

Diabetes and Ramadan

Practical Guidelines 2021



**International
Diabetes
Federation**



International Diabetes Federation (IDF), in collaboration with the
Diabetes and Ramadan (DAR) International Alliance

DISCLOSURE

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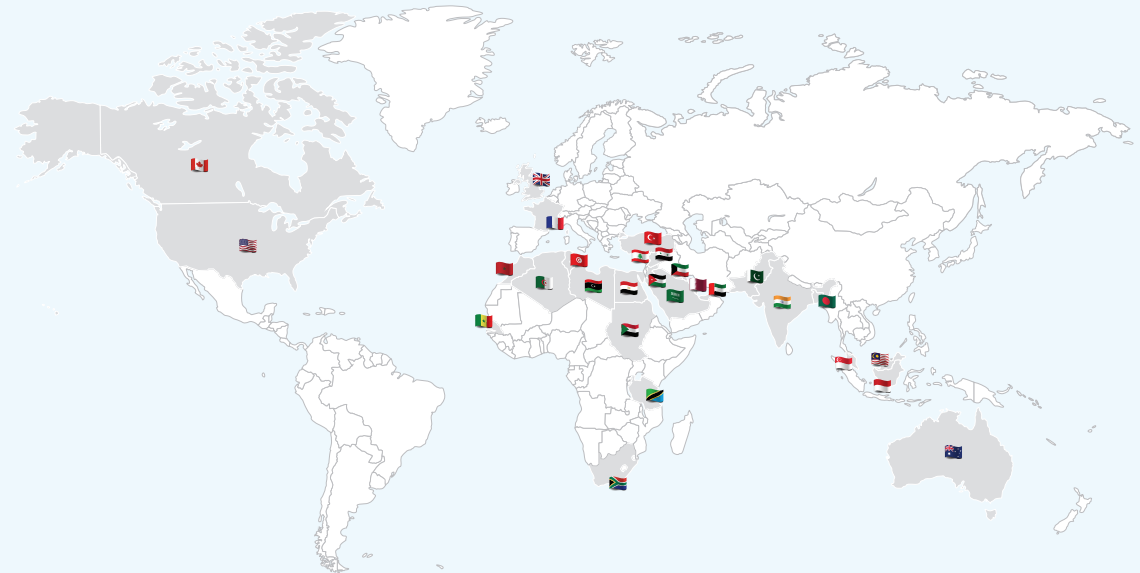
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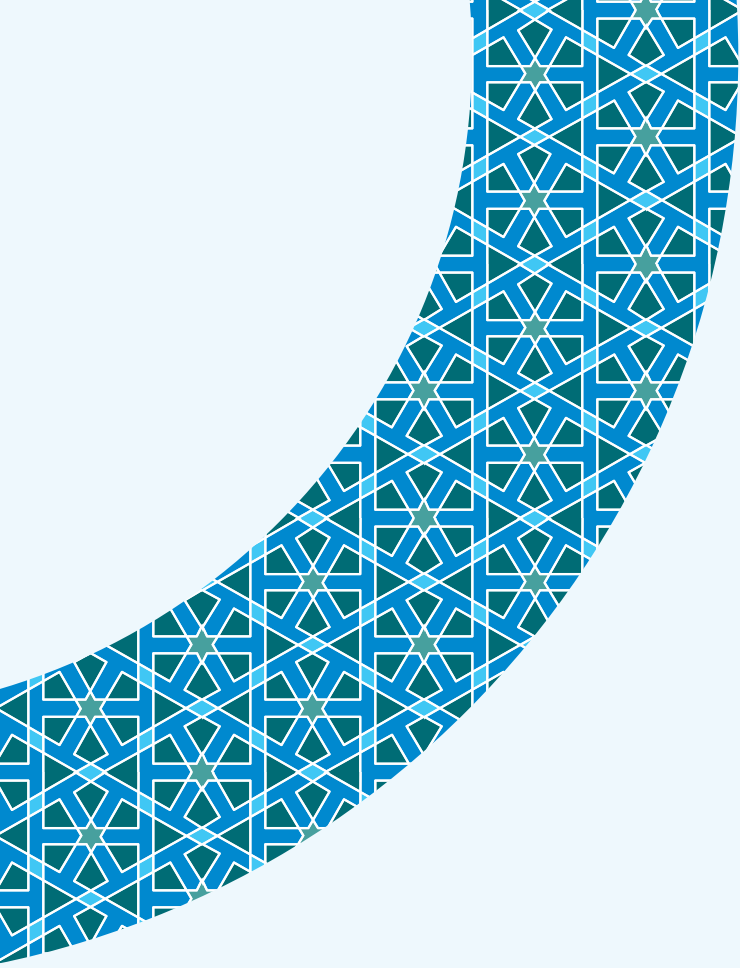
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FOREWORD

The holy month of Ramadan falls on the ninth month of the lunar calendar. It is one of the five pillars of Islam. Ramadan involves fasting every day for one month, between dawn and sunset. Fasting is an important component of Ramadan and allows Muslims to devote themselves to their faith.

Fasting is not recommended for everyone. People who are ill or live with a medical condition, including some people with diabetes, can be exempted. However, a majority of people living with diabetes choose to fast and sometimes choose to do so in contrary to medical advice. According to the latest estimates from the International Diabetes Federation (IDF), 463 million people are living with diabetes worldwide, a figure that is set to reach 700 million by 2045¹. This dramatic rise will be highest in regions with large Muslim populations such as Africa, Middle-East and North Africa and South-East Asia¹.

As a large number of people with diabetes fast during Ramadan, there is an urgent need for coherent, evidence-based, practical guidance to help them and the health professionals who support them to ensure a safe and healthy fast. IDF and the Diabetes and Ramadan (DAR) International Alliance have come together to deliver a comprehensive set of guidelines to meet this need.

This update of the IDF-DAR Practical Guidelines, first published in 2016, features new guidance based on a greater and more recent body of evidence. This includes an updated set of criteria for risk stratification; information on the impact of fasting on physical and mental well-being; specific guidance on the management of type 1 and type 2 diabetes in special populations such as pregnant women and the elderly; and information on changes to the risk of comorbidities such as cardiovascular disease, stroke and renal impairment.

These guidelines are intended to provide real-world recommendations to health professionals and the people with diabetes who choose to fast. It is our hope these guidelines will contribute to supporting people with diabetes to safely and successfully participate in Ramadan and enjoy the personal and spiritual benefits this can bring.

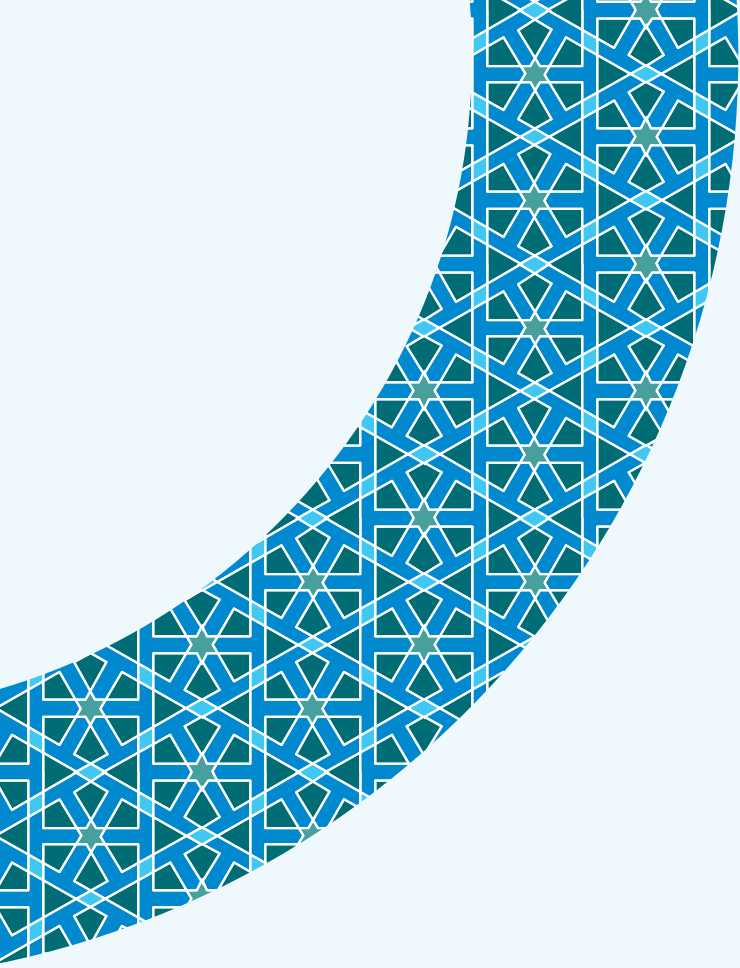
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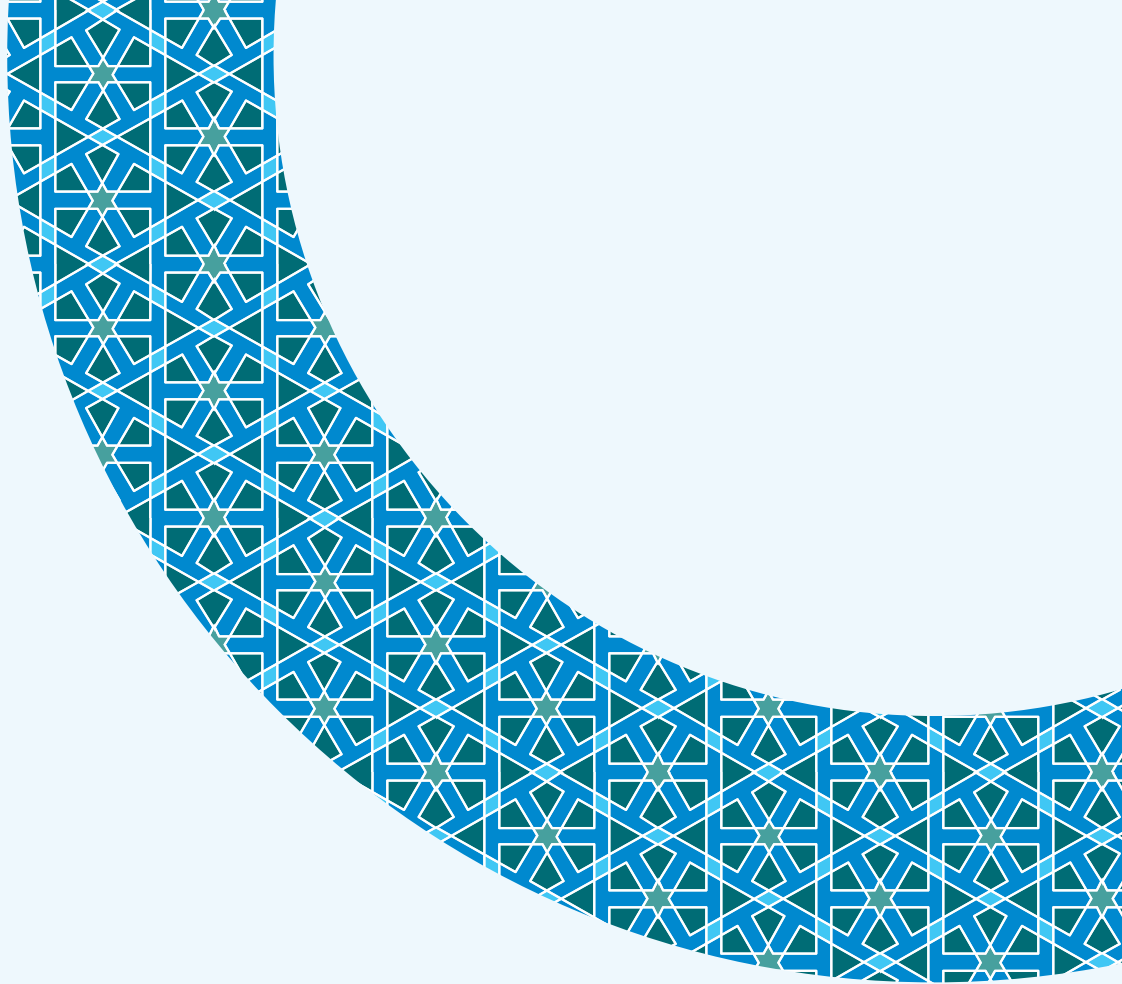


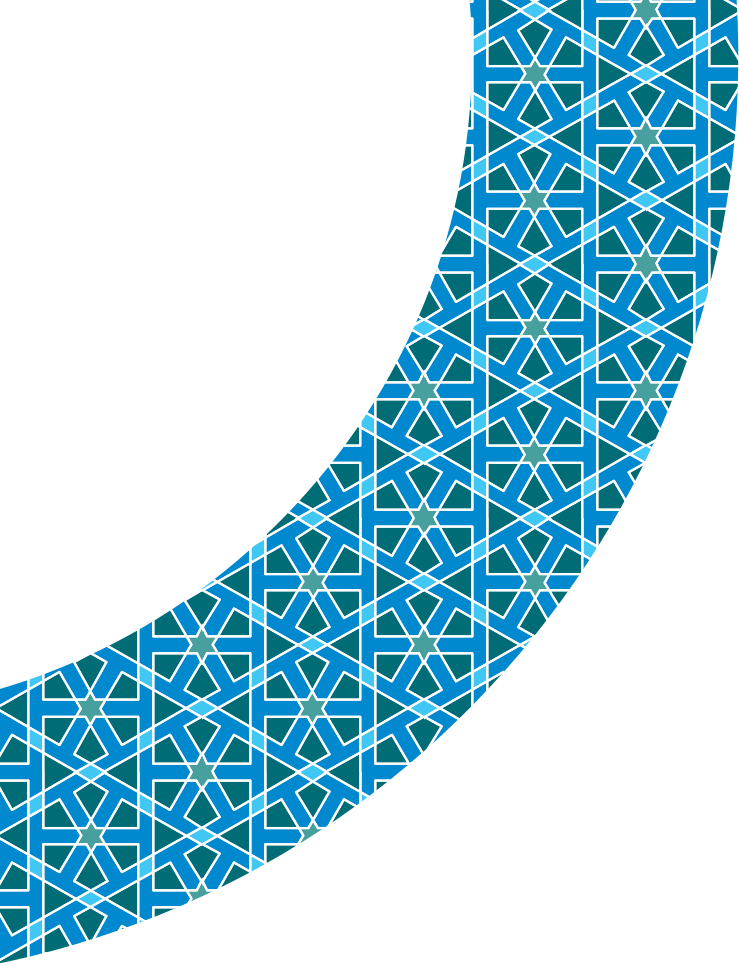
[1] International Diabetes Federation., IDF Diabetes Atlas. 2019. Brussels, Belgium.





