded that iGlarLixi is an effective and well-tolerated therapy for people with T2D who fasted during Ramadan. It was associated with a low risk of hypoglycemia, and improvement in diabetes was observed both during and after Ramadan.

The efficacy and safety of vildagliptin as an add-on therapy on glucose excursions of iftar Ramadan meals was investigated among adolescents and young adults with T1D using the advanced hybrid closed-loop (AHCL) treatment.<sup>24</sup> Fifty T1D patients receiving basal/meal insulin therapy and using MiniMed 780G AHCL were randomly assigned to receive vildagliptin (50 mg) with an iftar meal during Ramadan or no therapy. All participants received premeal insulin bolus based on the insulin-to-carbohydrate ratio (ICR) for each meal constitution. Vildagliptin was shown to blunt postmeal glucose surges together with concomitant exceptional euglycemia, with TIR significantly increased at the end of Ramadan in the intervention group from 77.8 to 84.7% ( $p=0.016$ ), and time above range (180–250 mg/dL) decreased from 13.6 to 9.7% ( $p=0.003$ ) without increasing hypoglycemia. A significant reduction was observed in automated daily correction boluses and total bolus dose with less aggressive ICR settings within the intervention group at the end of Ramadan. No severe hypoglycemia or diabetic ketoacidosis (DKA) were reported. Thus, adjunctive vildagliptin treatment seemed to mitigate postprandial hyperglycemia compared with premeal bolus alone and significantly improve TIR while reducing glycemic variability without compromising safety.

Four studies examined their use during RF.<sup>25–28</sup> Samkari et al assessed the safety and tolerability of empagliflozin in

**Table 3** Summary of the studies on various pharmacological therapies for diabetes during Ramadan

Study	Population	Medications	Outcome measures	Conclusions
Hassanein et al <sup>23</sup>	A prospective, observational study of 140 patients with T2D in four countries	Glargine U-300 (Gla-300)	HbA1c, FPG, symptomatic documented, and severe hypoglycemia	Gla-300 maintained the glycemic control of T2D during RF with less insulin dose and no increasing hypoglycemic risk
Hassanein et al <sup>22</sup> (SoliRam study)	A multinational, prospective, single-arm, real-world observational study of 409 patients with T2D	iGlarLixi	>1 episode of severe and/or symptomatic documented hypoglycemia (<70 mg/dL)	iGlarLixi is effective and well tolerated for people with T2D who intend to fast during Ramadan
Elbarbary and Ismail <sup>24</sup>	50 adolescents and young adults with T1D	Vildagliptin 50 mg add-on to insulin via MiniMed 780G AHCL	Efficacy and safety on glucose excursions of iftar	Adjunctive vildagliptin-mitigated postprandial hyperglycemia. Vildagliptin significantly increased TIR and reduced glycemic variability
Samkari et al <sup>25</sup>	220 adult patients with T2D (89 on empagliflozin vs. 131 control group)	Empagliflozin	Safety and tolerability	Empagliflozin produced less hypoglycemia during Ramadan; better eGFR after Ramadan
Sheikh et al <sup>26</sup>	89 adult patients with T2D	Empagliflozin, dapagliflozin	Safety and tolerability	Significant drop in eGFR, symptomatic dehydration with no hospitalization. No severe hypoglycemia
Goh et al <sup>27</sup>	98 adults with T2D single-center observational study	Empagliflozin	Risk of dehydration, ketosis, or hypoglycemia	Empagliflozin is safe and not associated with increased risk
Ghazi <sup>28</sup>	100 older people with T2D, aged ≥60 y	Empagliflozin vs. vildagliptin on top of metformin	Days broken, eGFR, hypoglycemia	No difference observed. SGLT2i is deemed safe in older adults

Abbreviations: AHCL, advanced hybrid closed-loop; eGFR, estimated glomerular filtration rate; FPG, fasting plasma glucose; RF, Ramadan fasting; SGLT2i, sodium-glucose cotransporter 2 inhibitor; T1D, type 1 diabetes; T2D, type 2 diabetes.

