



# Management of Diabetes Mellitus in Islamic Fasting

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ARTICLE INFO	ABSTRACT
<p><i>Article type:</i> Review Article</p>	<p><b>Introduction:</b> Millions of Muslims across the globe fast during the holy month of Ramadan, as well as on the other specific dates of the lunar calendar. Although the Islamic law exempts patients from fasting, more than 50 million Muslim patients with diabetes mellitus fast during Ramadan. Ramadan fasting in diabetic patients may increase the risk of various complications, such as hypoglycemia, hyperglycemia, diabetic ketoacidosis, hypovolemia, and thrombosis. This study aimed to review the safe management of blood glucose in the diabetic patients willing to fast during Ramadan.</p>
<p><i>Article History:</i> Received: 08 Jan 2019 Accepted: 05 Mar 2019 Published: 07 Apr 2019</p>	<p><b>Methods:</b> This literature review was conducted via searching in databases such as Medline, PubMed, PMC, Google Scholar, ScienceDirect, Cochrane Library, and the reference lists of relevant articles.</p>
<p><i>Keywords:</i> Diabetes Diabetes Complications Antidiabetic Medications Islamic Fasting Ramadan-focused Advice Medical Assessment before Ramadan Modifications in Medication Protocol</p>	<p><b>Results:</b> The diabetic patients who are willing to fast during Ramadan should be prepared within at least 1-2 months prior to the beginning of Ramadan through Ramadan-focused advice, medical assessment before Ramadan, modifications in their medication protocol, balanced diet, physical activity plans, and advice on the self-monitoring of blood glucose.</p> <p><b>Conclusion:</b> According to the results, safe Ramadan fasting in diabetic patients could be achieved with the help of healthcare providers, including physicians and pharmacists.</p>

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## Introduction

The five pillars of Islam include Shahada (faith), Salah (prayer), Zakāt (alms), Sawm (fasting), and Hajj (pilgrimage to Mecca) [1]. Millions of Muslims across the globe practice fasting during the holy month of Ramadan. In addition, the believers of Islam fast on other specific days of the lunar calendar. Fasting is an act of voluntary abstinence from eating and drinking. Muslims practicing Islamic fasting do not eat or drink from the sunrise until the sunset, and the average duration of Ramadan fasting is approximately 12-18 hours per day, depending on the season and geographical location [2]. According to prophet Muhammad (PBUH), fasting protects believers from sins and lustful desires like a shield. However, the Islamic law exempts patients, menstruating women,

pregnant women, breastfeeding women, the elderly, and travelers from fasting.

It has been estimated that 1.6 billion individuals follow Islam across the world [3]. The prevalence of diabetes among Muslims is approximately 90 million cases [4], while more than 50 million diabetic Muslims fast during Ramadan [5].

### **Health Benefits of Islamic Fasting**

Islamic fasting is similar to alternate day fasting and time-restricted feeding and is associated with several health benefits, including weight loss, reduced insulin resistance, blood glucose, and blood pressure, improved lipid profile, prevention of obesity, diabetes, cardiovascular diseases, and cancer,

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protection against neurodegeneration, diminished inflammation, improved general health, and extended life span [6].

### **Management of the Adverse Effects of Islamic Fasting**

Islamic intermittent fasting is associated with some adverse effects, such as dehydration, headaches, heartburn, constipation, decreased sleep quality, and anemia, which could be minimized with a balanced diet containing adequate fruits, vegetables, whole grains, and dairy products. Furthermore a healthy diet for fasting individuals should involve the avoidance of bulky, fatty and fried foods, as well as, drinking sufficient amounts of fluids (e.g., water, fruit juices, and soups) [7].

### **Islamic Fasting and Glucose Metabolism**

Lack of food intake while fasting decreases insulin secretion, thereby leading to the release of counter-regulatory hormones (e.g., glucagon and catecholamines), which causes glycogenolysis and gluconeogenesis. Prolonged fasting leads to the depletion of stored glycogen, followed by the release of fatty acids from adipocytes and the subsequent generation of

ketones. Ketones could be used as fuel by various organs, such as heart, liver, kidneys, and skeletal muscles [8].