CHAPTER 1	Introduction to the IDF-DAR Practical Guidelines	9
CHAPTER 2	Epidemiology of diabetes and fasting during Ramadan	21
CHAPTER 3	What happens to the body? Physiology of fasting during Ramadan	35
CHAPTER 4	The effects of fasting during Ramadan on physical and mental wellbeing	67
CHAPTER 5	Risk stratification of people with diabetes before Ramadan	87
CHAPTER 6	Diabetes and Ramadan: A medico-religious perspective	99
CHAPTER 7	Pre-Ramadan Assessment and Education	117
CHAPTER 8	The Ramadan Nutrition Plan (RNP) for people with diabetes	143
CHAPTER 9	Management of Type 1 diabetes when fasting during Ramadan	159
CHAPTER 10	Management of Type 2 diabetes when fasting during Ramadan	199
CHAPTER 11	Management of hyperglycaemia in pregnancy when fasting during Ramadan	245
CHAPTER 12	Management of diabetes among the elderly when fasting during Ramadan	257
CHAPTER 13	Risks of fasting during Ramadan: Cardiovascular, Cerebrovascular and Renal complications	271
CHAPTER 14	Identifying and overcoming barriers to guideline implementation	295
CHAPTER 15	Grading of evidence & areas of future research in diabetes and fasting during Ramadan	311
	GLOSSARY	325





CHAPTER 1

Introduction to the IDF-DAR Practical Guidelines

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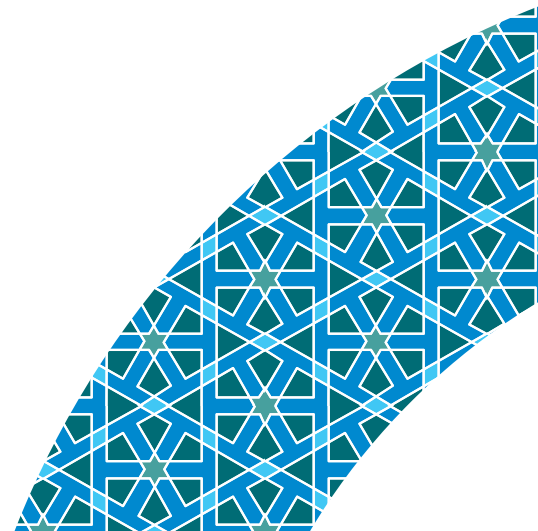
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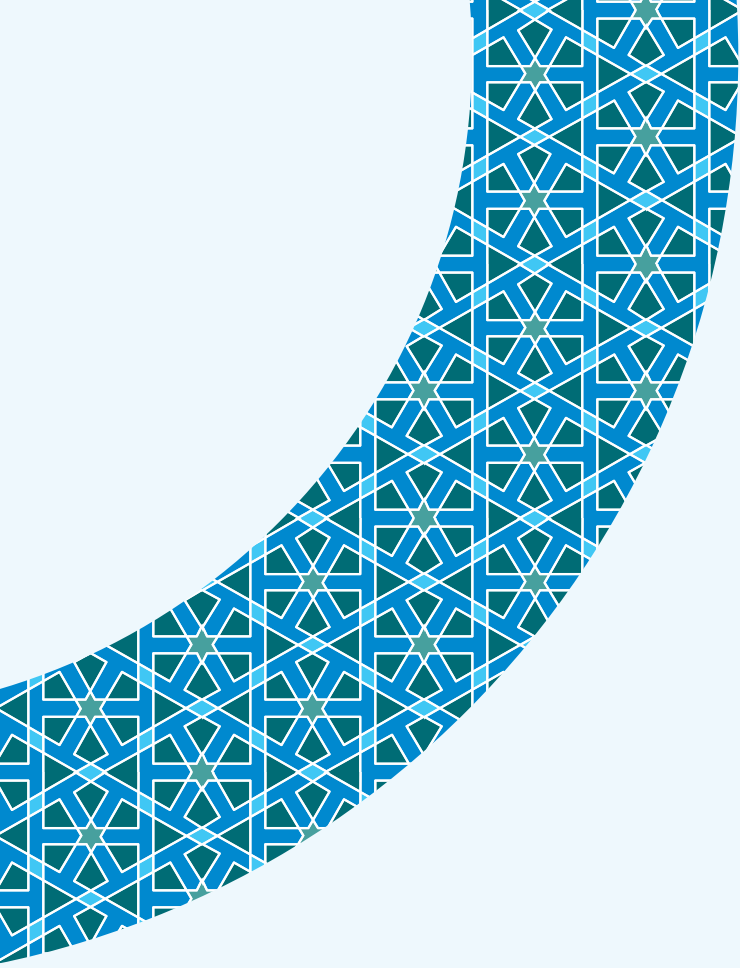
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CHAPTER 1

INDEX

1. RAMADAN FASTING REGULATIONS	12
2. THE NEED FOR PRACTICAL GUIDELINES ON DIABETES MANAGEMENT DURING RAMADAN FASTING	12
3. EPIDEMIOLOGY OF DIABETES IN MUSLIM POPULATIONS	13
4. PHYSIOLOGICAL EFFECTS OF FASTING, AND POTENTIAL RISKS TO PEOPLE WITH DIABETES	14
5. THE IMPORTANCE OF DIABETES AND RAMADAN EDUCATION	15
6. DIFFERENCES IN RAMADAN FASTING PRACTICES ACROSS THE WORLD: Consequences for Individuals with Diabetes	15
7. OPTIMISING STRATEGIES FOR THE MANAGEMENT OF DIABETES DURING RAMADAN	15
8. DISSEMINATING AND IMPLEMENTING THE GUIDELINES	16
SUMMARY	17
REFERENCES	18



1. RAMADAN FASTING REGULATIONS

Fasting during Ramadan is one of the five pillars of Islam and commemorates the time when the Holy Quran was revealed to Prophet Muhammad, peace be upon him. The month-long (29–30 day) fast is obligatory for all healthy Muslims who have reached puberty and is a time for spiritual contemplation and seeking nearness to God. Followers must refrain from eating and drinking between dawn and sunset, and must also abstain from using oral medications, sexual activity and smoking. It is believed that spiritual rewards for good deeds are multiplied during Ramadan, and there is an intense desire to participate in fasting, even among those who could seek exemption, such as the elderly, children, the infirm, and pregnant women. Missed fasts should be completed at other times; for example, when health is restored or after the delivery of a baby. Fasting outside of Ramadan (when the rest of the community is not observing a fast) can be challenging, and this may discourage people from taking advantage of granted exemptions. Those who are permanently incapacitated can compensate by *Fidya*, a donation of food or money to the poor, for every day's fast that is missed.

The timing of Ramadan is based on the lunar calendar (355 days per lunar year), which is shorter than the Gregorian (Western) calendar, and therefore Ramadan occurs 10–11 days earlier every year. This means that the duration of daylight fasting varies according to the time of year in which Ramadan falls. In some parts of the world, daylight can be as long as 20 hours in the peak of summer. Climate conditions also vary according to the date of Ramadan, with people fasting in very dry and hot weather some years and cold temperatures in others. Importantly, these factors may increase the risk of fasting among certain individuals that are particularly vulnerable, such as those with poorly controlled diabetes and those with comorbidities to diabetes. In order to achieve a safe fast during Ramadan, there needs to be a collaborative process between people with diabetes and healthcare professionals (HCPs) where advice is provided using the best available evidence that also allows for individualisation.

Many Muslims, even those who could seek exemption, have an intense desire to participate in fasting during Ramadan.

2. THE NEED FOR PRACTICAL GUIDELINES ON DIABETES MANAGEMENT DURING RAMADAN FASTING

The management of people with diabetes who fast during Ramadan has generally been based on expert opinion rather than medical evidence gained from scientific data. However, the introduction of the First Edition of IDF-DAR Diabetes and Ramadan Practical Guidelines, 2016 provided a practical tool to help HCPs support their approach to safely guide people with diabetes who wish to fast the holy Month of Ramadan [1].

Muslims living as a minority in any country, including The Americas, Oceania, Europe, may need extra attention since healthcare professionals (HCPs) who are not experienced in

dealing with fasting people with diabetes might not consult or even be aware of published recommendations [2]. Evidence-based guidelines are extremely important in supporting advice given to people with diabetes seeking to fast during Ramadan. To this end, research related to diabetes and Ramadan has tremendously increased in the last 5 years [3]. But a greater number of well-designed studies are still needed as important questions still remain:

- Is fasting during Ramadan associated with a significant risk or benefit for people with diabetes?
- What are the criteria that predispose people with diabetes to increased risk during fasting?
- What are the most effective methods of providing Ramadan focused education?
- What are the best possible nutrition plans for people with diabetes seeking to fast during Ramadan, and how can these be adapted for the different regions across the world?
- What are the most appropriate medications for people with diabetes who fast during Ramadan?
- Will the large number of new antidiabetic oral and injectable agents and newer devices bring us closer to safe management while fasting?
- What is the most appropriate type and regimen of insulin for people with diabetes who fast during Ramadan?

Most of the guidance available for the management of diabetes during Ramadan represents expert opinion rather than medical evidence.

Although the results from new clinical trials will provide much needed data in the future, there is an immediate requirement for up-to-date practical guidance. This second edition of the *IDF-DAR Diabetes and Ramadan Practical Guidelines* aims to address this need by providing HCPs with the latest evidence-based recommendations, allowing them to deliver the best possible care and support for people with diabetes fasting during Ramadan.

3. EPIDEMIOLOGY OF DIABETES IN MUSLIM POPULATIONS

In 2019 the number of people living with diabetes globally was estimated to be 463 million, with a rise of 51% (700 million) expected by 2045 [4]. The number of people with diabetes in the Middle East and North Africa (MENA) – a region where a high proportion of inhabitants are Muslim – is predicted to more than double by 2045. A similar increase is expected in South East Asia, another area where Islam predominates [4].



Ramadan is widely observed across the world. A recent survey in 39 countries involving over 38,000 Muslims reported that a median of 93% fasted during Ramadan [5]. The Epidemiology of Diabetes and Ramadan (EPIDIAR) study performed in 2001 found that 42.8% of people with type 1 diabetes mellitus (T1DM) and 78.7% of those with type 2 diabetes mellitus (T2DM) fasted for at least 15 days during Ramadan [6]. Likewise, the 2010 CREED study reported that 94.2% of participants with T2DM fasted for at least 15 days, and 63.6% fasted all days of Ramadan [2]. More recently, the DAR-MENA (Diabetes and Ramadan—Middle East and North Africa) T2DM study revealed that 86% of participants fasted for at least 15 days [7]. It is clear that fasting in Ramadan is a very important practice and has a major impact on the management of diabetes in Muslim population.

Considering that many Muslims living with diabetes are deciding to fast during Ramadan, the need for evidence based, practical guidance is greater than ever.

4. PHYSIOLOGICAL EFFECTS OF FASTING, AND POTENTIAL RISKS TO PEOPLE WITH DIABETES

Fasting during Ramadan has a number of physiological effects on both homeostatic and endocrine processes. In people with diabetes, these changes and the type of medication being taken to treat diabetes can be associated with the development of complications such as hypoglycaemia and hyperglycaemia [8].

Ramadan fasting not only alters the timings of meals, but it may also disturb sleeping patterns and circadian rhythms, all of which can affect an individual's metabolic state. Understanding these changes can help with the management of diabetes during Ramadan. **chapter 3: What happens to the body? Physiology of fasting during Ramadan**, takes a closer look at the effects of fasting on the body of both healthy individuals and those with diabetes. The impact of fasting on glucose homeostasis is of particular importance when considering the risks to people with diabetes.

To help HCPs deliver the best possible advice, individuals with diabetes can be stratified into different groups according to the risk that fasting would impose. These include low, moderate and high risk (Further details are available in **chapter 5: Risk stratification of people with diabetes before Ramadan**). This classification follows a more practical approach and has been developed using the feedback of 300 experienced physicians from across the world and approved by the Mofty of Egypt, the highest religious regulatory authority in Egypt. It is important for religious scholars to acquaint themselves with current recommendations so that they can give the best advice and support to individuals with diabetes both before and during Ramadan.

5. THE IMPORTANCE OF DIABETES AND RAMADAN EDUCATION

Diabetes self-management education and support (DSMES) addresses the practical, clinical, psychosocial, and behavioural aspects of care needed for daily self-management [9] and is essential for safe fasting during Ramadan. The objective of Ramadan-focused education is to raise awareness of the risks associated with diabetes and fasting, and to provide strategies for effective prevention [9]. The clear benefits of structured education on many aspects of Diabetes in Ramadan have been demonstrated in several studies in diverse populations [10-12]. The timing of this education is also important and should be given well before Ramadan commences. Yet, only two thirds of people with diabetes that do fast receive such counselling as shown in the Epidemiology of Diabetes and Ramadan (EPIDIAR) study [6]. It has been estimated that only 30-67% of physicians used a Ramadan focused educational program [13-18]. Education should be delivered in simple, clear local languages and should be engaging, motivational, culturally sensitive and be delivered by well-informed individuals. Ramadan-focused education should target three major groups: the general population, people with diabetes and HCPs (The details are highlighted in **chapter 7: Pre-Ramadan Assessment and Education**). Major aspects of structured education should include, but not be limited to, information on: Risk quantification, blood glucose monitoring, fluids and dietary advice, exercise and physical activity patterns, medication adjustments during fasting, when to break the fast, and the recognition of symptoms of various complications with self-management strategies.

6. DIFFERENCES IN RAMADAN FASTING PRACTICES ACROSS THE WORLD: Consequences for Individuals with Diabetes

Nutrition therapy plays a vital role in diabetes management during Ramadan. An individual's regional beliefs and culture should be considered when preparing their diet plan [19-21]. Ramadan can result in an extra burden of calories; *Iftar*, the meal taken when the fast is broken at sunset, often turns into a feast with huge volumes of food laden with sugar and carbohydrates. Since there is cultural variation in the traditional foods eaten at *iftar*, a well-trained dietician should be at the centre of the diabetes management and follow-up team. The Ramadan Nutrition Plan (RNP), which is supported by DAR is a mobile and web-based application that aims to provide HCPs with expert information to help them individualise medical nutrition therapy (MNT) for people with diabetes during Ramadan accounting for regional and cultural differences. The RNP provides a patient platform that includes the diabetes nutrition plan and an education component for Ramadan. Example meal plans for different countries and regions are included in this application. This could be very useful for individuals seeking to fast during Ramadan, particularly for those who do not have access to appropriate care. A full description of the RNP can be found in **chapter 8: The Ramadan Nutrition Plan (RNP) for people with diabetes**.

7. OPTIMISING STRATEGIES FOR THE MANAGEMENT OF DIABETES DURING RAMADAN

Fasting during Ramadan for people with diabetes carries considerable challenges. Individuals with diabetes should schedule a pre-Ramadan assessment with their HCP in order to discuss their decision to fast. This will enable the physician to assess risk, provide advice and produce an individualised treatment plan. With the correct guidance, many people with diabetes can fast



during Ramadan safely but they must be under the close supervision of HCPs and made aware of the risks of fasting. Individuals who fast against the medical advice should follow their treating team to receive detailed guidance to avoid the development of serious complications.

Generating optimised Ramadan-specific treatment regimens for each patient is essential if a physician is to offer the best possible care.

As already indicated, there is no one-plan-fits-all scenario, as each individual will have factors specific to them that will affect the treatment strategy. This is especially true for individuals that are considered high risk with a high probability of harm if they fast during Ramadan. This includes people with T1DM, pregnant women with diabetes, elderly individuals with diabetes and people with comorbidities such as cardiovascular disease (CVD), stroke and chronic kidney disease (CKD), many of whom will decide to fast against medical and religious advice. Guidance on the management of these high-risk populations, including dose adjustments to medication is given in **chapters 9, 11, 12 and 13**.

8. DISSEMINATING AND IMPLEMENTING THE GUIDELINES

Guidelines and educational resources are only of value if they are adhered to, in both Muslim-majority and Muslim-minority countries. However, several barriers to guideline implementation exist including healthcare professional (HCP) awareness; socio-cultural sensitivity; and community and system barriers. The COVID-19 global pandemic formally declared by the WHO since March 2020 has disrupted usual care mechanisms and added additional physical barriers that include restrictions to movement and lockdowns and dietary and psychological factors that can be more difficult to overcome. There are several methods to overcome these barriers, such as structured educational classes to both HCPs and people with diabetes and use of telecommunication so that care and support can be given remotely and to people that lack access. To this end, working with all members of the community including community workers and Imams is of significant value.