T2D patients during Ramadan in a prospective cohort study conducted for adult Muslim T2D patients.<sup>25</sup> Patients were categorized into two subcohorts (control vs. empagliflozin). The primary outcomes were the incidence of hypoglycemia symptoms and confirmed hyperglycemia. A propensity score (PS) matching and risk ratio (RR) were used to report the outcomes. Among the 1,104 patients with T2D screening, 220 patients were included, and empagliflozin was given to 89 patients as an add-on to oral hypoglycemic medications (OHDs). The two groups were comparable after matching with PS (1:1 ratio). Other oral glucose-lowering medications, such as sulfonylurea (SU), DPP-4 inhibitors (DPP-4Is), and biguanides, were not statistically different between the two groups. The risk of hypoglycemia symptoms during Ramadan was lower in patients who received empagliflozin than in the control group ( $p = 0.02$ ). Additionally, the risk of confirmed hypoglycemia was significantly different between the two groups. Sheikh et al<sup>26</sup> reported an observational study of the use of empagliflozin during Ramadan in patients with T2D in a Pakistani population at a university hospital. Participants were older 21 years and on stable SGLT2 inhibitor doses starting at least 2 months before Ramadan. Endpoint assessments were done 1 month before and within 6 weeks after Ramadan. Of the 102 participants enrolled, 82 completed the study with an average duration of T2D of 11.2 years. In all,

63% were on empagliflozin, whereas dapagliflozin was used by 37% of patients. Documented symptoms of hypoglycemia were reported in 7.3% of patients, and no severe hypoglycemia, hyperglycemia, dehydration, DKA, hospitalization, or discontinuation of SGLT inhibitors were reported. A reduction in HbA1c was noted alongside a reduction in the weight with an improvement in eGFR. Also, Goh et al<sup>27</sup> investigated the effects of empagliflozin in fasting T2D patients. This was a prospective cohort study in a single diabetes center in Malaysia. The empagliflozin group was on the study drug for at least 3 months. For the control group, patients not receiving SGLT2 inhibitors were recruited. Follow-up visits were performed before and during RF. During visits, anthropometric measurements, blood pressure, renal profile, and blood ketone were recorded. Symptoms of hypoglycemia were assessed via the hypoglycemia symptom rating questionnaire (HypoSRQ). The investigators recruited a total of 98 participants. Baseline anthropometry, blood pressure, and renal parameters were similar in the two groups. No significant changes in blood pressure, weight, urea, creatinine, eGFR, or hemoglobin levels during Ramadan were found in both groups. Likewise, no difference was detected in blood ketone levels or hypoglycemia indices. These studies suggested that the use of SGLT2 inhibitors during RF is associated with a lower risk of hypoglycemia symptoms and higher

tolerability, seems safe, and is not associated with an increased risk of dehydration, ketosis, or hypoglycemia. Similarly reassuring data were found in older adults as will be discussed below.<sup>28</sup>

Lee et al assessed the effects of interventions for people with T2D fasting during Ramadan by conducting a meta-analysis that included 17 RCTs with 5,359 participants, with a 4-week study duration and at least 4 weeks of follow-up.<sup>29</sup> At least one high-risk domain in the risk of bias assessment was present. Four trials compared DPP-4Is with SUs. DPP-4Is may reduce hypoglycemia compared to SUs. Serious hypoglycemia was similar between groups. The evidence about the effects of DPP-4Is on adverse events other than hypoglycemia and HbA1c changes was very uncertain. Two trials compared meglitinides and SU; the evidence is very uncertain about the effect on hypoglycemia and HbA1c changes. One trial compared SGLT2 inhibitors with SU. SGLT2 inhibitors may reduce hypoglycemia compared to SU. The evidence was very uncertain for serious hypoglycemia and adverse events other than hypoglycemia—SGLT2 inhibitors result in little or no difference in HbA1c. Three trials compared GLP-1 analogs with SUs. GLP-1 analogs may reduce hypoglycemia compared to SUs. The evidence for serious hypoglycemia was very uncertain. Evidence suggests that GLP-1 analogs result in little to no difference in adverse events other than hypoglycemia, treatment satisfaction, or change in HbA1c. Two trials compared insulin analogs with biphasic insulin—the evidence about the effects of insulin analogs on hypoglycemia and serious hypoglycemia. The

evidence for the effect of insulin analogs on adverse effects other than hypoglycemia, all-cause mortality, and HbA1c changes was very uncertain. Two trials compared telemedicine with usual care. The evidence regarding the effect of telemedicine on hypoglycemia was very uncertain compared with usual care, health-related quality of life (HRQoL), and HbA1c change. Two trials compared Ramadan-focused patient education and usual care. The evidence needed to be more certain about the effect of Ramadan-focused patient education on hypoglycemia and HbA1c change.