This study aimed to review the safe management of blood glucose in the diabetic patients practicing Islamic fasting during the holy month of Ramadan, as well as on the other days of the lunar calendar.

### **Material and methods**

This literature review was conducted via searching in databases such as Medline, PubMed, PMC, ScienceDirect, Google Scholar, Cochrane Library, and the reference lists of relevant articles using keywords such as diabetes, diabetes complications, antidiabetic medications, diabetes mellitus, Islamic fasting, Ramadan fasting, Ramadan-focused advice, medical assessment before Ramadan, and modifications in the medication protocol.

### **Results**

Islamic fasting might be associated with few complications, such as hypoglycemia, hyperglycemia, diabetic ketoacidosis, hypovolemia, and thrombosis (Table 1).

**Table 1.** Diabetes Complications Associated with Islamic Fasting

Diabetes Complications	Author(s)	Proposed Mechanisms
Hypoglycemia	Loke S. C. et al. [9]	Risk of hypoglycemia increased by abstinence from eating in Islamic fasting
Hyperglycemia	Cryer P. E. et al. [12]	Prolonged fasting decreased insulin levels, which may induce glycogenolysis and gluconeogenesis, resulting in hyperglycemia.
	Al-Maatouq M. A. [13]	Excessive reduction of antidiabetic medication dosage to avoid hypoglycemic complications during fasting hours; excessive food intake during non-fasting hours may elevate the risk of hyperglycemia.
Diabetic Ketoacidosis	Almalki M. H. et al. [8]	Prolonged fasting caused the depletion of stored glycogen, followed by the release of fatty acids from adipocytes and the subsequent generation of ketones.
Hypovolemia	Maideen P., Mohamed N. et al. [7] Al-Maatouq M. A. [13]	Islamic fasting may be associated with dehydration due to the decreased fluid intake during fasting hours. Hyperglycemia induced by prolonged fasting caused osmotic diuresis, leading to electrolytes loss and hypovolemia.
Thrombosis	Al-Arouj M. et al. [5]	Risk of thrombosis increased due to fasting-induced dehydration, leading to increased blood viscosity and diabetes-associated hypercoagulability.

Diabetic patients may be able to fast safely during Ramadan by adopting some strategies, such as Ramadan-focused diabetes education, medical assessment before Ramadan, adherence

to a healthy diet, physical activity, blood glucose monitoring (Table 2), and physician-recommended modifications in their medication protocol (Table 3).

**Table 2.** Strategies for Safety of Ramadan Fasting in Diabetic Patients

Strategies	Author(s)	Recommendations
Ramadan-focused Diabetes Education	Bravis V. et al. [19]	Ramadan-focused diabetes education encompassed advice regarding meal planning, physical activity, self-monitoring of blood glucose (SMBG), dosage and timing of antidiabetic medications, and management of disease complications.
Pre-Ramadan Medical Assessment	Hassanein M. [20]	Healthcare professionals, diabetic patients, and caregivers needed to be trained on diabetes management in Ramadan fasting.
Balanced Diet	Hui E. et al. [22]	Diabetic patients willing to fast during Ramadan should be medically assessed 1-2 months prior to Ramadan by diabetes care specialists or primary healthcare physicians.
	Akbani M. F. et al. [60]	Diabetic patients practicing Islamic fasting should be encouraged to adhere to a healthy diet containing fiber-rich foods, vegetables, fruits, and foods with slow energy release (e.g., foods rich in complex carbohydrates).
Physical Activity Plan	Karamat M. A. et al. [64]	Diabetic patients should be advised to exercise during non-fasting hours.
	Qureshi B. [65]	Diabetic patients should be advised to consume complex carbohydrates and drink plenty of water before Taraweeh prayers to avoid hypoglycemia and dehydration.
SMBG	Masood S. N. et al. [66]	Safer Ramadan fasting could be assured in diabetic patients by encouraging SMBG.