SUMMARY

- With the worldwide prevalence of diabetes increasing, and the number of fasting Muslims set to rise, the importance of effective guidelines for the management of diabetes during Ramadan fasting is clear.
- There is a paucity of evidence-based medicine in the field of diabetes management during Ramadan. Indeed, many recommendations are based on expert opinion rather than clinical evidence. However, in recent times a significant number of studies have been published in the area of diabetes and Ramadan.
- People with diabetes intending to fast during Ramadan should be categorised into low, moderate and high-risk groups.
- Pre-Ramadan education has been shown to reduce the incidence of hypoglycaemia. However, guidance given by medical professionals, particularly in Muslim-minority countries, may be suboptimal.
- Different medications to treat diabetes have varying levels of hypoglycaemic risk, and Ramadan-specific treatment regimens including dose and/or timing adjustments should be produced for each individual with diabetes.
- The implementation of guidelines requires effective communication with, and education of, all those involved. This includes the individuals with diabetes themselves, HCPs, religious leaders, and members of the wider community.
- Education, communication and accessibility are all critical to the success of the guidance provided in this document.
- The *IDF-DAR Practical Guidelines* provide HCPs with both practical information and the background behind recommendations. These management recommendations will help HCPs optimise care and ensure people with diabetes who plan to fast during Ramadan can do so safely.

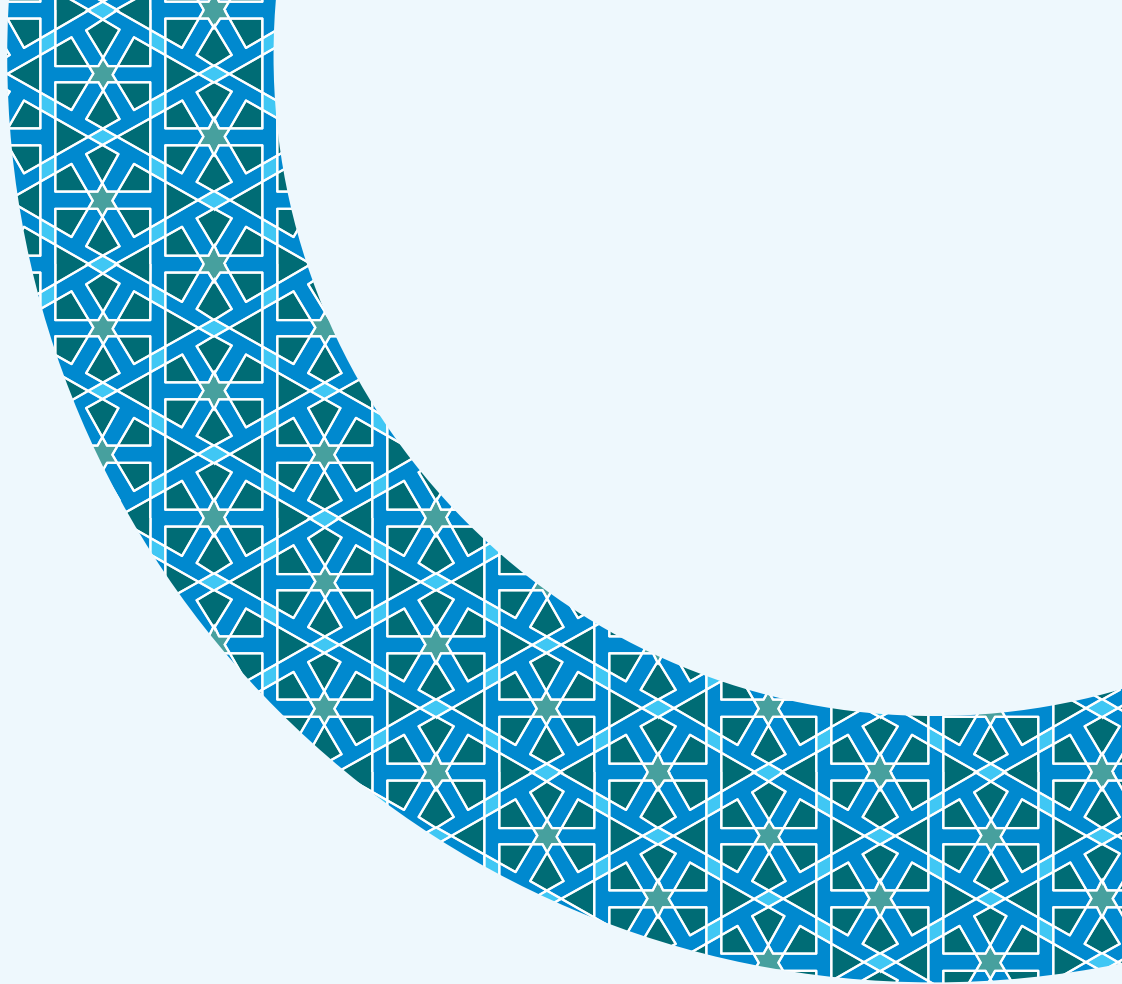


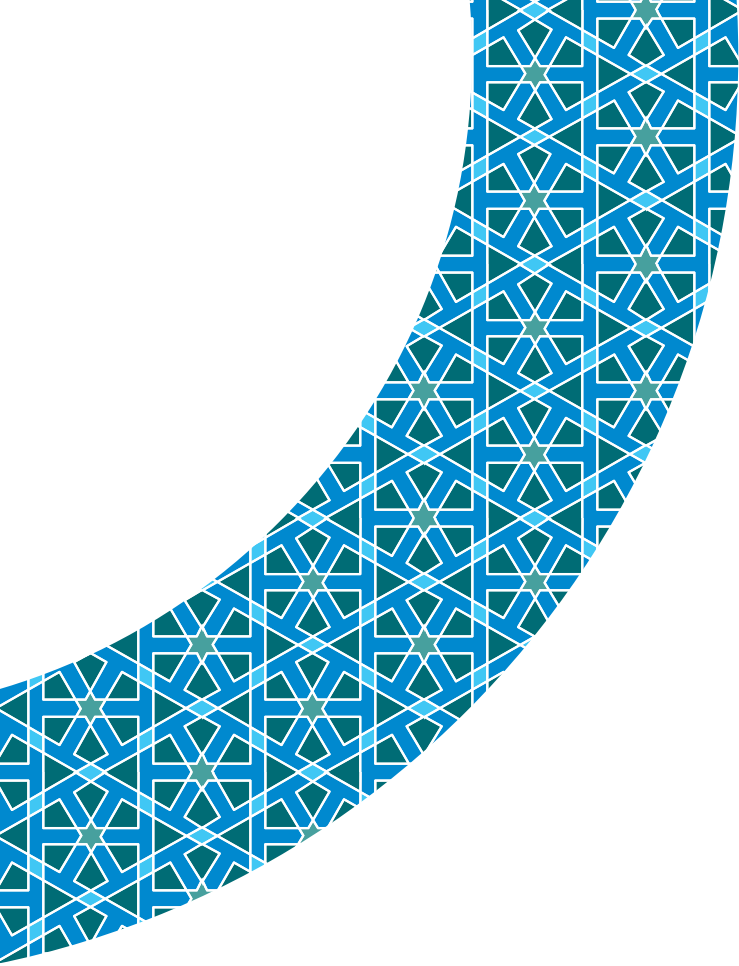
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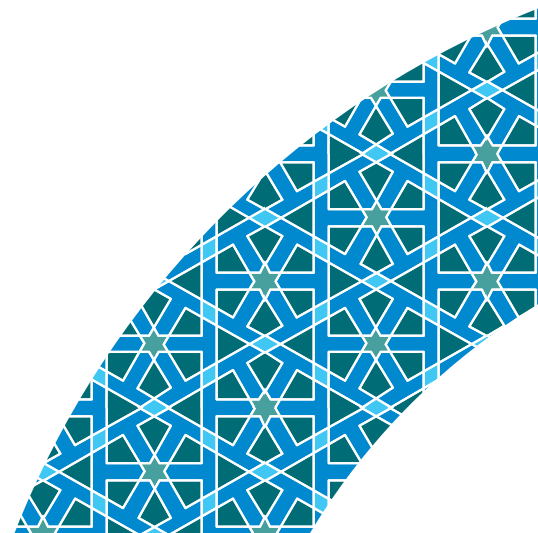


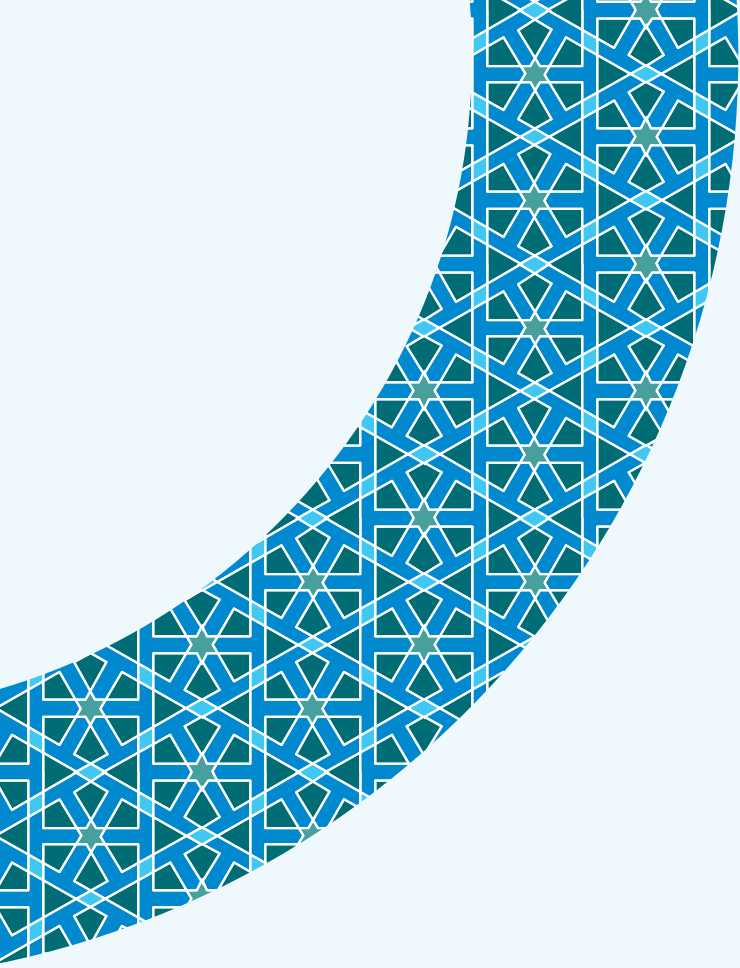
CHAPTER 2

Epidemiology of diabetes and fasting during Ramadan

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CHAPTER 2

INDEX

1. THE GLOBAL IMPACT OF DIABETES	25
2. DIABETES AND RAMADAN	27
3. THE EPIDEMIOLOGY OF DIABETES AND RAMADAN	27
3.1 Epidemiology of T1DM	28
3.2 Epidemiology of T2DM	30
SUMMARY	32
REFERENCES	33



WHAT IS KNOWN?

- The prevalence of diabetes is increasing throughout the world.
 - The global Muslim population is also increasing, and so the prevalence of diabetes will disproportionately affect Muslim majority countries.
- Despite being exempt, many people with diabetes fast for at least half of Ramadan.

WHAT IS NEW?

- New research has become available since the previous edition of these guidelines.
- Different countries have varied fasting practices during Ramadan.
- Research conducted in the Middle East and North Africa (MENA) region and globally have shown that many people with diabetes still do not receive Ramadan-specific education.
- The majority of people with type 1 diabetes mellitus (T1DM) are treated with basal-bolus insulin regimens.
- There is evidence to suggest age specific differences among those with T1DM in fasting practices and outcomes during Ramadan.

WHAT IS MISSING?

- Greater research that assesses the fasting practices during Ramadan:
 - T1DM and type 2 diabetes mellitus (T2DM)
 - Age specific research into people with T1DM during Ramadan
 - Specific research for the elderly with T2DM
 - Country specific research
 - Access to Ramadan-focused education.

1. THE GLOBAL IMPACT OF DIABETES

Over recent decades, the prevalence of diabetes has been increasing throughout the world and this trend is set to continue [1, 2]. Estimates for 2019 indicated that there were approximately 463 million people with diabetes in the world, with 1 in 2 adults are undiagnosed (232 million people), and this total number is predicted to rise 700 million (10.9%) by 2045 with a 51% increase [2].

There are two important aspects to consider in the epidemiology of diabetes:

1. The number of people with diabetes in the International Diabetes Federation (IDF) Africa region is projected to have the highest increase of all the IDF Regions (143%) by 2045
2. The IDF Middle East and North Africa Region currently has the highest age-adjusted diabetes prevalence of all IDF Regions - almost 12% [2].

Diabetes and its complications bring about substantial economic loss including to those living with it, their families, to health systems and national economies through direct medical costs and the impact of losses to work and wages [3].

Approximately, an annual \$760 billion is devoted to global healthcare spending on diabetes, which is \$33 billion more than in 2017. Forecasts show that this expenditure will reach \$825 billion and \$845 billion in the years 2030 and 2045 respectively [2, 4].

There are at least 463 million people living with diabetes throughout the world.

The 9th edition of the Diabetes Atlas has shown the prevalence of diabetes in adults aged 20–79. Out of all IDF regions, MENA had the highest age adjusted diabetes prevalence with 12.2% (95% CI 8.3–11.8). Within the MENA region Sudan had the highest prevalence with 22.1% (95% CI 9.5–24.3). Among the remaining IDF regions, Africa had the lowest prevalence with 4.7% (95% CI 3.2–8.1) [2].

According to 2019 estimates, the number of deaths linked to diabetes and its complications is 4.2 million [2]. The majority of these deaths occur in those under the age of 60 and are located in Africa (73.1%), the MENA region (53.3%) and the SEA region (51.5%) [2].

Moreover, the number of Muslims is expected to approach 1.9 billion in 2019, which is about 24% of the world's population. As of 2015, 1.8 billion or approximately 24.1% of the world population were Muslim [5]. The approximate percentages of the total population that are Muslim in different geographic regions are as follows: 93% in the Middle East-North Africa (MENA) [6], 83% in Central Asia [7], 42% in Southeast Asia [8], 31% in South Asia [9], 29–31% in Sub-Saharan Africa [10], 1.5% in Oceania [11], around 5% in Europe [12], and 1% in the Americas [13]. We note that all of these regions impacted by diabetes.



Notably, the MENA region has a high and growing Muslim population [14, 15]. Muslims comprise almost a quarter of the world’s population and as of 2010, nearly 1.6 billion followers of Islam worldwide. The number of Muslims is projected to increase by 73% by 2050, which will make Islam the fastest-growing world religion over the next four decades [14]. Most countries with a majority Muslim population are in less-developed regions of the world and less-developed countries are disproportionately affected by diabetes [1, 2]. Further, data reported in 2019 showed more than 79% of people with diabetes were living in low- and middle-income countries [2]. As a result of rapid modernisation, the demographic patterns in developing Islamic countries are changing substantially. Future generations will see increases in life expectancy, increased urbanisation and a reduction in the burden of infectious disease — all of which will contribute to an increase in the prevalence of diabetes (Figure 1). Likewise, dramatic changes in development in these regions are having a negative impact on lifestyle; some subsequent effects of development include increasing levels of poor-quality nutrition and sedentary behaviour that in turn facilitate weight-gain and an increase in the risk of diabetes [16, 17]. Another concern is smoking, which is a growing problem in low- and middle-income countries and a risk factor for diabetes [18, 19].