### Diabetes Technology

The latest data on diabetes and technology during Ramadan in 2023 are presented in ►Table 4.<sup>24,30–35</sup> These are briefly summarized here. AlGhatam et al in a randomized pilot study investigated the effects of different insulin pump settings on TIR.<sup>30</sup> Patients classified as having low to moderate risk for fasting were assigned to either a control group to receive basal insulin adjustments only or an intervention group to use the temporary basal rate and extended bolus features in addition to the basal insulin modifications. The percentage of time spent at different glucose ranges was measured by continuous glucose monitoring (CGM). The percentage of time spent within the target increased significantly in the intervention group from 63 to 76% (mean difference, 27% points;  $p < 0.001$ ). The percentage of time spent in hyperglycemia levels 1 and 2 met the criterion of significance, indicating that the intervention group spent less time in hyperglycemia. However, there was no

**Table 4** Summary of the use of diabetes technology during Ramadan fasting

Study	Population	Technology	Outcome measures	Conclusions
AlGhatam et al <sup>30</sup>	30 T1D patients	Insulin pump settings	Time in range (TIR)	Pump therapy could improve glycemic control
Messaoudi et al <sup>31</sup>	Two T1D patients (illustrative case report)	MiniMed 780G AHCL system	Efficacy, safety, and patient satisfaction	Demonstrable reliability and efficacy
Wannes et al <sup>32</sup>	19 adolescents and older children with T1D (8–16 y)	MiniMed standard HCL (670G) or AHCL (780G) systems	Coefficient of variation, TIR, and time in hypoglycemia	RF was associated with a maintained optimum TIR and no significant hypoglycemia
Al Ozairi et al <sup>33</sup>	32 T1D in a randomized crossover study	CGM during a baseline week of normal activity and resistance and aerobic exercise	Interstitial glucose responses during remotely supervised exercise	RF can safely reduce glucose levels and may be of greater benefit when performed in the evening
Al-Sofiani et al <sup>34</sup>	449 T1D patients	CareLink Personal data; MiniMed 780G system	Effectiveness and safety in real-world users	The system is effective, safe, and fast in adapting to the lifestyle changes
Elbarbary and Ismail <sup>24</sup>	50 adolescent and young adults with T1D	AHCL treatment by MiniMed 780G	Post-iftar glucose excursions	Less glucose excursions at iftar by vildagliptin add-on therapy
Wannes et al <sup>35</sup>	An 11-year-old adolescent with T1D	Open-loop sensor-augmented pump therapy with predictive low glucose, AHCL system	Glucose control metrics, quality of life	Illustrative case report of the impact of using progress in diabetes technology on diabetes control and quality of life

Abbreviations: AHCL, advanced hybrid closed-loop; CGM, continuous glucose monitoring; HCL, hybrid closed-loop; T1D, type 1 diabetes; T2D, type 2 diabetes; RF, Ramadan fasting.

significant difference in the percentage of time spent in hypoglycemia ranges. The investigators concluded that incorporating technological approaches to insulin pump therapy in clinical practice guidelines could improve glycemic control during Ramadan. Messaoudi et al assessed the efficacy, safety, and patient satisfaction of the MiniMed 780G AHCL system in managing glycemic control in two individuals with T1D throughout RF.<sup>31</sup> The glycemic target was established at 110 mg/dL, with the potential implementation of a temporary objective if blood glucose levels fell below 100 mg/dL. The glycemic parameters of CGM, including TIR, time above range, and time below range, were comparable in both patients before and during RF. In addition, there was a high level of satisfaction among the patients with the technology. These preliminary findings are encouraging and require further research involving more patients. Wannes et al assessed the efficacy and safety of a hybrid closed-loop (HCL) system during RF in a pediatric cohort with T1D.<sup>32</sup> Glucose control outcomes in older children and adolescents aged 8 to 16 years with automated insulin delivery for T1D were analyzed during Ramadan and 1 month before Ramadan. Participants on MiniMed standard HCL (670G) or advanced HCL (780G) systems of Medtronic were categorized as fasting or nonfasting. The average age of the 19 participants (8 and 11 on standard and advanced HCL systems, respectively) was 11.4 years. Eleven patients fasted during Ramadan. Pump setup and sensor statistics were the same during Ramadan and the month before; no difference was found between the two groups in terms of insulin and glucose control metrics, with practically the same coefficient of variation, TIR, and time spent in hypoglycemia, maintained within the international recommended targets. Total daily doses were paradoxically higher in patients who fasted during Ramadan ( $p = 0.01$ ) without repercussions on glucose control metrics. The investigators concluded that standard and advanced HCL use during Ramadan was safe and was associated with a maintained TIR greater than 70% and no significant hypoglycemia in adolescents and older children with T1D. Al Ozairi et al compared glucose responses in remotely supervised exercise performed before or after breaking the fast in people with T1D in a randomized crossover design study in Kuwait.<sup>33</sup> Thirty-two participants were recruited for the study (mean age: 34 years; body mass index [BMI]: 26 kg/m<sup>2</sup>). Glucose levels were measured using CGM during a baseline week of normal activity. Remotely supervised exercise was performed thrice weekly, either before or after breaking the fast. The exercise involved resistance and aerobic exercise and was supervised during a video call. The authors demonstrated that remotely supervised exercise performed during Ramadan can safely reduce glucose levels and may be of greater benefit when performed in the evening. Al-Sofiani et al<sup>34</sup> reported on the effectiveness and safety of the MiniMed 780G automated insulin delivery system in real-world users during Ramadan. Care-Link Personal data were extracted from MiniMed 780G system users from the Gulf region. Users were included if they had  $\geq 10$  days of sensor glucose data during the month of Ramadan 2022 and in the month before and after. For the