**Table 3.** Physician-recommended Modifications in Medication Protocol

Antidiabetic Medications	Author(s)	Recommendations
Metformin	Al-Maatouq M. A. [13], Hui E. et al. [22]	Experts advise that two-thirds of daily dose of metformin be taken with Iftar, and the remaining dose of metformin be taken at Sahur.
Dipeptidyl Peptidase-4 (DPP4) Inhibitors	Aziz K. M. [36], Schweizer A. et al. [37], Hanif W. et al. [38], Shete A. et al. [39]	Safety and effectiveness of vildagliptin make it a viable treatment option for patients with type II diabetes who are willing to fast during Ramadan.
Glucagon-like Peptide-1 (GLP-1) Mimetics	Azar S. T. et al. [41], Brady E. M. et al. [42]	Effectiveness of liraglutide is comparable to that of sulfonylureas with the risk of hypoglycemia in Ramadan fasting.
Sodium-glucose Cotransporter-2 (SGLT-2) Inhibitors	Kelwade J. et al. [45]	SGLT-2 inhibitors should be initiated at least 2-4 weeks prior to Ramadan since they are associated with diuresis and fluid loss.
Sulfonylureas	Al-Arouj M. et al. [5] Al-Maatouq M. A. [13]	Caution is advised in patients using sulfonylureas during Ramadan. Two-thirds of the daily dose of sulfonylureas may be recommended at Iftar, with one-third administered at Sahur.
Meglitinides	Hassanein M. et al. [51]	Daily dose of meglitinides is divided and taken before Iftar and Sahur.
Thiazolidinediones	Almalki M. H. et al. [53]	Daily dose of thiazolidinediones is recommended to be adjusted as half a dose taken at Sahur (predawn meal), with the remaining one and a half dose taken at Iftar (sunset meal).
Alpha-glucosidase Inhibitors	Pan C. et al. [57]	Risk of hypoglycemia was low with acarbose monotherapy.
Insulin	Pathan M. F. et al. [58]	Blood glucose of patients with type II diabetes receiving insulin therapy and willing to fast during Ramadan could be managed with the injections of intermediate- or long-acting insulin and pre-meal, rapid-acting insulin.
	Ibrahim M. et al. [11]	Risk of hypoglycemia might decrease by administering rapid-acting insulin instead of regular human insulin before meals.
	Pathan M. F. et al. [58]	In Islamic fasting, patients receiving premixed insulins could take half of their usual evening dose at the predawn meal ( <i>Sahur</i> ), with the usual morning dose taken at the sunset meal (Iftar).
	Benbarka M. M. et al. [59]	Insulin pump is preferred in patients with type I diabetes who are willing to fast during Ramadan.

## Discussion

### **Diabetic Complications Associated with Islamic Fasting**

The diabetic patients who have the intention for prolonged fasting during Ramadan may be susceptible to potential complications, such as hypoglycemia, hyperglycemia, hypovolemia, thrombosis, and diabetic ketoacidosis [5].

### **Hypoglycemia**

Abstinence from food in Islamic fasting increases the risk of hypoglycemia. The rate of hypoglycemia has been reported to be 1.6 times higher in diabetic patients during fasting hours compared to non-fasting hours [9]. However, the Epidemiology of Diabetes and Ramadan (EPIDIAR) study estimated the risk of severe hypoglycemia to be 4.7 times higher in type I

diabetes and 7.5 times higher in type II diabetes during Ramadan fasting hours compared to non-fasting hours [10]. The risk of hypoglycemia could be prevented through measures such as regular blood glucose monitoring, pre-Ramadan assessment, avoidance of skipping predawn meals, and avoidance of strenuous physical activities while fasting [11].