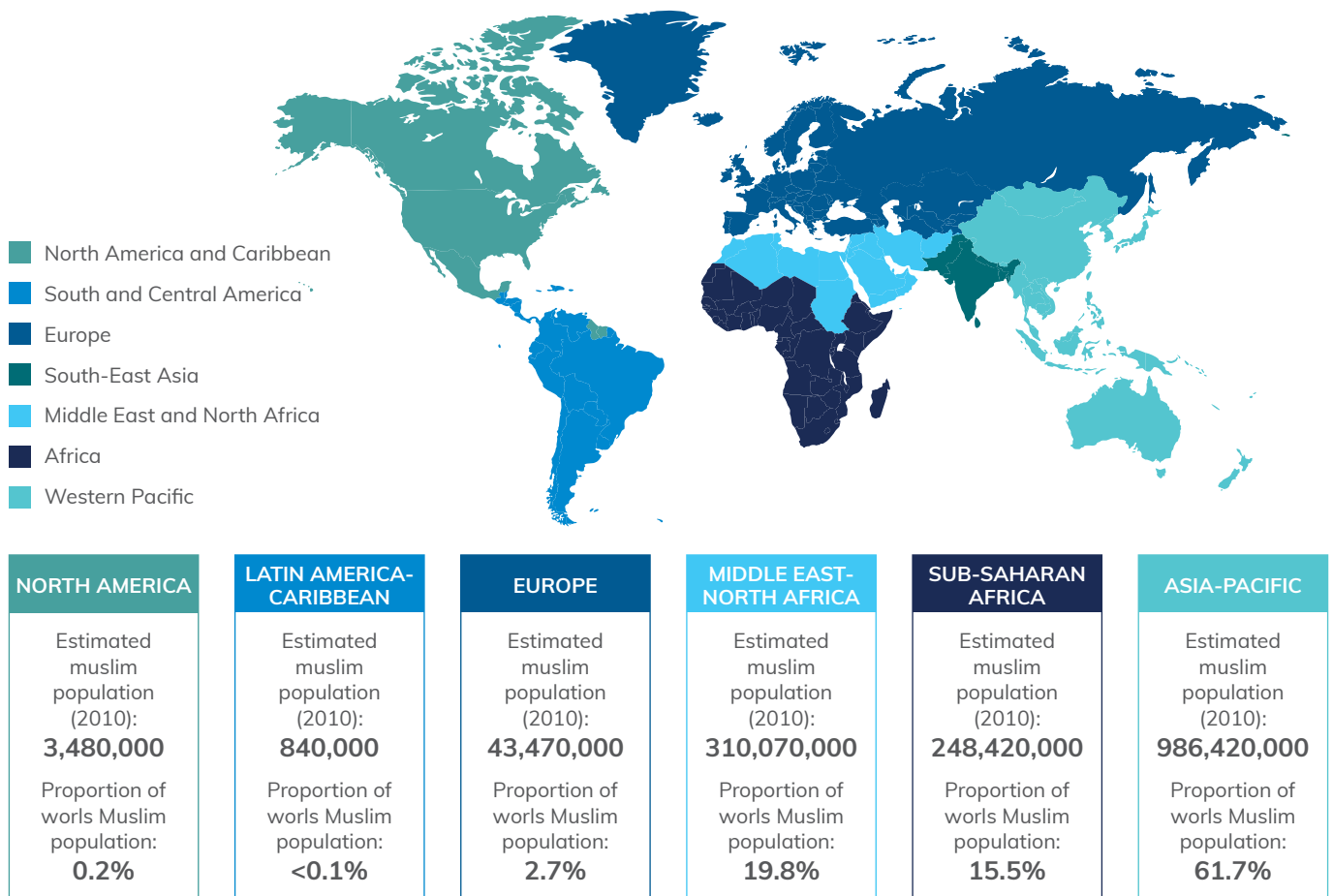


FIGURE 1
The growing problem of diabetes in countries with a majority Muslim population [20]

Although the aggregate increase in diabetes in regions such as Europe and North America is predicted to be less pronounced, it is important to understand that the prevalence of diabetes may vary within regions or even between communities within the same country. For example, a study in the UK found that the age-standardised prevalence of type 2 diabetes mellitus (T2DM) in the South Asians was almost four times higher than that for non-South Asians. Here, 64% of South-Asians came from majority Muslim countries (Pakistan and Bangladesh) [21]. Similarly, patients with diabetes who belong to ethnic minority groups in the UK and North America have been found to be at greater risk for developing diabetes-related complications [22].

2. DIABETES AND RAMADAN

Ramadan is a holy month for Muslims and, as one of the five pillars of Islam, fasting during this time is prescribed for all. The month lasts for 29–30 days, during which the consumption of food and drink is forbidden between dawn and dusk. Depending on the season and geographic location, each period of fasting may last from ten to twenty hours. Fasting is mandatory for all Muslim adults (including adolescents that have reached the age of puberty), with certain groups exempted, such as those who are suffering with illness — this includes some people with diabetes. Because of the metabolic nature of the disease, people living with diabetes are at greater risk of complications from marked changes in food and fluid intake. Potential health hazards include hypoglycaemia, hyperglycaemia, dehydration and acute metabolic complications such as diabetic ketoacidosis (DKA) [23]. Despite being exempt, many people with diabetes still participate in fasting during Ramadan [24-27]. It is important that the decision is made on an individual basis and in consultation with the patient's treating physician, taking into account the severity of illness and the level of risk involved [23]. These topics are considered in more detail in other chapters of these guidelines.

Fasting during Ramadan may provide enduring benefits. Indeed, Ramadan can provide an opportunity for a better lifestyle, assisting weight loss and smoking cessation [28]. For patients with diabetes who choose to fast, Ramadan may help to strengthen the therapeutic alliance between the patient and physician and can provide an opportunity to improve diabetes management, with a focus on self-care and the regulation of medication and meal timing.

Fortunately, the development and accessibility of education programs along with the advent of new medication and new recommendations have greatly improved the management of diabetes and Ramadan in practice. The publication of many studies on the management of diabetes and Ramadan has also greatly contributed to the improvement of knowledge. As a result, a large number of people with diabetes can fast during Ramadan [26].

3. THE EPIDEMIOLOGY OF DIABETES AND RAMADAN

Several multi-national and regional studies in the past decade have provided important information regarding the frequency of fasting in Ramadan among people with diabetes and their associated characteristics. These studies help us to better understand the differences and similarities with regards to patterns of fasting in different geographical regions, primarily Asia, Europe, Middle East and Gulf nations and North Africa (see **Table 1** and **2**). Most recent



estimates for the global Muslim population and global diabetes prevalence suggests a large majority of Muslims perform fasting during Ramadan.

When comparing the prominent multi-national studies investigating fasting during Ramadan of the last 2 decades, we highlight the findings of the EPIDIAR study of Ramadan 2001 [24], the CREED study of Ramadan 2010 [25], the DAR-MENA study of Ramadan 2016 [26, 29] and the recently completed DAR Global Survey of Ramadan 2020 [30]. All of these studies involved adult participants with T1DM and T2DM [31], with the exception of the most recent DAR Global survey which additionally included participants below 18 years. The multi-regional EPIDIAR study was the largest study of Ramadan-fasting among people with diabetes (n=12,914) followed by the DAR Global Survey (n=7348) which was performed almost 2 decades after EPIDIAR. The DAR-MENA study was performed in 10 countries in Middle East and North African region was a smaller study of (n=1885). Among these three studies (EPIDIAR; DAR global survey; DAR-MENA) there were varying proportions of people with T1DM and T2DM; the CREED study reported on only T2D participants.

3.1 Epidemiology of T1DM

People with T1DM have been categorised as high and very high risk for developing specific complications during Ramadan-fasting such as hypoglycaemia, hyperglycaemia and dehydration. Those with T1DM that are intending to fulfil Ramadan fasting should have a pre-Ramadan medical assessment to evaluate their suitability for fasting and ensure Ramadan-focused diabetes education with self-monitoring of blood glucose (SMBG) along with adjustments in insulin dose and regimens are made to minimise glycaemic complications. The proportions of participants with T1DM in the EPIDIAR, DAR-MENA and DAR Global Survey were 8.7%, 7.2% and 20.2% respectively. The DAR Global survey had the highest percentage of participants with T1DM; 25% were ≤ 18 years old with a mean age of 14.5 years [30]. There was a slight difference in the distribution of gender in the study participants and mean age range between 28 years to 32 years and a mean disease duration between 10 years to 14 years among the EPIDIAR, DAR-MENA and DAR Global Survey [24, 26, 30]. Rates of co-morbidities and diabetes-related complications were clearly different among the different cohorts. Information on pre-Ramadan HbA1c was available in the more recent studies and was similar at 8.3% and 8.5% for the DAR-MENA T1DM study and the DAR Global Survey study respectively [29, 30].

More adults with T1DM have decided to fulfil Ramadan-fasting in recent years, with a clear increase in individuals being able to fast for at least 15 days of Ramadan. Generally, there was a lower percentage of people with T1DM who could complete 30 days of fasting, equating to approximately 1 in 4 adults from the DAR Global. Also of interest is the intention to fast and their differences geographically. The lowest rates of fasting were observed in Turkey, Morocco and Algeria, 13%, 22% and 26%, respectively. Comparatively, higher rates of fasting were reported in Pakistan, Malaysia and the Kingdom of Saudi Arabia, at 76%, 85% and 90%, respectively [30].

The DAR Global Survey included a specific analysis of participants < 18 years and > 18 years old. More participants in > 18 years age group received Ramadan-focused diabetes education and made decisions to abstain from fasting. The results of this survey highlighted that hypoglycaemia and hyperglycaemia complications occurred frequently in approximately

61% and 45% of participants respectively from the total cohort. There was a high rate of SMBG with 97.6% in those < 18 years and 95.2% > 18 years old. As expected, those in the < 18years age group had a shorter duration of diabetes, fewer co-morbidities and diabetes-related complications but higher levels HbA1c (9.5% or 12.5 mmol/L vs 8.5% 10.9 mmol/L) compared to those aged > 18 years old [30].

TABLE 1: DEMOGRAPHIC AND CLINICAL CHARACTERISTICS IN STUDIES OF RAMADAN-FASTING AMONG ADULTS (≥18 YEARS) WITH T1DM

Study	EPIDIAR	DAR-MENA T1DM	DAR Global Survey
Year of Ramadan	2001	2016	2020
Region	Asia, Middle East, North Africa, Europe	Middle East, North Africa	Asia, Europe, Middle East, North Africa
N°. of countries	13	10	13
N°. of participants (n)	1,070	136	1113*
Proportion of Type 1 diabetes in whole study (%)	9	7.2	20.2
Age, Mean (SD), years	31.0 (12.7)	32 (9.5)	28.2 (9.0)
Gender, male / female, % participants	50.0 / 50.0	55.1/44.9	47.1 / 52.9
Fasting practices			
Intention to Fast, % participants	43	76.9	69.6
Fasting > 15 days, % participants	42.8	72.3	80
Fasting 30 days, % participants	NA	48.5	26.8 [†]
Mean n°. of fasting days (SD)	23	26.9 (5.9)	23.7 (7.4)
Diabetes characteristics			
Duration of DM, Mean (SD) years	10 (7.6)	14.0 (7.7)	11.78 (7.0)
Pre-Ramadan HbA1c, Mean (SD) %	NA	8.3 (1.7)	8.5 (1.8)
Diabetes Comorbidity, % participants			
Hypertension	16.8	2.2	7.8
Dyslipidemia	14.1	2.2	11.2
Diabetes complications, % participants			
Neuropathy	23.9	27.9	9.4
Retinopathy	21.6	8.8	12.5
Nephropathy	14.2	8.1	9
Coronary artery disease, Stroke	7.5	NA	1.1
Peripheral arterial disease	7.9	NA	NA
Diabetic Foot Problems	6.8	NA	1.9

* those > 18 years, entire Type 1 diabetes cohort was 1483



3.2 Epidemiology of T2DM

In regard to the epidemiology of Ramadan-fasting among people with T2DM, Hassanein *et al.* recently produced a review comparing three landmark studies over the last 20 years; EPIDIAR [24], DAR-MENA T2DM [26] and DAR Global survey [32]. Here Hassanein *et al.* discussed the key findings and compared the results across studies in order to produce a comprehensive overview of the current state of fasting in individuals with T2DM that fast during Ramadan [31]. In this section we consider the findings of Hassanein *et al.* along with the addition of the CREED study [25].

The largest study was the EPIDIAR with 11,173 participants with T2DM representing 91.3% of the overall study cohort, followed by the DAR Global Survey with 5865 participants with T2DM representing 79.8% of the entire study cohort [24, 32]. In the DAR global survey, the decision to fast during Ramadan varied widely geographically with lowest intentions in Morocco (42.6%) and highest in KSA and Bangladesh, 97.1% and 98.1%, respectively [32].

The EPIDIAR, CREED and DAR-Global survey had similar proportions with regards to gender, with approximately 51% being female [24, 25, 32]; the DAR-MENA T2DM had a slightly higher proportion of male participants (56%) [26]. The mean age of participants across the four studies were similar at around 50-55 years old. The duration of diabetes was highest in the more recent studies of Ramadan 2016 [26] and 2020 [31] at 10 years and slightly lower in the earlier studies of EPIDIAR and CREED as seen in **Table 2**. The reported mean HbA1c levels before Ramadan varied across these studies, with the more recent years reporting higher levels. In addition, the rates of the co-morbidities of hypertension and dyslipidaemia were seen to differ between the studies. Microvascular complications such as neuropathy affected approximately 1 in 3–5 people and nephropathy around 1 in 9–11 people with T2DM [25, 26, 31]. There was a trend towards a lower rate of macrovascular disease and diabetes related foot problems in the later studies [26, 31]. A plausible explanation for these statistics may be that there have been improvements in the overall cardiovascular risk management as well as improvements in diabetes footcare prevention and management in recent years.

It is evident that rates of fasting have remained stable across these studies spanning almost two decades, with more than 4 out of 5 people intending to fast during Ramadan and with a mean duration of fasting of 27 days. Well over half the participants in these consecutive studies were able to complete the full month of Ramadan-fasting and three quarters of were able to complete at least half of the month with the highest rates of approximately 94% [25, 31], in both the CREED study of Ramadan 2010 and in the DAR Global Survey, a decade later. These two studies also reported fasting post-Ramadan in the month of *Shawal* and found that more than a quarter of survey participants performed this non-obligatory fasting, and the mean number of days was found to be 6 days [31].

TABLE 2: DEMOGRAPHIC AND CLINICAL CHARACTERISTICS IN STUDIES OF RAMADAN-FASTING AMONG PEOPLE WITH T2DM

Study	EPIDIAR	CREED	DAR-MENA T2DM	DAR Global Survey
Year of Ramadan	2001	2010	2016	2020
Region	Asia, Middle East, North Africa, Europe	Asia, Europe, Middle East, North Africa	Middle East, North Africa	Asia, Europe, Middle East, North Africa
N°. of countries	13	13	10	20
N°. of participants (n)	11,173	3250	1749	5865
Age, Mean (SD), years	54.0 (11.0)	56.9 (10.7)	55.2 (11.1)	55.1 (11.8)
Gender, male / female, % participants	49.0/51.0	48.5 / 51.5	55.6 / 44.4	49.0/51.0
Fasting practices				
Intention to Fast, % participants	86	NA	89.7	83.6
Fasting > 15 days, % participants	78.7	94.2	86.3	94.8
Fasting 30 days, % participants	NA	63.6	57.3	61.9
Mean n°. of fasting days (SD)	27	27.2 (6.0)	27.7 (5.0)	27.3 (6.1)
Fasting outside Ramadan, % of participants	NA	29.9	NA	26.1
Breaking of fast, % participants	NA	*	NA	12.5
Diabetes characteristics				
Duration of DM, Mean (SD) years	7.6 (5.8)	8.4 (6.3)	10.2 (8.0)	10.5 (7.7)
Pre-Ramadan HbA1c, Mean (SD) %	NA	7.6 (1.6)	8.0 (1.6)	8.4(1.9)
Diabetes Comorbidity, % participants				
Hypertension	48.8	62.1	27.5	49.7
Hyperlipidaemia	32.5	56.6	13.7	40.6
Diabetes complications, % participants				
Neuropathy	27.8	19.8	32.8	21.7
Retinopathy	19.7	12.4	9.2	13.9
Nephropathy	12.1	11.1	8.9	10
Coronary artery disease, Stroke	18.8	12.4	NA	10.8
Peripheral arterial disease	10	3.4	NA	NA
Diabetic Foot Problems	5.1	3.9	NA	3.2

NA = not available

*249 of 524 participants hypoglycaemia episodes resulted in breaking of fast



The Ramadan-focused diabetes education places an emphasis on identifying situations to break the fast in order to prevent severe glycaemic complications, either hypoglycaemia or hyperglycaemia. In the CREED study, around 9% of participants experienced at least one episode of hypoglycaemia with an accumulative total of 524 episodes among 285 participants. In 48% of episodes, there was intervention that led to the appropriate breaking of fasting [25]. In the DAR Global survey, 1 in 8 participants (12.5%) had a break in their fasting, and among those with hypoglycaemia (15.7%) more than half had to break their fast (58%) [31].