main analysis, CGM endpoints were aggregated monthly and reported by time of day (daytime and nighttime). Additional analyses were performed to study the pace at which the algorithm adapts. Glycemic control was well kept in the 449 included users (mean sensor glucose = 153 mg/dL; glucose management indicator = 7.0%; TIR = 70.7%; time below 70 mg/dL = 2.3%). Although some metrics differed from the month before, absolute differences were small and were considered clinically irrelevant. During Ramadan, there was no increased risk of hypoglycemia during daytime, TIR was highest during daytime (80.0% vs. 60.4% during nighttime), while time above 180 mg/dL was highest during nighttime. The algorithm adapted immediately upon lifestyle change. The investigators concluded that the MiniMed 780G automated insulin delivery system is effective, safe, and fast in adapting to the substantial changes in the lifestyle of people with T1D during Ramadan. In the investigation of the efficacy and safety of vildagliptin as an add-on therapy on glucose excursions of iftar Ramadan meals among adolescents and young adults with T1D described by Elbarbary and Ismail, 50 T1D patients employed the MiniMed 780G AHCL system, as discussed earlier.<sup>24</sup> Also, Wannes et al described insulin pump therapy and glucose control during RF in a child with T1D.<sup>35</sup> This illustrates progressing from an open-loop sensor-augmented pump therapy with predictive low-glucose management to an AHCL system. The child fasted for two successive Ramadan seasons under two innovative insulin administration technologies regarding diabetes management. He had an 8-year history of diabetes, and his case exemplifies the progression from a conventional regimen to an AHCL system over the past decade in terms of diabetes management and treatment and the testing of multiple daily injections (MDIs) and continuous subcutaneous insulin infusion (CSII) therapy. The authors argued that the AHCL system, with automatic adjustments of basal insulin delivery and automated bolus correction in response to CGM readings and a flexible, temporary target feature, allows improved glycemic outcomes and reduced hypoglycemia during fasting periods of more than 14 hours per day during the month of Ramadan, which could not be reached using the advanced CSII with the suspend before low system. Further study on a larger scale should be performed to confirm their findings.

Furthermore, Litvinova et al attempted to systematize the global patenting trends of digital sensors for CGM and analyze their effectiveness in controlling the treatment of patients with diabetes of different ages and risk groups.<sup>36</sup> The LENS database was used to build the patent landscape of sensors for CGM. A retrospective analysis showed that the patenting of sensors for CGM had a positive trend over the analyzed period (2000–2022). Several leading development companies are involved. Since 2006, a new approach has emerged where digital sensors are used for CGM, and smartphones act as receivers for the data. Additionally, telemedicine communication is employed to facilitate this process. This opens up new opportunities for assessing the glycemic profile (glycemic curve information, quantitative assessment of the duration and amplitude of glucose fluctuations, and so on), which may contribute to improved diabetes