### **Hyperglycemia**

Insulin secretion decreases due to the reduced circulating glucose levels while fasting. As such, prolonged fasting may lead to hyperglycemia due to the excessive glycogenolysis and gluconeogenesis induced by inadequate insulin levels in the patients with severe insulin deficiency [12]. Furthermore, the excessive reduction of antidiabetic dosage to avoid hypoglycemic complications while fasting and excessive food intake during the non-fasting hours in Ramadan may increase the risk of hyperglycemia [13]. According to the EPIDIAR, Ramadan fasting increases the incidence of severe hyperglycemia requiring hospitalization, and the risk is, approximately three-fold in type I diabetes and five-fold in type II diabetes [10].

### **Diabetic Ketoacidosis**

The risk of diabetic ketoacidosis may increase in the patients with type I diabetes who practice Islamic fasting. In these patients, prolonged fasting leads to the depletion of stored glycogen, which is followed by the release of fatty acids from adipocytes and the subsequent generation of ketones [8]. Inadequate insulin levels in diabetic patients leads to the excessive production of ketones, thereby causing diabetic ketoacidosis. On the other hand, the excessive reduction of the injective dose of insulin to avoid hypoglycemia during Islamic fasting may contribute to the development of diabetic ketoacidosis in type I diabetes. However, the incidence of diabetic ketoacidosis was not reported to increase significantly in Libyan diabetic patients practicing Islamic fasting during Ramadan [14].

### **Hypovolemia**

Islamic fasting may be associated with dehydration since fluid intake is restricted during fasting hours [7]. Hyperglycemia induced by prolonged fasting causes osmotic diuresis,

thereby leading to electrolytes loss, hypovolemia, and orthostatic hypotension [13]. Hypovolemia and orthostatic hypotension may cause syncope, falls, injuries, and bone fractures.

### **Thrombosis**

The risk of thrombosis increases in fasting individuals due to the induced dehydration and leads to increased blood viscosity and diabetes-associated hypercoagulability [5].

### **Management of the Diabetic Patients Practicing Islamic Fasting**

The diabetic patients who are willing to fast during Ramadan are classified into four categories, including extremely high-risk, high-risk, at moderate risk, and low-risk [15]. Therefore, these patients should be prepared prior to Ramadan in order to prevent the complications associated with fasting.

### **Strategies to Enhance the Safety of Ramadan Fasting in Diabetic Patients**

The diabetic patients who intend to fast during Ramadan should adopt some strategies to ensure safety; such examples are Ramadan-focused diabetes education, medical assessment before Ramadan, physician-recommended modifications in their medication protocol, adherence to a healthy diet, physical activity, and blood glucose monitoring [5].

### **Ramadan-focused Advice**

Ramadan-focused diabetes education could ensure improved glycemic control, weight loss, reduction of low-density lipoprotein cholesterol, and safe fasting practices in diabetic patients [16-18]. Such education encompasses recommendations regarding meal planning, physical activity, self-monitoring of blood glucose (SMBG), dosage and timing of antidiabetic medications, and management of the possible complications [19].

Healthcare professionals, diabetic patients, and their caregivers must be trained on proper diabetes management during Ramadan [20]. In this regard, a cross-sectional study conducted on 477 diabetic patients indicated that only 54.3% of the sample population received education about diabetes during Ramadan. Therefore, it is recommended that proper education and training be implemented by

healthcare providers to diabetic patients [21].

### **Medical Assessment before Ramadan**

The diabetic patients who are willing to fast during Ramadan should be assessed medically 1-2 months prior to Ramadan by diabetes specialists or primary healthcare physicians [22]. Moreover, the blood examination of these patients must be ordered and performed during their pre-Ramadan assessment. In addition, diabetic patients and their caregivers should be advised regarding the risks associated with fasting, changes in antidiabetic medications, dietary patterns, and physical activity [23].

### **Physician-recommended Modifications in Medication Protocol**

Antidiabetic medications include metformin, dipeptidyl peptidase-4 (DPP4) inhibitors, glucagon-like peptide-1 (GLP-1) agonists, sodium-glucose cotransporter-2 (SGLT-2) inhibitors, sulfonylureas, meglitinides, thiazolidinediones, alpha glucosidase inhibitors and insulin [24].