Not much published data is available with regards to fasting practices and outcomes among older adults with T2DM. In the DAR Global Survey cohort with T2DM, a specific analysis was performed to compare those < 65 years and \geq 65 years old. It was clear from this study that older adults \geq 65 years more frequently chose not to fast, experienced higher rates of having to break the fast, higher rates of hypoglycaemia and hyperglycaemia as well as higher rates of requiring acute hospital care — either emergency department care or hospital admissions. Older people with diabetes have an increased risk of complications during Ramadan, this is related to the longer duration of diabetes and is often accompanied with higher rates of co-morbidities and diabetes-related complications as well as higher rates of insulin use. Hypoglycaemia awareness may also be present in the elderly with diabetes, placing them at risk of recurrent and severe hypoglycaemia. A specific emphasis must be placed on pre-Ramadan diabetes education and SMBG with appropriate adjustments in glucose lowering medications. This will help to allow older adults to safely fast if they so choose to participate in fasting during Ramadan [31].

SUMMARY

- The global prevalence of diabetes is increasing, and this will disproportionately affect Muslim-majority countries.
- Fasting in Muslim populations is not limited to Ramadan and guidance can be supportive throughout the year.
- There is evidence of age specific differences in fasting practices and outcomes in people with T1DM.
- Greater research is needed to fully characterise fasting practices in people with diabetes during Ramadan.

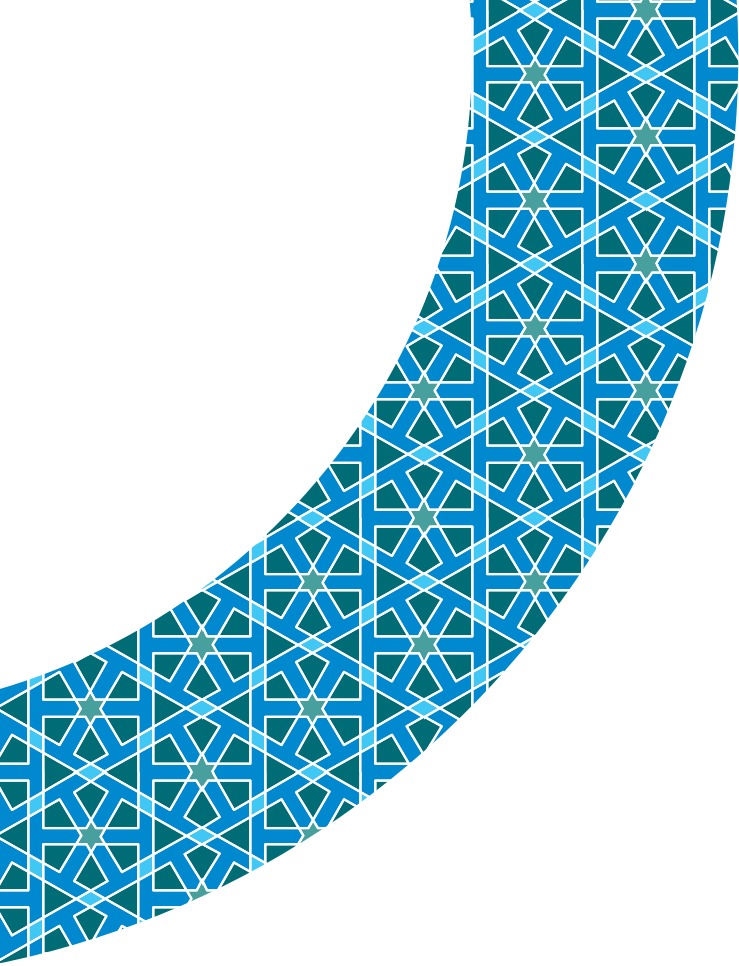
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CHAPTER 3

What happens to the body? Physiology of fasting during Ramadan

Chapter lead:

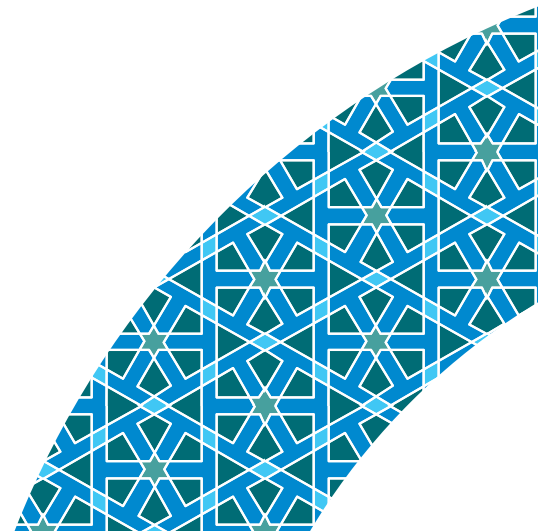
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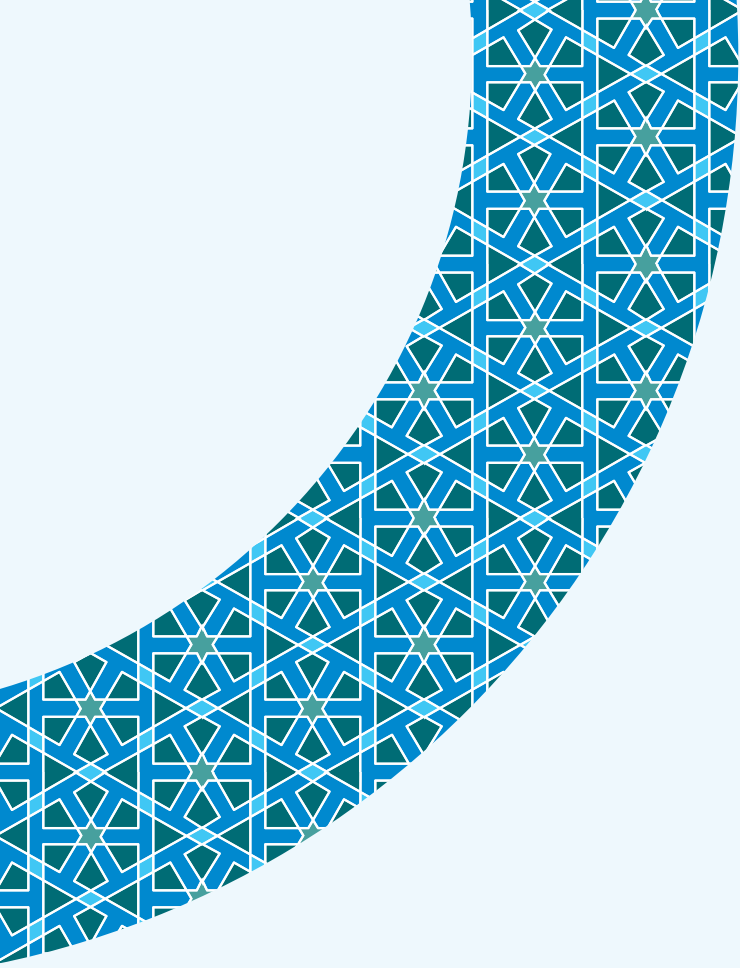
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CHAPTER 3

INDEX

1. INTRODUCTION	40
2. RAMADAN PHYSIOLOGY FASTING IN HEALTHY INDIVIDUALS	40
3. SLEEP AND CIRCADIAN RHYTHM	41
3.1 Changes in sleeping patterns during Ramadan	41
3.2 Effects on Circadian Rhythm	42
4. FLUID BALANCE AND RAMADAN	43
5. ENERGY BALANCE THE CONCEPT: ENERGY INTAKE (EI) AND ENERGY EXPENDITURE (EE)	44
5.1 Energy intake when fasting during Ramadan	44
5.2 Energy Expenditure and its components when fasting during Ramadan	44
5.3 Effects of Ramadan fasting on body weight and composition, in healthy individuals	46
6. GLYCAEMIC CHANGES DURING RAMADAN FASTING IN HEALTHY INDIVIDUALS	47
6.1 Glucose homeostasis	47
6.2 Insulin sensitivity	47
6.3 Glucose profile	48
7. LIPID CHANGES DURING RAMADAN IN HEALTHY INDIVIDUALS	49



CHAPTER 3

INDEX

8. HORMONAL CHANGES DURING RAMADAN FASTING IN HEALTHY INDIVIDUALS	50
8.1 Cortisol	50
8.2 Adiponectin	50
8.3 Leptin	51
8.4 Ghrelin	51
8.5 Other hormones	51
9. NEW EVIDENCE OF CHANGES THAT CAN OCCUR WHEN FASTING DURING RAMADAN	53
9.1 Ramadan fasting and gut microbiota	53
9.2 Ramadan fasting and gene expression	54
10. PATHOPHYSIOLOGY OF FASTING IN INDIVIDUALS WITH DIABETES	54
10.1 Glycaemic control and glucose variability	55
10.2 Effect of Medication type	57
11. RAMADAN FASTING AND OTHER MEDICAL CONDITIONS: RELEVANCE TO DIABETES	59
11.1 Hypothyroidism	59
11.2 Bariatric surgery	60
SUMMARY	61
ACKNOWLEDGEMENTS	61
REFERENCES	62

WHAT IS KNOWN?

- Fasting during Ramadan can alter meal schedules, fluid intake, and the circadian rhythm.
- A reduction in body weight may also occur as a result of fasting during Ramadan.
- The glucose profiles of people without diabetes are remarkably stable and within the normal ranges, and aside from some small excursions around *Iftar*, the profiles are not too different from the non-Ramadan period.
- People with diabetes may be at risk as fasting during Ramadan can increase glucose variability and the risks of hyperglycaemia and hypoglycaemia; there is a significant and rapid rise in glucose at *Iftar* in people with diabetes.

WHAT IS NEW?

- Fasting during Ramadan is associated with a reduction in total sleeping time of about one hour and is linked to an increase in day time sleepiness.
- Changes to indicators of body clock mechanisms have been demonstrated which can affect many hormonal rhythms.
- Despite there being changes to activity patterns and reductions in energy expenditure, there is no significant change in the total energy expenditure. Likewise, resting energy expenditure does not change significantly during Ramadan fasting.
- An overall reduction in energy intake of around 240 kcal/day during Ramadan fasting has been shown in one study.
- There is a gradual shift in the proportion of fuel utilisation from carbohydrates to fat as the fasting day progresses.
- Several studies have shown up to a twofold reduction in insulin sensitivity during Ramadan fasting.
- Low density lipoprotein (LDL) and triglyceride (TG) levels have been seen to decrease during the Ramadan fast (RF).
- Hormonal changes during Ramadan fasting include a reduction in morning adiponectin levels, large increases in morning leptin levels and reductions to morning and evening growth hormone levels. A modest reduction in testosterone in men has also been reported.
- Gut microbiota changes and genetic changes can occur when fasting during Ramadan.
- People with other medical conditions can be at risk of changes unrelated to glucose homeostasis and face practical issues when conducting the Ramadan Fast. Important conditions to consider are previous bariatric surgery, chronic kidney disease and hypothyroidism.

WHAT IS MISSING?

- Further research is needed into the direct short-term and long-term effects of the changes that occur during the RF.
- Further research needs to be conducted in people with diabetes to assess whether the changes seen in healthy individuals are exacerbated.
- These changes need to be separated by diabetes type and people with accompanying comorbidities.
- More comprehensive studies of hormonal changes with Ramadan fasting are needed.



1. INTRODUCTION

The Ramadan fast (RF) entails a major shift from the normal ways of eating to an exclusive nocturnal eating pattern. In this form of intermittent fasting, multiple modulations of the human body physiology may occur [1]. These changes can induce or alter pathophysiological states depending on the pre-existing state of the disease and the individual's compliance to diet, lifestyle, and therapeutic regimens [2].

During Ramadan, individuals that fast tend to avoid consulting their doctors [3]. It is therefore not surprising that potentially invasive studies have been difficult to conduct, leading to a relative paucity of direct evidence regarding the physiological effects of the RF. Obtaining evidence for guidelines can be problematic; it is very difficult to ask individuals to volunteer for Ramadan related research studies at a time of spiritual focus and when there is an anticipation of breaking the fast in family union and obligations to attend religious practices in the feeding hours. Studies can also take longer to complete as Ramadan occurs only once a year, so there is a small window of opportunity to collect information.

Much of the insight gained to date has been extrapolated from studies involving subjects who have fasted for more than 48 hours. However, recently, many more studies of the RF have been conducted, with new and updated evidence emerging on different aspects of physiology during Ramadan and these will be discussed in this chapter. The chapter will be presented in four sections: Physiology, Pathophysiology in Diabetes, and Pathophysiology of the RF in other conditions, particularly those commonly encountered in people with diabetes.

2. RAMADAN PHYSIOLOGY FASTING IN HEALTHY INDIVIDUALS

The RF affects several fundamental aspects of human physiology including sleeping patterns and circadian rhythmicity, fluid balance, energy balance, and glucose homeostasis. It represents a major shift from normal ways of eating as well as in sleep and wakefulness patterns. The RF differs from other common forms of fasting (**Figure 1**); as no food or drink is consumed during the hours of daylight, the time between meals during Ramadan is much longer than in other months of the year. This has important implications for physiology, with ensuing changes in the rhythm and magnitude of fluctuations in several homeostatic and endocrine processes. The duration of the fast impacts the physiological changes that occur; this is of particular relevance when Ramadan falls during longer summer days, with higher latitudes experiencing the most hours of daylight. For instance, the Ramadan fasting day in the summer of Scandinavian countries can last more than 17 hours.

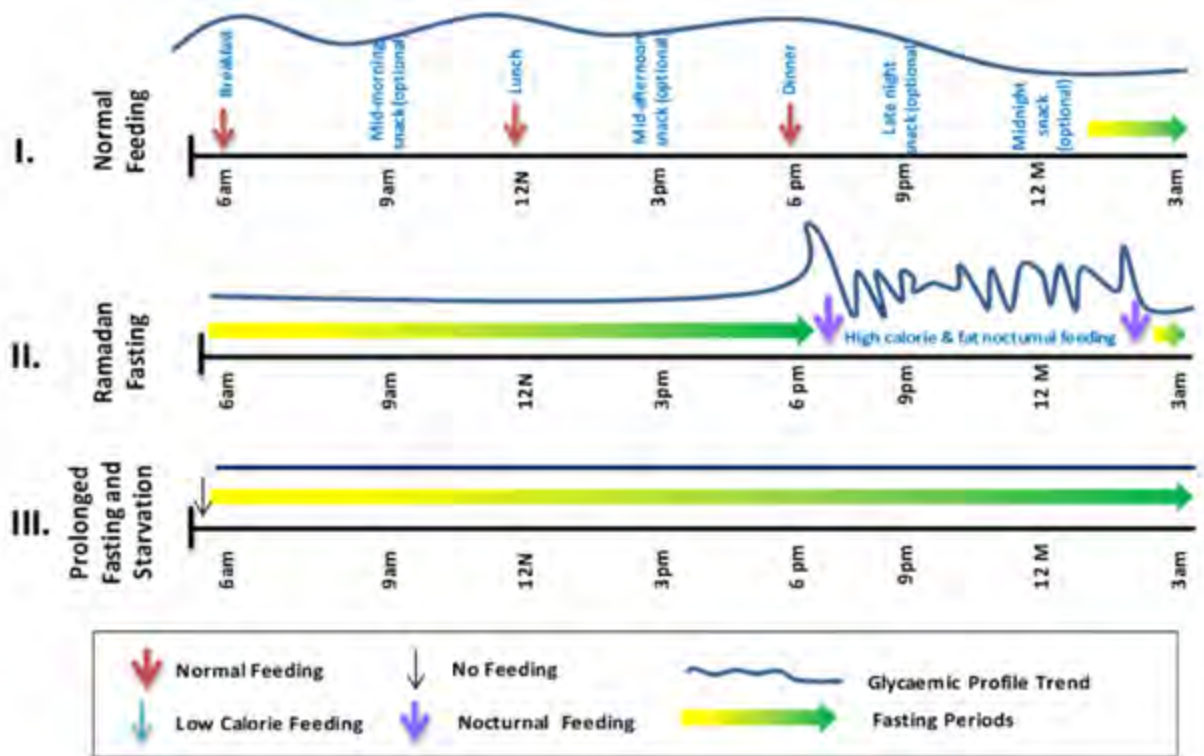


FIGURE 1

Changes in feeding patterns and energy intake during various fasting periods.