management. Several digital sensors for minimally invasive glucose monitoring are patented, have received Food and Drug Administration (FDA) approval, and have been on the market for over 10 years. Their effectiveness in the clinic has been proven, and the advantages and disadvantages have been clarified. Digital sensors offer a noninvasive option for monitoring blood glucose levels, providing an alternative to traditional invasive methods. This is particularly useful for patients with diabetes who require frequent monitoring, including before and after meals, during and after exercise, and in other scenarios where glucose levels can fluctuate. However, noninvasive glucose measurements can also benefit patients without diabetes, such as those following a dietary treatment plan, pregnant women, and individuals during fasting periods like Ramadan. The availability of noninvasive monitoring is especially valuable for patients in high-risk groups and across different age ranges. New world trends have been identified in patenting digital sensors for noninvasive glucose monitoring in interstitial skin fluid, saliva, sweat, tear fluid, and exhaled air. Several noninvasive devices have received the CE mark approval, which confirms that the items meet the European health, safety, and environmental protection standards. The sensors mentioned earlier have characteristics that make them popular in treating diabetes: they do not require implantation, do not cause an organism reaction to a foreign body, and are convenient to use. The development of systems, which include digital sensors for CGM, mobile applications, and web platforms for professional analysis of glycemic control and implementation of unified glycemic assessment principles in mobile health care, represents promising approaches to controlling glycemia in patients.

## Ramadan Fasting and Diabetes in Special Groups

### Diabetes in Pregnancy

In 2023, two studies addressed glucose control during pregnancy,<sup>37,38</sup> and one focused on the outcome.<sup>39</sup> Alsulami and Ghamri determined the fasting and postprandial blood glucose levels.<sup>37</sup> They predicted hypoglycemia risk factors through a prospective cohort study at a single tertiary hospital in 53 pregnant women with gestational diabetes mellitus (GDM) and 17 pregnant women with T2D in their second and third trimesters during RF. The FBG and PPBG levels during Ramadan were compared to those of the previous month, and hypoglycemia was defined as blood glucose less than 60 mg/dL. The GDM and T2D groups were similar in age, parity, number of fasting days, and daily fasting hours. Only 26.9% of the women permitted to fast were given special instructions for RF. Dietary intervention was more common in the GDM group, whereas insulin and metformin treatment was more common in the T2D group. Fasting glucose FBG levels decreased significantly after RF in both groups. However, there was a significantly higher number of hypoglycemia events in the T2D group. Alamoudi et al conducted a prospective observational study in Jeddah to compare the risk of hypoglycemia, glucose patterns, and fasting tolerance in pregnant women with GDM versus women without GDM during Ramadan.<sup>38</sup> Pregnant women

with and without GDM managed by diet or metformin who were planning on fasting during Ramadan and were dedicated to applying an FGM device for 2 weeks were recruited. Women with GDM received standard-of-care diabetes education regarding fasting during Ramadan. Thirty women with gestational age  $\geq 24$  weeks completed the study: 8 without GDM (group 1), 16 with GDM on diet (group 2), and 6 with GDM on metformin (group 3). Mean age, body mass index, and prior pregnancies were not different. Breaking RF was reported in 43% of all participants because of hypoglycemia, hyperglycemia, and other reasons, including fatigue and acute illness. On the other hand, Abdullah et al<sup>39</sup> compared maternal and perinatal outcomes of RF during pregnancy in women with and without GDM in a prospective case-control study conducted in Karachi, Pakistan. Normoglycemic pregnant women and those identified as GDM ( $n=52$ ) on oral glucose tolerance tests who fasted during Ramadan were included. Women with GDM were categorized into those on diet control and those on diet plus metformin. The study questionnaire included demographic details, days of fasting, and self-reported hypoglycemic episodes. Maternal outcomes included preterm birth and pregnancy-induced hypertension. The perinatal outcome included hyperbilirubinemia, hypoglycemia, weight of the placenta, and Apgar score. Fifty-seven women with GDM and 25 women with normoglycemia were included in the study. Average days of fasting were 16 days (range: 5–30 days). Women with GDM were older; had raised levels of HbA1c, mean FBS, and mean RBS; and had higher BMI at delivery. The HbA1c level and the head circumference of the baby were found to be lower in those who fasted for more than 20 days among normoglycemic pregnant women. No other maternal and neonatal outcomes were found to be significantly affected by RF among pregnant women with/without GDM.

These studies suggest that pregnant women with non-insulin-treated GDM, compared to those without GDM, experienced similar difficulties in tolerating RF and increased risk of hypoglycemia.<sup>38</sup> RF may improve fasting glucose control in pregnancy and T2D was identified as a risk factor for hypoglycemia.<sup>38</sup> Also, GDM does not affect maternal and perinatal outcomes among pregnant women during RF. However, the studies are limited by the small sample size and observational design.<sup>39</sup>

### Older Adults

The safety and tolerability of SGLT inhibitors among older adults with T2D fasting during Ramadan were evaluated in 100 patients aged  $\geq 60$  years.<sup>28</sup> In group 1, 50 patients were on vildagliptin and metformin, and in group 2, 50 patients were on empagliflozin and metformin. HbA1c and estimated glomerular filtration rate (eGFR) were measured before and 2 months after Ramadan. Episodes suggesting hypoglycemia and volume depletion were estimated. Days to break fasting were also compared. The mean age and HbA1c of the two groups were not different. No difference was observed in episodes suggesting hypoglycemia and volume depletion, nor days to break fasting, suggesting that SGLT2 inhibitors may be used safely as they were well tolerated among older

adults with T2D fasting during Ramadan, provided patients were well prepared and educated.