#### **Metformin**

Metformin is used as the first-line medication in the treatment of type II diabetes in overweight patients [25]. The rate of severe hypoglycemia is minimal with the use of metformin during Ramadan. In addition, experts recommend that two-thirds of the daily dose of metformin be taken with Iftar meals, while the remaining dose of metformin should be taken at the Sahur meal [13, 22].

#### **Dipeptidyl Peptidase-4 (DPP4) Inhibitors**

DPP4 inhibitors (e.g., sitagliptin and vildagliptin) have been most frequently investigated in Ramadan fasting in the patients with type II diabetes. Reports suggest that the use of DPP-4 inhibitors in Islamic fasting is preferred over the use of sulfonylureas [26].

The incidence of hypoglycemia has been reported to decrease in Ramadan fasting in the patients switching to sitagliptin therapy compared to those staying on sulfonylureas (e.g., glibenclamide and glimepiride) [27, 28]. In this regard, the STEADFAST study [29] and VECTOR study [30] have indicated that treatment with vildagliptin alone is effective in Ramadan fasting since it is associated with the

lower incidence of hypoglycemia compared to sulfonylureas. According to the VIRTUE study in the Middle East, Asia [31], Egypt [32] and Pakistan [33], vildagliptin-treated patients have proper blood glucose and body weight control, while they are at the lower risk of hypoglycemia, compared to sulfonylurea-treated patients [34].

According to the results of the VERDI study [35] and some other research in this regard, the safety and effectiveness of the aspects of vildagliptin make this drug a viable treatment option for the patients with type II diabetes who are willing to fast during Ramadan [36-39].

#### **Glucagon-like Peptide-1 (GLP-1) Agonists**

GLP-1 agonists (e.g., exenatide and liraglutide) have been investigated frequently during Ramadan in the patients with type II diabetes. According to the literature, the risk of hypoglycemia is low or nil in the patients using exenatide during Ramadan, while further investigations must be focused on the effectiveness of exenatide [40]. In this regard, the LIRA-Ramadan trial [41] and Treat 4 Ramadan Trial [42] have concluded that the effectiveness of liraglutide is comparable to that of sulfonylureas, with the lower risk of hypoglycemia in Ramadan fasting.

#### **Sodium-glucose Cotransporter-2 (SGLT-2) Inhibitors**

SGLT-2 inhibitors include dapagliflozin, canagliflozin, and empagliflozin. There are limited trials regarding the use of SGLT-2 inhibitors in the patients with type II diabetes during Ramadan. A study conducted in Dubai (United Arab Emirates) indicated that it is safe to use SGLT-2 inhibitors during Ramadan fasting [43]. Furthermore, the CRATOS study has demonstrated that the use of canagliflozin is associated with the reduced risk of hypoglycemia compared to sulphonylurea [44]. Treatment with SGLT-2 inhibitors should be initiated at least 2-4 weeks prior to Ramadan as these agents are associated with diuresis and fluid loss [45].

#### **Sulfonylureas**

Sulfonylureas are among the first-generation drugs (e.g., tolbutamide and, chlorpropamide) and second-generation drugs (e.g., gliclazide,

glipizide, and glibenclamide) [46]. Considering that sulfonylureas are insulin secretagogues, they are associated with the risk of hypoglycemia. Caution is advised in the patients using sulfonylureas during Ramadan [5].

A five-country observational study in this regard reported one or more symptomatic hypoglycemic events experienced by 271 patients (19.7%) among 1,378 participants during Ramadan. In addition, the incidence of hypoglycemia was reported to be higher (25.6%) in the glibenclamide-treated patients and lower (14%) in the gliclazide-treated patients [48]. Therefore, use of glibenclamide is not recommended in Islamic fasting due to the high risk of hypoglycemia, while gliclazide has been reported to be safer among various sulfonylureas in Islamic fasting since, it is associated with fewer hypoglycemic events [49]. Two-thirds of the daily dose of sulfonylureas may be recommended at Iftar, while one-third of the dosage should be administered at Suhour [13].