The above feeding and fasting patterns are: (I) normal feeding, (II) Ramadan fasting and (III) prolonged fasting and starvation. The figure illustrates hourly differences in feeding patterns between various fasting models: hourly timings of fasting, feeding and energy intake (meals) are indicated per day in relation to fasting periods (arrows) and reflected in glycaemic control (trend). Adapted from Lessan et al. [4].

3. SLEEP AND CIRCADIAN RHYTHM

3.1 Changes in sleeping patterns during Ramadan

Sleeping patterns are invariably altered during the RF (Figure 2) [1, 5]. Typically, sleep is broken before dawn to enable Muslims to eat before fasting begins (*Suhoor*). Most will return to sleep afterward and wake for a second time to start the day. Some fasting Muslims may sleep in the afternoon. Following the evening meal (*Iftar*), many will stay awake until midnight, or later. The impact of Ramadan on sleep includes decreased total sleep time, delayed sleep, decreased sleep period time, decreased rapid eye movement (REM) sleep duration, decreased proportion of REM sleep, and increased proportion of non-REM sleep, and increased sleep latency [5, 6].

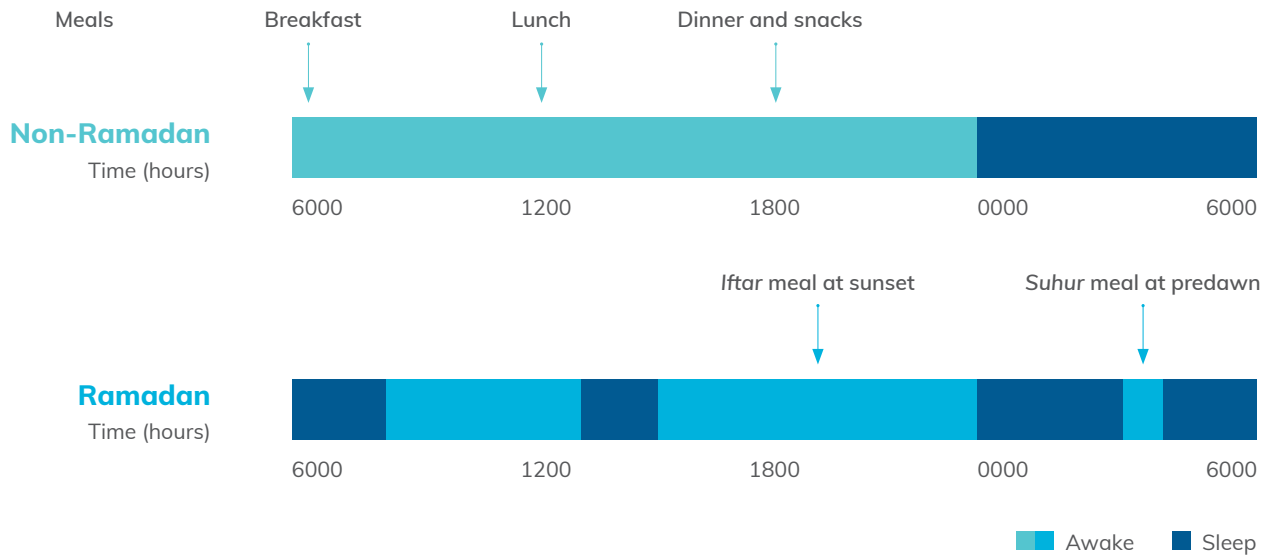


FIGURE 2

Comparison of sleeping and activity patterns between Ramadan and non-Ramadan periods.

During non-Ramadan days there is breakfast, lunch, and dinner at specific times. During Ramadan, breakfast (*Suhoor*) is much earlier and is taken just before dawn; there is no lunch and the *Iftar* meal is taken just after sunset. Also, during non-Ramadan days, the sleeping pattern is continuous from night through to the early morning hours, while in Ramadan, the sleeping pattern is more fragmented between the early morning hours, the afternoon, and midnight. Adapted from Saadane et al. [7].

A recent meta-analysis found total sleep time (TST) during Ramadan to be reduced by around 1 hour [8]. This resulted in increased daytime sleepiness indicated through a 1-point increase in the Epworth sleepiness scale (ESS). Another review that examined the impact of Ramadan fasting on sleep-wake patterns among physically active individuals and found similar reductions in TST [9].

Sleep deprivation has been associated with decreased glucose tolerance [10], and the correlation between sleeping duration and insulin resistance has been a subject of renewed medical interest [11, 12]. Short sleep duration is also independently associated with weight gain, particularly in younger individuals [1].

3.2 Effects on Circadian Rhythm

It cannot be over-emphasised that the shift from routine and “normal” mealtimes and sleep/wakefulness patterns during Ramadan are sudden and truly drastic. Eating times change from daylight to the darker hours between sunset and dawn. This can profoundly impact the circadian pattern of the body with consequential cardiometabolic changes [13]. Indicators of the body clock mechanisms have been found to alter; one study reported changes in the acrophase of proximal skin temperature (an indicator of core body temperature) indicating a shift-delay in the circadian clock [14]. Many hormone rhythms have been shown to alter with Ramadan fasting. These include serum leptin, ghrelin, cortisol, and melatonin levels [1, 5, 6, 15, 16]. Some of these will be discussed further in other sections of this chapter.

4. FLUID BALANCE AND RAMADAN

Absolute restriction of fluid intake between dawn and sunset is an integral aspect and of Ramadan. This can have potentially important consequences, particularly in individuals with poorly controlled diabetes. Some effects that need addressing, in otherwise healthy individuals, are the extent of fluid and electrolyte loss during the fasting day, and potential adverse effects or beneficial benefits this may have on the person. The effects of total fluid restriction in experimental settings, in manners somewhat akin to the Ramadan fast, have been investigated by Danielsson and colleagues [17] (Figure 3). Twenty young healthy female volunteers were subjected to a prolonged fast (from 10 pm–4 pm next day) and had their weight and fluid output recorded. The study showed that the rate of fluid loss for the initial overnight period (10 pm to 8 am the next day) was 1.26 g/kg body weight/hour and that for the next day's time period was 0.99 g/kg body weight/hour. The corresponding total fluid deficit was 1.47 kg for the full 18-hour period of fasting. Although this study was not performed to address the Ramadan fast, the measurements can be a useful guide when thinking about fluid fluxes during the RF.

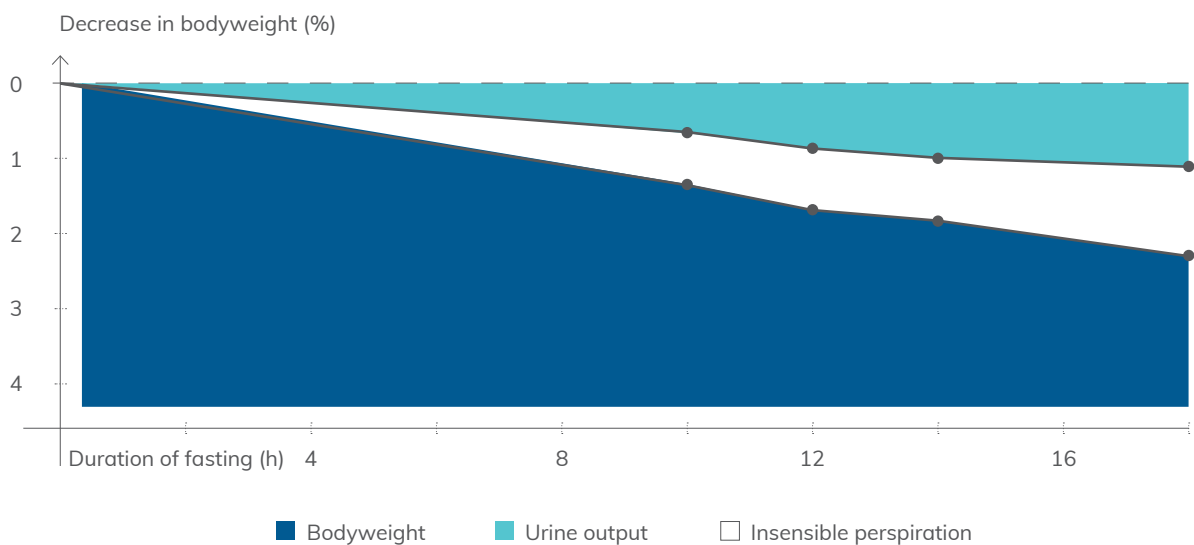


FIGURE 3

Fluid deficits during prolonged overnight fasting in young healthy adults.

Contributions of urine output and estimated insensible perspiration to the relative decrease in body weight in 20 (10 female) study participants subjected to prolonged 18-hour overnight fasting from 22:00 to 16:00. Adapted from Danielsson et al. [17].

Reported changes to the fluid balance with the RF include a higher fluid and total water intake and a marked rise in urine osmolality in the afternoon, indicating a compensatory water conservation and a reduction in obligatory urine output [18]. Currently, the available evidence in the literature do not support concerns about the association of Ramadan fasting with pathological dehydration in normal circumstances [19]. However, dehydration may be a more relevant issue in hot climates or in individuals who undertake intensive physical labour as well as by osmotic diuresis caused by hyperglycaemia. Dehydration can lead to hypotension and subsequent falls or other injuries [20].



5. ENERGY BALANCE

THE CONCEPT: ENERGY INTAKE (EI) AND ENERGY EXPENDITURE (EE)

Ramadan fasting affects meal patterns. As such it is expected that food and energy intake will alter. Furthermore, activity patterns also change with potential changes in energy expenditure. The concept of energy balance during Ramadan fasting merits further exploration and will be discussed here.

5.1 Energy intake when fasting during Ramadan

An obvious change during the RF is the omission of lunch and the prolonged gap between the two main meals of the day. This has direct effects on appetite and hunger scores during the daylight hours which rises steadily, reaching a peak by *Iftar* time. This, potentially, can lead to a disproportionate volume of food being eaten at sunset. Interestingly, the pattern of increasing hunger during a Ramadan fasting day has been reported to show some adaptation and attenuation in female participants towards the end of Ramadan [21, 22].

There are few studies of energy and food intake during the RF. El Ati *et al.* investigated a group of 16 healthy female volunteers fasting during Ramadan and reported 84% of total daily energy intake was taken at the evening meal, and the remaining 16% was taken between 8 p.m. and midnight [23]. This is in contrast to periods before Ramadan where breakfast, lunch and dinner constituted 9.4%, 41.6% and 21.8% of the total daily energy intake. Although the findings of this small study cannot be generalised to the larger population of fasting Muslims, the observation of a disproportionately large meal at *Iftar* time is a common finding [24, 25]; often reflected in feeding patterns (Figure 2) and in glycaemic profiles.

A study of 160 healthy fasting men by Nachvak *et al.* found an overall reduction in energy intake of around 1 MJ/day (239 Kcal/day) during the Ramadan fast. This would be equivalent to an energy deficit of 7170 Kcal over 30 days. Assuming that the energy intake records were accurate, there were no changes in the 24-hour energy expenditure and the generally accepted formula of 7000 Kcal being equivalent to a 1 kg body fat loss, a deficit of 7170 Kcal by the end of Ramadan would be equivalent to 1 kg weight loss by the end of Ramadan. However, in the same study a 2 kg weight loss was reported, suggesting some inaccuracies in the food intake records, or differences in the overall energy expenditure accompanying the RF [26].

The apparent daily energy deficit incurred by the RF is much less than the energy deficit of skipping lunch (350 Kcal vs approximately 800 Kcal) which suggests some degree of compensation, mostly through an increase in energy intake during the non-fasting hours.

5.2 Energy Expenditure and its components when fasting during Ramadan

The resting metabolic rate (RMR), activity energy expenditure (AEE) and thermic effect of food (TEF) are three components of a 24 hour total energy expenditure (TEE) [27]. RMR is the energy expended when an individual is in a fully rested position, but not sleeping. Typically, it is the largest component of energy expenditure. The RMR is affected by weight, gender, age and muscle mass; of these, muscle mass is the best determinant of RMR. In addition, the RMR is also affected by hormonal changes and is particularly sensitive to changes in thyroid hormones. The AEE is the energy expended due to activity. In sedentary individuals, the AEE

makes up a smaller component of the TEE. The AEE is also the most variable component of the TEE and can be several times higher than the RMR in professional athletes. TEF is the energy cost of digesting food, or the increase in measured metabolic rate in response to a meal. This rise in the TEF actually starts even before the ingestion of food and typically continues for several hours thereafter. Proteins have a higher cost of energy in terms of TEF compared to fat and carbohydrate rich food. TEE is the sum of the three components (RMR+AEE+TEF); direct measurements of TEE in free-living conditions is challenging but can be done using the doubly labelled water as the gold standard.

As the RF has been associated with changes in sleep, weight, activity patterns and mealtimes and content, it is feasible that some or all components of energy expenditure may alter fasting during Ramadan. Lessan *et al.* investigated different aspects of energy expenditure [28]; see **Figure 4**. TEE during and after Ramadan fasting was measured using the doubly labelled water method; RMR was measured using indirect calorimetry. The study found no significant difference in TEE (2125 Kcal/day vs 2299 Kcal/day) or the RMR (1365 v 1362 Kcal/day) with Ramadan fasting compared to the non-Ramadan period. It is also important to consider that there were major differences in activity patterns between the two periods, with a significantly lower step count during Ramadan (9950 steps/day) compared to post-Ramadan (11363 steps/day). Participants were noted to be more active at night-time during Ramadan with less activity during the day. It has been postulated that the reduction in activity energy expenditure was offset by the reduced time spent during sleep in Ramadan.

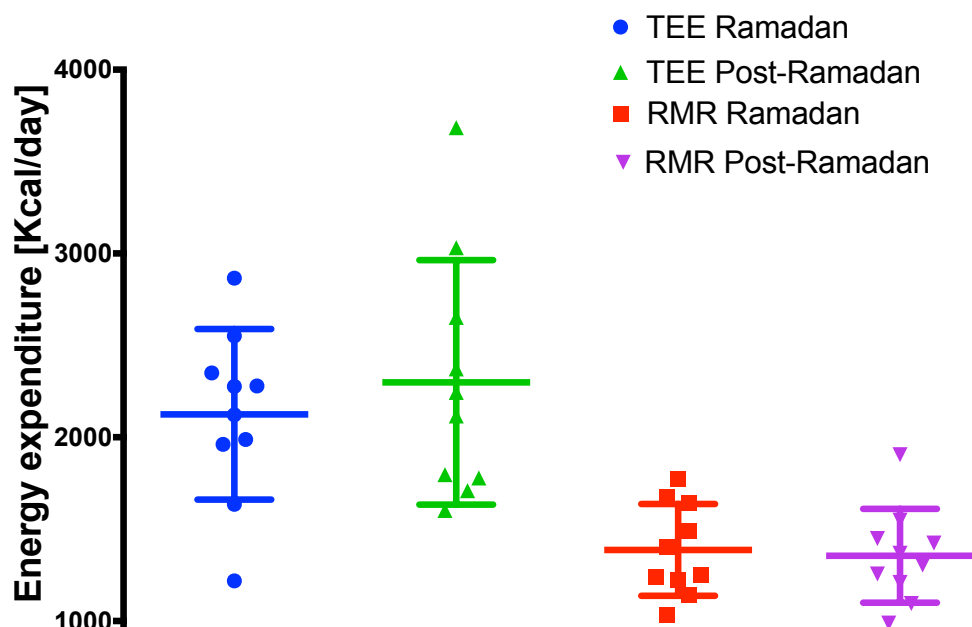


FIGURE 4

Resting energy expenditure (TEE) and total energy expenditure (TEE) during Ramadan and post-Ramadan.