### Young Adults

The behavior and attitudes of a population with T1D during and outside of Ramadan were examined in a descriptive study in two health establishments in Constantine, Algeria.<sup>40</sup> The study involved 63 patients with T1D from both sexes with a mean age of 21.2 years. The average duration of diabetes was 6.6 years. HbA1c averaged 8.1%. Less than a third (28.6%) of the patients practiced RF, averaging 13.8 days. Only 31.7% consulted their doctors before observing RF, and 77.8% monitored their blood sugar mainly before breaking the fast. COVID-19 affected 15.9% patients, and hyperglycemia was the most recorded diabetes-related complication. Therefore, despite health risks, if patients with T1D insist on fasting, early consultation and diabetes monitoring before RF are recommended.

### Complications

#### Diabetic Ketoacidosis and Hypoglycemia

Ata et al examined the differences in the number of DKA episodes during Ramadan compared to the rest of the year in patients with T1D and T2D in Qatar with view to examine the seasonality of DKA between 2015 and 2021.<sup>41</sup> Of 922 patients, 52% had T1D and 48% had T2D. The median age was 35 years. There were 94 DKA admissions in six collective Ramadans, whereas the DKA admissions ranged from 61 to 88 episodes in other months ( $p=0.3$ ). The highest DKA admissions were observed in autumn ( $N=236$ ) and the lowest in spring ( $N=226$ ;  $p=NS$ ). Also, Ruqaib et al evaluated the factors associated with the increased risk of DKA during Ramadan among patients on SGLT2 inhibitors and assessed DKA risk during RF in a retrospective study in 99 patients with T2D treated with empagliflozin.<sup>42</sup> Most patients ( $n=61$ ) had a 6- to 10-year history of diabetes. About 93% of the patients were used to RF, whereas only 5 patients did not fast previously during Ramadan. The patients had known complications, such as hypertension, dyslipidemia, cardiovascular disease, and other associated diseases. None of the participants had DKA during RF. Thirty-one of the fasting patients broke fasting during Ramadan for 1 to 5 days, and only 2 did so for more than 6 days. On the other hand, Tan et al explored driving experiences and coping strategies to ensure safe driving among people with T2D who fasted during Ramadan in an exploratory qualitative study.<sup>43</sup> They purposefully selected people with T2D who drove and fasted during Ramadan. Two major themes were identified: (1) knowing oneself and (2) voluntary self-restriction. Participants described the importance of understanding how RF affected them and their level of alertness. Participants often adjusted their daily activities and tested their blood glucose levels to prevent experiencing hypoglycemia. Other coping strategies reported were adjusting their medications and driving restrictions or driving in the mornings when they are more alert.

In conclusion, these studies lend support to the notion that DKA occurrence does not increase during Ramadan,

with no evidence of seasonal variations in the rates of DKA. Also, because of the risks and effects of hypoglycemia among those who fast, there is a need to provide appropriate and focused patient education during Ramadan to people with T2D to ensure safe performance of complex activities such as driving. SGLT2 inhibitors are effective antidiabetic agents that can be safely used in PWD during RF. Finally, understanding the experiences and coping mechanisms of PWD while driving during Ramadan should help in the management of diabetes during RF.

#### Renal Disease

Mohammad et al studied the effect of RF on diabetic nephropathy in patients with T2D. They included 90 patients, aged between 40 and 60 years, wishing to fast the whole of Ramadan.<sup>44</sup> There was a highly statistically significant increase in serum creatinine and serum urea after Ramadan in all the studied groups. The change in GFR was higher in macroalbuminuria. The percentage change in the urine albumin-to-creatinine ratio (UACR) in the micro- and macroalbuminuria groups was significantly lower than that in the normoalbuminuria and macroalbuminuria groups. No significant differences were found regarding the BMI, systolic blood pressure, diastolic blood pressure, FBG, postprandial blood glucose, and HbA1c before and after Ramadan. The authors concluded that RF had no harmful impact on albuminuria among patients with T2D. However, fasting led to a significant decline in renal function parameters among PWD and albuminuria. This decline is more prominent in patients with macroalbuminuria than in those with microalbuminuria. Thus, fasting should be avoided in patients with a severe renal impairment. Adequate hydration and dietary modification should be stressed during pre-Ramadan health care education. On the other hand, no negative impacts on glycemic control and other metabolic parameters were observed. Nevertheless, further trials to assess the role of fasting in at-risk patients are still needed.