### **Meglitinides**

Meglitinides are short-acting insulin secretagogues, such as repaglinide and nateglinide. These agents are effective in the treatment of the patients with type II diabetes and irregular meal timing in order to decrease the postprandial glucose. Meglitinides are associated with the lower incidence of hypoglycemia compared to sulfonylureas [50]. Use of meglitinides may be preferred over sulfonylureas in Islamic fasting due to their shorter duration of action and lower risk of hypoglycemia. Preferably, their daily dose is divided, and they are taken before Iftar and Sahur [51].

### **Thiazolidinediones**

Thiazolidinediones are the agonists of PPAR- $\gamma$  receptors, such as rosiglitazone and pioglitazone [52]. The risk of hypoglycemia in thiazolidinedione monotherapy is low, and there is no need for dosage adjustment. However, the combination therapy may elevate the risk of hypoglycemia while fasting, and the daily dosage is recommended to be adjusted as half a dose taken at Sahur, with the remaining one and half dose taken at Iftar [53].

Use of thiazolidinediones is not widely

recommended during Ramadan due to side effects such as weight gain, water retention, and risk of heart failure [54]. According to a double-blind, randomized, multi-center study, the patients treated with pioglitazone during Ramadan had significant complaints of ankle edema and weight gain. Among 37 patients who received pioglitazone treatment, 16 cases complained of ankle edema [55].

### **Alpha-glucosidase Inhibitors**

Alpha-glucosidase inhibitors include acarbose, miglitol, and voglibose. Using these agents may have adverse gastrointestinal effects, such as flatulence, diarrhea, and abdominal pain [56]. On the other hand, the risk of hypoglycemia has been reported to be low with acarbose monotherapy in a randomized double-blind study [57]. The successful use of alpha-glucosidase inhibitors has also been reported in diabetic patients in the Middle East during Ramadan [11].

### **Insulin**

Management of the blood glucose of the patients with type II diabetes receiving insulin therapy who are willing to fast during Ramadan possible with the injections of intermediate- or long-acting insulin, as well as pre-meal, rapid-acting insulin [58]. The risk of hypoglycemia might decrease with the administration of rapid-acting insulin instead of regular human insulin before meals.

In many Muslim countries, the management of patients with type II diabetes is performed using premixed insulins [11]. In Islamic fasting, the patients receiving premixed insulins are allowed to take half of their usual evening dose at the predawn meal (Sahur) and their usual morning dose at the sunset meal (Iftar) [58]. Fasting may increase the risk of hypoglycemia in the patients using insulin, while the risk could reduce with the use of basal insulin analogs (e.g., detemir and glargine) or rapid-acting insulin analogs (lispro, aspart, and glulisine) [11].

Insulin pump is preferred in the patients with type I diabetes who are willing to fast during Ramadan [59]. Monitoring of blood glucose is also advised in the patients receiving insulin in order to prevent hyperglycemia due to excessive eating during non-fasting hours and the hypoglycemia caused by prolonged fasting.

Additionally, insulin pump helps to deliver insulin continuously over 24 hours, and it is easy to adjust the delivery of insulin from the insulin pump based on the blood glucose level.

### **Balanced Diet**

The blood glucose of diabetic patients might be controlled poorly if the dietary regimen during non-fasting hours is not managed properly. The diabetic patients practicing Islamic fasting should be encouraged to adhere to a healthy diet, which involves the consumption of fiber-rich foods, vegetables, fruits, and foods with slow energy release (e.g., rich in complex carbohydrates) [60, 61]. Other observations in this regard include the avoidance of high-calorie foods (e.g., sugary drinks) and foods rich in saturated and simple fats [62] at Iftar and Sahur [63].

### **Physical Activity Plan**

Diabetic patients are at a higher risk of dehydration and hypoglycemia while performing rigorous exercise during fasting hours and should be advised to exercise during non-fasting hours [64]. During Ramadan, the special night-time prayers (Taraweeh prayers) are performed daily and often last for 1-2 hours. Taraweeh prayers may also have the potential to induce dehydration and hypoglycemia [11]. The diabetic patients who perform Taraweeh prayers could consider it as a part of their daily exercise program [65]. In addition, fasting diabetic patients should be advised to consume complex carbohydrates and drink plenty of water before Taraweeh prayers in order to avoid hypoglycemia and dehydration.