There is no significant difference in TEE, or RMR between Ramadan and post-Ramadan periods (2224 Kcal/d compared with 2121 kcal/d, respectively). Adapted from Nader Lessan *et al* [28].



5.3 Effects of Ramadan fasting on body weight and composition, in healthy individuals

Hunger-satiety cycles and food utilisation during Ramadan change in accordance to the shift in the timing of the main meal [21]. The gap between the main meals can intensify feelings of hunger, particularly towards the end of daylight hours. Resisting the temptation to have a particularly large meal at *Iftar* can be difficult and studies have reported a large proportion of total daily calorie intake occurs at this time [29]. In general, studies have reported the effect of Ramadan on weight change to be varied, with a reduction in weight, or no change at all being the most common findings. However, in some individuals a net energy excess can lead to overall weight gains.

This inter-individual variability in weight trends with Ramadan fasting is determined by personal, cultural and social factors; but genetic, epigenetic and other factors such as gut microbiome may also play a role. The question of weight change with the RF has been explored in several, albeit small, studies. The reported net change has been modest with an average weight loss of 1-2 kg by the end of Ramadan. A meta-analysis of earlier studies by Kul *et al.* showed a small weight loss of around 0.7 kg in fasting men, but not women [22]. The largest study by Hajek *et al.*, conducted on 202 participants recruited at mosques in East London, showed a net weight loss of around 0.8 kg by the end of Ramadan with the lost weight being regained 4-5 weeks after Ramadan [30].

Two other meta-analyses have explored the RF and changes in weight. Fernando *et al.* showed that the mean weight loss associated with Ramadan fasting was 1.34 kg and that most of the weight was regained a few weeks after Ramadan [31]. A positive correlation between starting body mass index (BMI) and weight lost during the fasting period was also identified. Furthermore, there was a significant reduction in fat percentage between pre-Ramadan and post-Ramadan in people that were overweight or obese, but not in those of normal weight. Loss of fat-free mass was also significant between pre-Ramadan and post-Ramadan but was about 30% less than loss of absolute fat mass. At 2–5 weeks after the end of Ramadan, there was a return towards, or to, pre-Ramadan measurements in weight and body composition. The study concluded that even with no advice on lifestyle changes, there are consistent, albeit transient reductions in weight and fat mass with the Ramadan fast, especially in people with overweight or obesity [31]. Another meta-analysis found the pooled weight reduction with Ramadan fasting to be around 1 kg (95% confidence interval: – 1.164 kg to – 0.880 kg) [32]. Sub-group analyses found fasting time (measured in hours/day) to be the best correlate of weight change at the end of Ramadan, while age and sex not being as influential. Expectedly, the season of the fasting month and geographical location also impacted the effect of Ramadan fasting on body weight [32]. However, this reported weight loss is not universal, some other studies have reported weight gain [33]. Additionally, some studies have found possible gender differences in weight change, with net weight losses observed in males and no weight changes observed in females [22]. Another study found that weight loss was greater in Asian populations compared to Africans and Europeans and that there does not appear to be a gender difference in the absolute magnitude of weight loss with Ramadan fasting [34]. These results highlight the variability in outcomes and may be because of the different contexts of individuals that fast during Ramadan.

6. GLYCAEMIC CHANGES DURING RAMADAN FASTING IN HEALTHY INDIVIDUALS

Depending on the duration, fasting can be divided into three distinct phases: the post-absorptive phase lasting from 6-24 hours; the gluconeogenic phase lasting from 1-10 days, and the protein conservation phase which occurs if fasting lasts greater than 10 days. The RF is an intermittent form of fasting and, as such, it is a post-absorptive state with a partial overlap into the gluconeogenic phase. The fast is interrupted by the feasting period at sunset. During the fast, the central nervous system and many other tissues preferentially use glucose produced by glycogen breakdown [35] (**Figure 5A** and **5B**).

6.1 Glucose homeostasis

In healthy individuals, increases in glucose levels in the blood after eating stimulates insulin secretion, which in turn triggers the liver and muscles to store glucose as glycogen (**Figure 5A**) [35]. During fasting, circulating glucose levels fall and insulin secretion is suppressed [35]. Glucagon and catecholamine secretion is increased, stimulating glycogenolysis and gluconeogenesis, which then leads to an increase in blood glucose levels [35]. Liver glycogen can provide enough glucose for the brain and peripheral tissues for around 12 hours [20]. Each fasting period is often longer than 12 hours and may therefore be considered to be a state of intermittent glycogen depletion and repletion (**Figure 5B**). When glycogen stores are depleted and levels of insulin are low, fatty acids are released from adipocytes and oxidised to generate ketones, which can be used as fuel by many organs, preserving glucose for the brain and erythrocytes [20].

In the earlier (morning) part of the fasting day, there is a marked dominance of carbohydrate usage as the main source of fuel, whereas lipids become more important towards the afternoon and the time for breaking the fast at sunset (*Iftar*) draws closer [4, 36]. In practice, most people who take their first meal at dawn are in a state of glycogen depletion by the late afternoon, at which point ketogenesis occurs. Omission of *Suhoor* leads to a depletion of glycogen stores and results in a ketotic state much earlier in the fasting day.

6.2 Insulin sensitivity

Insulin sensitivity has been investigated in several studies. Many of these studies identified an association between fasting during Ramadan and with evening hypercortisolism and insulin resistance [16, 37, 38]. Ajabnoor *et al.* reported a Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) of 1.98 in the morning measured before Ramadan increasing to 4.51 in morning during Ramadan. The corresponding evening values for pre-Ramadan and Ramadan were 4.94 and 12.01 respectively [37]. As such, the RF should be considered a state of insulin resistance.

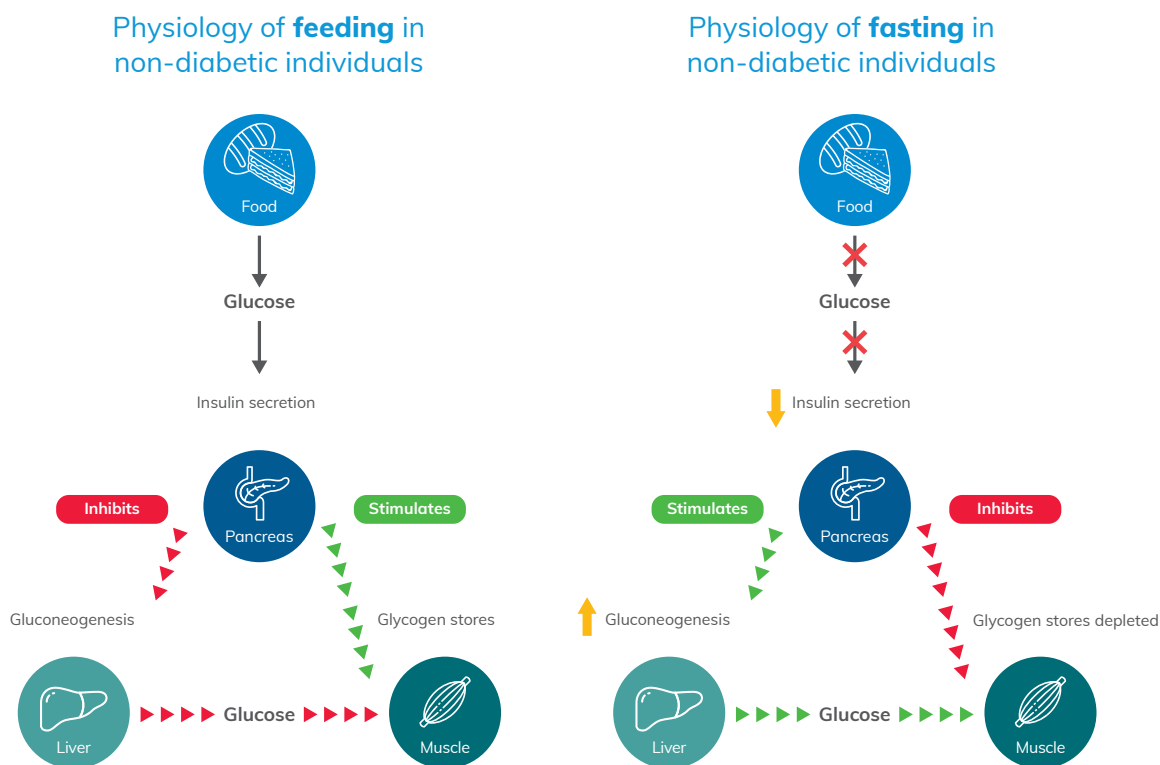


FIGURE 5

Physiology of feeding and fasting in non-diabetic healthy individuals.

Panel A: In individuals without diabetes, after eating, increased glucose levels in the blood stimulate insulin secretion, which in turn triggers the liver and muscles to store glucose as glycogen.

Panel B: During fasting, circulating glucose levels fall and insulin secretion is suppressed. Glucagon and catecholamine secretions are increased, stimulating glycogenolysis and gluconeogenesis leading to an increase in blood glucose levels [39].

6.3 Glucose profile

Studies utilising continuous glucose monitoring (CGM), that have been performed over the last few years have shed some light on other important changes to glucose homeostasis in the context of the RF. Several parameters have been examined including indicators of overall glycaemic control, hyperglycaemia and hypoglycaemia risk and glucose variability. The number of participants in these studies are typically quite small, and as such, the results should be interpreted with caution. Several studies report a reduction in fasting glucose levels during Ramadan [22, 40, 41]. However, most CGM studies, remarkably, showed stable blood glucose levels in healthy individuals (without diabetes) during fasting hours, with no significant differences in the markers of glucose exposure and average, highest or lowest glucose sensor readings [42]. At *Iftar*, a modest rise in interstitial glucose (and therefore blood glucose) is seen, but with this increase it remains within normal ranges [43].

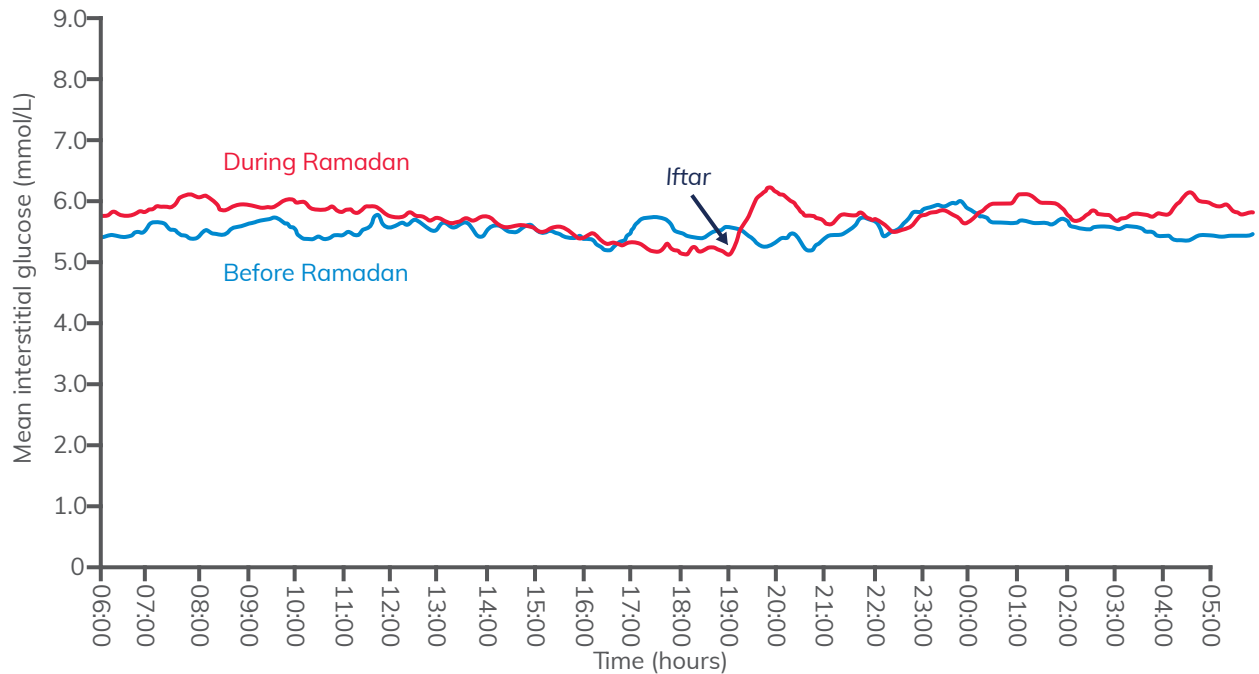


FIGURE 6

Mean continuous glucose monitoring (CGM) profiles from healthy individuals before and during Ramadan.

Figure adapted from Lessan *et al.* [43].

Interestingly, glucose homeostasis does not appear to revert back to that of pre-Ramadan in the early post-Ramadan period. Pallayova *et al.* reported a statistically significant increase in the hyperglycaemic (> 140 mg/dL) area under the curve (AUC) after Ramadan compared to both before and during Ramadan, along with an increased glucose variability after Ramadan ($p=0.01$). Both the area under the interstitial glucose concentration curve for the entire day and the average glucose were positively associated with BMI during ($p=0.004$ and $p=0.005$, respectively) and after Ramadan ($p=0.01$ and $p=0.01$, respectively) indicating that overweight and obese, but otherwise healthy subjects might be more prone to higher glucose excursions during Ramadan which could continue for days after the Ramadan fasting period has ended. The study also indicated atypical CGM patterns in a small group of subjects, distinguished by a prolonged increased glucose exposure, particularly in response to a meal [42].

7. LIPID CHANGES DURING RAMADAN IN HEALTHY INDIVIDUALS

Several studies have demonstrated that Ramadan fasting is associated with favourable effects on the lipid profile of healthy individuals [29, 44-46]. A meta-analysis, published in 2014 and involving 30 articles investigating the effect of Ramadan fasting on parameters including blood lipids, found no change overall in high density lipoprotein (HDL) or triglyceride (TG) levels, but large significant decreases in low density lipoprotein (LDL) levels [22]. There were however some differences in the effects of fasting on lipid profile between genders, with a statistically



significant increase in HDL in females, and a small statistically significant decrease in TG levels in males after Ramadan [22].

8. HORMONAL CHANGES DURING RAMADAN FASTING IN HEALTHY INDIVIDUALS

Changes in sleeping patterns during the Ramadan fast occur to accommodate for an early morning meal and also for the time spent in prayers, particularly in the evenings and early mornings. It is therefore expected that circadian and hormonal rhythms may alter. Several hormones have been investigated in the last few years and their changes with Ramadan fasting have been described. In reviewing the literature on hormones and hormone changes during Ramadan fasting, it is important to consider the effects on different factors including pulsatile secretion, circadian rhythmicity, stress response, and also the effect of eating and timing of meals. Other important factors to consider are gender and weight. As such, the effect of Ramadan on hormones may be different between men and women, and also in individuals of different ages or weight. Changes in hunger and hormones are described below; **Figure 7A**.