#### Cardiovascular Disease

Tahapary et al aimed to determine intercellular adhesion molecule-1 (ICAM-1) changes in T2D and non-DM patients during RF.<sup>45</sup> A retrospective cohort study was performed on 26 patients with T2D and 21 persons without DM. Measurements were taken 4 weeks before (T0) and 14 days after RF (T1). The median ICAM-1 level in T2D patients was 340.9 ng/mL at T0 and 312.3 ng/mL at T1, while the ICAM-1 level in nondiabetic patients was 482 at T0 and 398.4 ng/mL at T1. There was no significant difference in the ICAM-1 level between the study groups at both T0 and T1 ( $p>0.05$ ). Both T2D and non-DM patients had lower ICAM-1 levels following RF. However, only non-DM persons had a significantly lower post-Ramadan ICAM-1 ( $p=0.008$ ). The investigators concluded that there was a significant decrease in the ICAM-1 level in T2D and non-DM patients after RF.

#### Mental Health

Akkuş and Kiliç studied the feelings, difficulties, attitudes, and spiritual coping status of Turkish patients with T2D

toward RF.<sup>46</sup> The sample of this descriptive qualitative study consists of 14 patients diagnosed with T2D. They determined two main themes and relevant subthemes. The first was “the feelings and difficulties experienced due to diabetes mellitus” with the subthemes 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.” The authors concluded that PWD continued to fast despite difficulties and facilitated coping and relaxation.

### COVID-19

Different aspects of the impact of COVID-19 infection on diabetes for people observing RF were assessed by a few investigators.<sup>47–51</sup>

The DaR Global survey was conducted in 13 countries to assess the impact of the COVID-19 pandemic on the intentions to fast and the outcomes of fasting in PWD with chronic kidney disease (CKD).<sup>47</sup> The study included 6,736 PWD, of which 10.5% had CKD. There were 16.7% patients with T1D and 83.3% with T2D, and 65.2% patients with T1D and 76.1% with T2D had CKD. Episodes of hypoglycemia and hyperglycemia were more frequent among people with T1D compared to those with T2D (64.5 and 43.5% vs. 25.2 and 22.3%, respectively). Visits to the emergency department and hospitalization were more frequent among people with CKD, but no significant difference was found between people with T1D and T2D. Therefore, the COVID-19 pandemic seemed to have only a minor effect on the intention to fast during Ramadan in PWD and people with CKD, and hypoglycemia, hyperglycemia, emergency visits, and hospital admissions were more frequent among people with diabetic kidney disease.

Alamoudi et al<sup>48</sup> compared patients in Saudi Arabia with other countries regarding patient attitudes toward RF and complications related to fasting during the COVID-19 pandemic. Data were collected from Saudi Arabia and 12 other Muslim-majority countries via physician-administered questionnaires within post-Ramadan 2020. A total of 1,485 T1D patients were analyzed; 47.5% were Saudis. In total, 1,056 (71.1%) participants fasted during Ramadan, of which 636 (90.2%) were Saudi patients. The COVID-19 pandemic did not affect the decision to fast in Saudi patients with T1D, while it significantly influenced the decision in other countries (1.4 vs. 9.9%,  $p < 0.001$ ). More Saudis needed to break the fast due to a diabetes-related complication compared to others (67.4 vs. 46.8%,  $p \leq 0.001$ ). The mean number of fasting days in Saudi Arabia and other countries was 24 and 23, respectively. Hypoglycemic events were more common among Saudis during Ramadan compared to other countries. There was a significant difference in timing; the largest peak for Saudi patients was after dawn, while it was presunset for patients from the other countries. Daytime hyperglycemia was also more common among Saudi patients. However, it was a less likely cause to break the fast. The investigators noted that observing RF is extremely common among Saudi T1D patients compared to other Muslim countries. It was not affected by the COVID-19 pandemic and was

associated with a higher frequency of hypoglycemic and hyperglycemic episodes.