### **Self-monitoring of Blood Glucose (SMBG)**

The blood glucose levels of fasting diabetic patients should be monitored during Ramadan for better glycemic control. According to the EPIDIAR study, only 67% of the patients with type I diabetes and 37% of the patients with type II diabetes performed the SMBG during Ramadan [10]. In contrast, a study conducted in Pakistan indicated that blood glucose levels were monitored by the majority of the patients (>90%) who received diabetes-related education [16]. Safer Ramadan fasting could be assured in diabetic patients by encouraging SMBG [66].

### **Self-management**

Diabetes self-management education (DSME) helps diabetic patients to recognize the basics of diabetes, dietary plans, physical activity, complications of diabetes, SMBG, and management of hypoglycemia and hyperglycemia in order to decrease the frequency of hypoglycemic episodes [67]. DSME and medication adjustment in Ramadan (DEAR) program emphasizes on the self-management of diabetes during Ramadan so as to improve glycemic control and decrease the complications of diabetes in the patients [68].

### **Recommendations to Prevent the Risk of Adverse Events**

In order to prevent the risk of adverse events in the diabetic patients willing to practice Ramadan fasting, these individuals must take specific measures, such as consulting healthcare providers at least one month prior to Ramadan, avoiding the skipping of Sahur, large meals at Iftar and Sahur, and strenuous physical exercise during fasting hours, frequent SMBG, and regular recording of blood glucose readings.

### **Role of Healthcare Providers**

Healthcare providers (e.g., general practitioners and pharmacists) play a pivotal role in the management of glycemic control in the diabetic patients practicing Ramadan fasting. According to a study performed in Pakistan, one-third of the studied general practitioners lacked the knowledge of diabetes management in Ramadan [69]. Therefore, the physicians employed in primary healthcare centers were recommended to attend related workshops, conferences, and meetings in order to receive training on the effective and safe management of diabetes during Ramadan [70].

Pharmacists could help the diabetic patients who fast during Ramadan by providing accurate information regarding the management of blood glucose [71, 72]. In a study conducted in Qatar, pharmacists were interested in participating in the management of diabetic patients during Ramadan [73]. On other hand, the findings of the study in Pakistan indicated that the hospital and community pharmacists needed to receive training on diabetes management during Ramadan [74]. Another study in Egypt emphasized on continuous educational

programs targeting practicing pharmacists to update their knowledge on the management of diabetes during Ramadan [75].

As Ramadan fasting is associated with the increased risks of diabetes complications, blood glucose management is considered a challenge for the patients and healthcare providers. In order to provide optimal care to the diabetic patients who are willing to fast during Ramadan, the International Diabetes Federation (IDF) and the Diabetes and Ramadan (DAR) International Alliance have collaboratively drafted the required standards known as IDF-DAR Practical Guidelines [76]. According to the "Diabetes Canada 2018 clinical practice guidelines for the prevention and management of diabetes", the diabetic patients who practice Islamic fasting during Ramadan should comply with the IDF-DAR Practical Guidelines [77].

## Conclusion

The Islamic law exempts patients from fasting during Ramadan. However, most of the patients with diabetes are willing to observe month-long fasting in Ramadan and may develop some complications, such as hypoglycemia, hyperglycemia, diabetic ketoacidosis, hypovolemia, and thrombosis. In order to avoid these complications, fasting diabetic patients should be prepared prior to Ramadan through receiving Ramadan-focused advice, pre-Ramadan medical assessment, modifications in their medication protocol, adherence to a balanced diet, physical activity plan, and advice on SMBG. Furthermore, healthcare providers, such as physicians and pharmacists, could play a key role in the blood glucose management of the diabetic patients practicing Islamic fasting during Ramadan.

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