Babiker et al<sup>49</sup> reported a cross-sectional study that assessed the effect of the lockdown during the COVID-19 pandemic on the lifestyle and quality of life (QoL) on fasting children living with T1D during Ramadan in the Middle East and North Africa (2020–2021). They compared the child (self) and parent (proxy) reports using PEDQoL v3.0 disease-specific questionnaires during the lockdown and non-lockdown periods. They also assessed the correlations with lifestyle changes using regression and gap analyses. A total of 998 reports from 499 children with T1D aged 8 to 18 years (study = 276 children; control = 223 children) and their parents during RF in lockdown and nonlockdown periods. Fathers were more involved in their children’s care during lockdown. Patients had better compliance with treatment, a reversed sleep pattern, increased food intake, and less exercise. Children and parents perceived better QoL during lockdown. Self-reports and proxy reports differed in all domains during the nonlockdown period. In gap analysis in the study, the gap was approximated between children’s and parents’ perceptions in all domains during lockdown, but that was not statistically significant.

### Cultural, Professional, and Advocacy Perspectives

Alabbod et al<sup>50</sup> investigated the approaches adopted by Iraqi physicians to manage diabetes during Ramadan through a cross-sectional online survey. The participants were specialist Iraqi doctors from different regions involved in managing PWD. In total, 140 responses were collected in this study. Most participants were family physicians, followed by internal medicine physicians and endocrinologists. Among the respondents, 94.3% advised their patients regarding RF; 84.3% of this advice was based on several factors. Over half (53%) do not follow a specific guideline and depend on their experience (70.2% of them were family physicians). Pre-Ramadan education was provided by 75% of participants. A minority (14.3%) allowed patients with T1D to fast, and 32.1% allowed those with T2D on insulin to fast. Recent DKA and severe hypoglycemia were the main reasons for not allowing people to fast.

Regarding treatment modification during fasting, 56.4% of physicians changed the frequency of administration. Finally, 67.8% scored 7/10 or above in the questions to test physicians’ familiarity with the established international guidelines. This survey underscores the importance of medical education for doctors, particularly family physicians.

Hillier et al<sup>51</sup> evaluated the HCPs’ knowledge, attitudes, practices, and perspectives in providing care to Muslims in Western countries who fast during Ramadan, intending to identify research gaps and opportunities for improving health care services for Muslims during Ramadan. Their scoping review found that HCPs’ knowledge of RF practices varies, with many needing more adequate knowledge. While HCPs recognize potential health complications, adjustments to medications for fasting patients, especially those with diabetes, are often neglected. Challenges in care included language barriers, limited cultural training, and resource awareness. Strategies identified to address barriers include

reducing language barriers, providing resources in relevant languages, and enhancing cultural competence training. Further research is required on HCPs' knowledge of providing care to Muslims during Ramadan, the impact of cultural competency training, and diverse health care interventions for fasting Muslims. Addressing these gaps may enhance culturally safe care and improve patient outcomes.

Haque et al<sup>52</sup> shared their approach to optimizing care for Bangladeshi patients with diabetes in the United States, with particular attention to culturally sensitive care and nutrition counseling. Culturally sensitive care is an approach to health care that considers a patient's cultural background, beliefs, and values when providing medical care. The authors concluded that health care providers should be aware of and respect cultural differences, involve family members in caring for Bangladeshi patients, provide language-concordant care, and incorporate traditional Bangladeshi foods and religious practices into the nutrition counseling plan. They also noted that by providing culturally sensitive care and nutrition counseling, health care providers can improve diabetes management and ultimately improve the QoL not only for Bangladeshi patients with diabetes but also for those from other cultural backgrounds.

## Conclusion

The impact of RF on diabetes continued to interest health care providers and researchers in 2023. However, the literature volume of 2023 was smaller than in the preceding couple of years.<sup>6–8</sup> The themes were similar to the previous years, with increased interest in newer medications. They were particularly building up on the safety profile of the newest class of drugs, namely, SGLT2 inhibitors. Different groups were interested in the validation and utility of the DAR-IDF risk stratification scale. The benefit of diabetes technology during Ramadan was assessed in both T1D and T2D patients. Isolated reports addressed diabetic emergencies, COVID-19, cardiovascular risk, and patient and professional perspectives. Although the field of RF and diabetes may have been deemed saturated, it will remain as dynamic as diabetes care itself evolves around safer fasting for PWD, wider awareness among health care providers and patients, the safety of the newer medications, in addition to the emerging concepts around RF in PWD.

### Authors' Contributions

All named authors contributed to the article's drafting, revision, and finalization to fulfill the ICMJE authorship criteria.

### Compliance with Ethical Principles

Formal ethical approval is not required.

### Funding

None.

### Conflict of Interest

None declared.

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