8.1 Cortisol

Cortisol is the chief glucocorticoid hormone under hypothalamic and pituitary control and secreted by the adrenal cortex. Cortisol secretion normally follows a circadian rhythm with a peak in the morning and a trough in the evening. It is also a stress hormone, with levels rising in response to physical and psychological stress. All of these factors may be of relevance in the context of the RF. Cortisol has important effects on blood glucose, through its effects on insulin sensitivity. A high level of cortisol is associated with a rise in blood glucose. Studies on the changes in cortisol with Ramadan with considerations to circadian changes have been very few. Bahijri *et al.* investigated various metabolic and hormonal parameters in 23 participants before and during Ramadan fasting [16]. Samples were taken at 9 AM and 9 PM. The study found lower morning cortisol levels and higher evening cortisol levels during Ramadan compared to the pre-Ramadan period (**Figure 7B**). The morning to evening cortisol ratio changed from 2.55 to 1.22. This reduction in the morning to evening cortisol ratio seems to be consistent in the few studies that have looked at cortisol circadian rhythmicity during Ramadan fasting.

8.2 Adiponectin

Adiponectin, hormone and adipokine, which is involved in regulating glucose levels as well as fatty acid breakdown, impacting metabolic activity and insulin sensitivity via actions on fat tissue, liver and skeletal muscle by regulating glucose metabolism and mitochondrial biogenesis [47]. Adiponectin modulates glucose metabolism and high levels are associated with increased insulin sensitivity [48]. Adiponectin is also indirectly involved with the inhibition of gluconeogenesis [48]. Plasma adiponectin levels can rise in response to caloric restriction; see **Figure 7C**. One study exploring the role of adiponectin during the RF observed a significant reduction in healthy males after 4 weeks of Ramadan [37] and another reported decreased levels of adiponectin in the mornings during Ramadan, compared to *Sha'ban*, whereas evening adiponectin levels showed no significant difference between these two periods [41]. Conversely, a study involving healthy males with risk factors for type 2 diabetes mellitus (T2DM) reported a significant increase in adiponectin at the end of Ramadan [49].

8.3 Leptin

Leptin is a satiety hormone secreted by the white adipose tissue. It has negative effects on feeding through its effects on the hypothalamus. Leptin also has important roles in bone metabolism and immunity. There are different patterns of leptin secretion between Ramadan and non-Ramadan times; see **Figure 7C**. In healthy individuals, leptin level rise in response to food. Its secretion follows a circadian rhythm, with a peak between 10 PM to 3 AM [50]. Leptin levels are positively related to weight and body fat. The effects of Ramadan on serum leptin seems to be directly related to the changes in the time of eating. Ajabnoor *et al.*, in 2014, showed that compared to the pre-Ramadan period, Ramadan fasting leptin levels were much higher in the morning, but evening levels were similar to that of pre-Ramadan [37]. Alzoghaibi *et al.* found similar effects, but also reported reduction in night-time levels of leptin when compared with the period before and after Ramadan [51].

8.4 Ghrelin

Ghrelin is also an appetite stimulating peptide hormone. Circulating Ghrelin levels are high pre-prandially and drop after eating. As such, Ghrelin levels and its fluctuations might be expected to alter during RF. However, Alzoghaibi *et al.* found no significant differences in Ghrelin in individuals of a healthy weight during the RF [51]. Another more recent study in overweight and obese individuals reported a marked reduction in ghrelin in the last week of Ramadan [15].

8.5 Other hormones

Growth hormone is also an important hormone that can alter during Ramadan. It is known to affect insulin sensitivity, and acts as an important regulator of protein and fat metabolism as well as bone health. In children, it has a vital role in healthy growth and development. Growth hormone is normally secreted in a pulsatile manner. Its secretion also follows a circadian pattern, with the highest peaks in the early hours of the morning. As such, any study of growth hormone changes in the setting of Ramadan will need to take these into consideration with multiple samples taken during the 24-hour period. No such comprehensive study has been conducted as of yet. However, in the study by Ajabnoor *et al.*, 9 AM and 9 PM growth hormone levels were taken in 23 healthy individuals, and lower levels were found during Ramadan in both the morning and the evening [37].

Other hormonal changes reported in RF include a modestly reduced reduction in testosterone in single men, towards the end of Ramadan period [52].

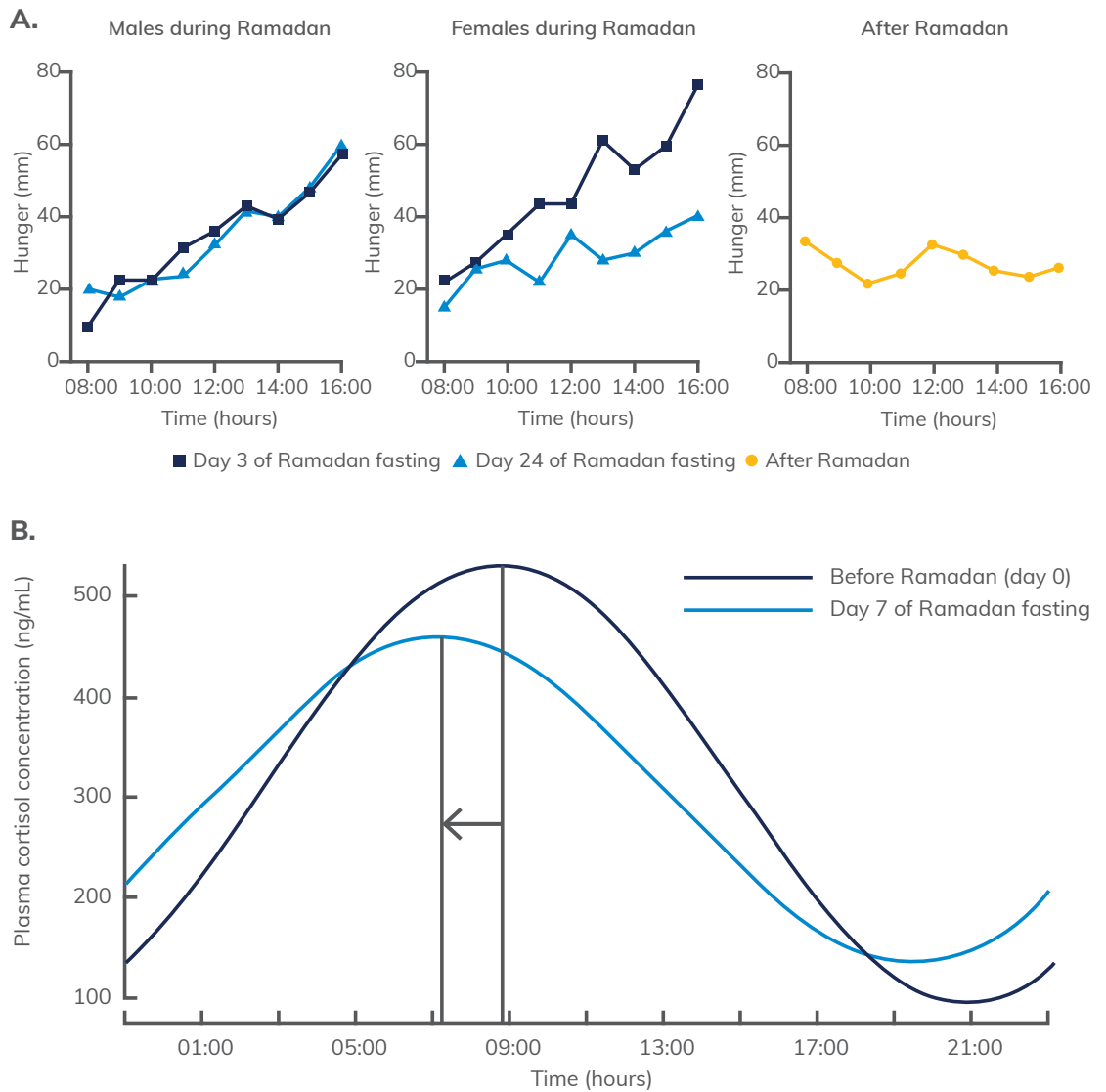


FIGURE 7

Physiology of feeding and fasting in healthy individuals.

Panel A: Changes in hunger–satiety cycles during Ramadan. During fasting hours, there is a progressive rise in hunger rating which peaks just before *Iftar* time. Hunger–satiety cycles during Ramadan change in line with the shift in the timing of main meals, with wider gaps between meals intensifying feelings of hunger. This increase in the hunger during fasting hours is seen in both sexes and is intense by *Iftar*. However, in females, some adaptation seems to occur, and by day 24 of Ramadan fasting, the hunger rating during fasting hours appears to reduce in intensity. Adapted from Finch et al., [21].

Panel B: Changes in cortisol circadian rhythm during Ramadan. Changes to sleep and food intake impact on circadian rhythms; compared with non-Ramadan periods, lower morning cortisol levels and higher evening cortisol levels have been observed during Ramadan. Adapted from Diabetes and Ramadan: Practical Guidelines International Diabetes Federation (IDF) [39].

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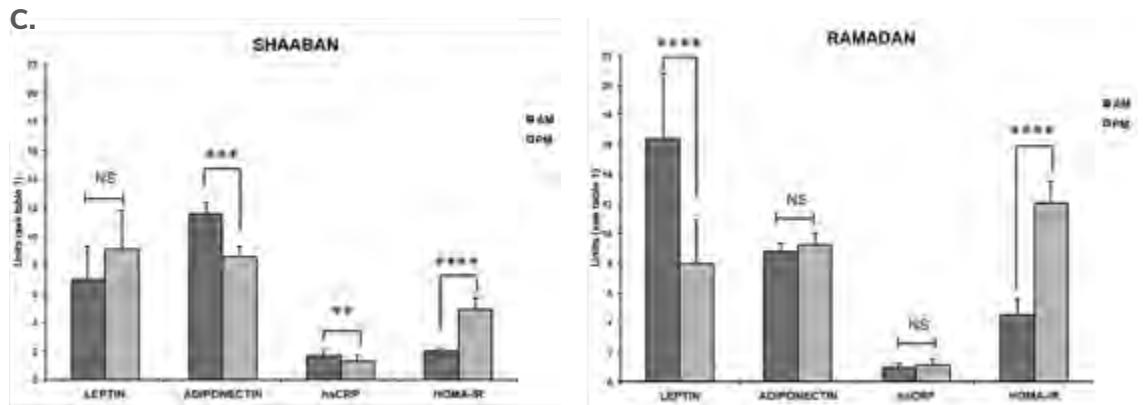


FIGURE 7

Physiology of feeding and fasting in healthy individuals.

Panel C: Circulating day and night levels of leptin, adiponectin, hsCRP and HOMA-IR during Sha'ban – (a) and 2 weeks into the Ramadan – (b) in 23 healthy young Saudi Arabians. ** $p < 0.01$, *** $p < 0.005$, **** $p < 0.0001$. Adapted from Ajabnoor et al. [37].

9. NEW EVIDENCE OF CHANGES THAT CAN OCCUR WHEN FASTING DURING RAMADAN

9.1 Ramadan fasting and gut microbiota

Gut microbiota have emerged recently as an integral player in the progression of chronic diseases of obesity, and diabetes, alongside a range of other environmental and genetic factors [53, 54].

Recent studies indicate that dietary modifications, including intermittent fasting, have a substantial role in changing the gut microbiota in a way that improves the immune system and body metabolism. Furthermore, this positive change in gut microbiota has been found to affect body fat composition by changing the white adipose tissue into more mitochondria-dense browned tissue through a process known as “browning or beiging”, which in turn help to increase energy expenditure and reduce the chances of developing obesity [55].

The specific effect of Ramadan fasting on the gut microbiome has not been extensively studied. A pilot study (N=9) from Turkey revealed that that microbial richness was significantly increased at the end of the Ramadan fasting period; no significant differences were found in terms of phylogenetic diversity metrics [56]. Studies in model organisms, such as mice, support the findings in humans and highlight the important changes that can occur to gut microbiota when fasting is conducted. Most recently, intermittent fasting has been found to reshape gut microbiota in healthy mice, with the length of the daily fasting interval being an important influencing factor [57].

The human salivary microbiota has been looked at as an important non-invasive approach to explore the bacteria shed from oral surfaces. This type of microbiota might also mirror oral



and general health [58]. Recent work using next-generation sequencing (NGS) techniques, on salivary microbiota and 16S ribosomal deoxyribonucleic acid (rDNA) from 64 obese individuals who were fasting during Ramadan, showed a statistically significant change in the phylum *Candidatus Saccharibacteria*/TM7 at the end of Ramadan when compared to the pre-Ramadan. The significance of this change is not currently known.

9.2 Ramadan fasting and gene expression

Although genes are inherently fixed and cannot be changed throughout the human life, it is well established that dietary and lifestyle behaviours affect human gene expressions [59], in a way that may modulate the risk of developing chronic diseases such as diabetes [60]. This effect of dietary and lifestyle behaviours is expressed by virtue of the epigenetic mechanisms such as histone acetylation and DNA methylation that affect the degree of gene expression [61].

The epigenetic effect of Ramadan fasting has been an area of recent interest. Some studies have indicated an impact of observing fasting during Ramadan on *CLOCK* circadian rhythm-controlling genes, a central component of the circadian molecular clock [62], antioxidant enzyme-controlling genes (*TFAM*, *SOD2*, and *Nrf2*) [63], and metabolism and aging-controlling genes (*SIRT1* and *SIRT3*) [63]. In the study of Ajabnoor *et al.*, *CLOCK* gene expression was significantly higher in the morning than in the evening during the pre-fasting month (*Sha'ban*) than during Ramadan fasting month, a matter that is explained by the changes in the sleep pattern encountered during Ramadan fasting days [62]. This significant change in the *CLOCK* gene expression has an adverse effect on glucose homeostasis and may contribute to the reported changes in insulin secretion patterns and increases in insulin resistance during Ramadan [16, 37]. These results highlight the potential adverse effect of staying up for long time during the night hours of the Ramadan month, a widely observed practice in many Islamic communities during Ramadan.

Madkour *et al.*, investigated 56 overweight and obese participants and showed that the relative gene expressions, compared to normal healthy controls, for the antioxidant genes (*TFAM*, *SOD2*, and *Nrf2*) were significantly upregulated by variable degrees at the end of Ramadan (90.5%, 54.1%, and 411.5%, respectively). For the metabolism-controlling gene (*SIRT3*), genetic testing showed strong evidence ($p < 0.001$) of downregulation, concomitant with a non-statistically significant reduction in *SIRT1* gene expression at the end of Ramadan [64]. These results suggest that Ramadan fasting ameliorates gene expressions of anti-inflammatory and antioxidant regulatory genes, implying that Ramadan fasting may entail a protective effect against oxidative stress and its adverse metabolic-related derangements in non-diabetic obese individuals.

10. PATHOPHYSIOLOGY OF FASTING IN INDIVIDUALS WITH DIABETES

When fasting, insulin resistance/deficiency can lead to excessive glycogen breakdown and increased gluconeogenesis in people with type 1 diabetes mellitus (T1DM) and T2DM. In addition, in T1DM, augmented ketogenesis can occur. As a result, the risks facing people with diabetes are heightened during Ramadan. These include hypoglycaemia, hyperglycaemia, diabetic ketoacidosis, dehydration and thrombosis [20]. As well as fasting, the act of feasting during Ramadan also carries risks for those with diabetes (Figure 8).

The landmark Epidemiology of Diabetes and Ramadan (EPIDIAR) study found that during Ramadan there was a 4.7-fold and 7.5-fold increase in the incidence of severe hypoglycaemic complications in people with T1DM and T2DM, respectively, compared to non-Ramadan periods [65]. During the fast, people with T1DM may fail to secrete adequate levels of glucagon in response to hypoglycaemia, leading to further decreases in blood glucose levels [20].

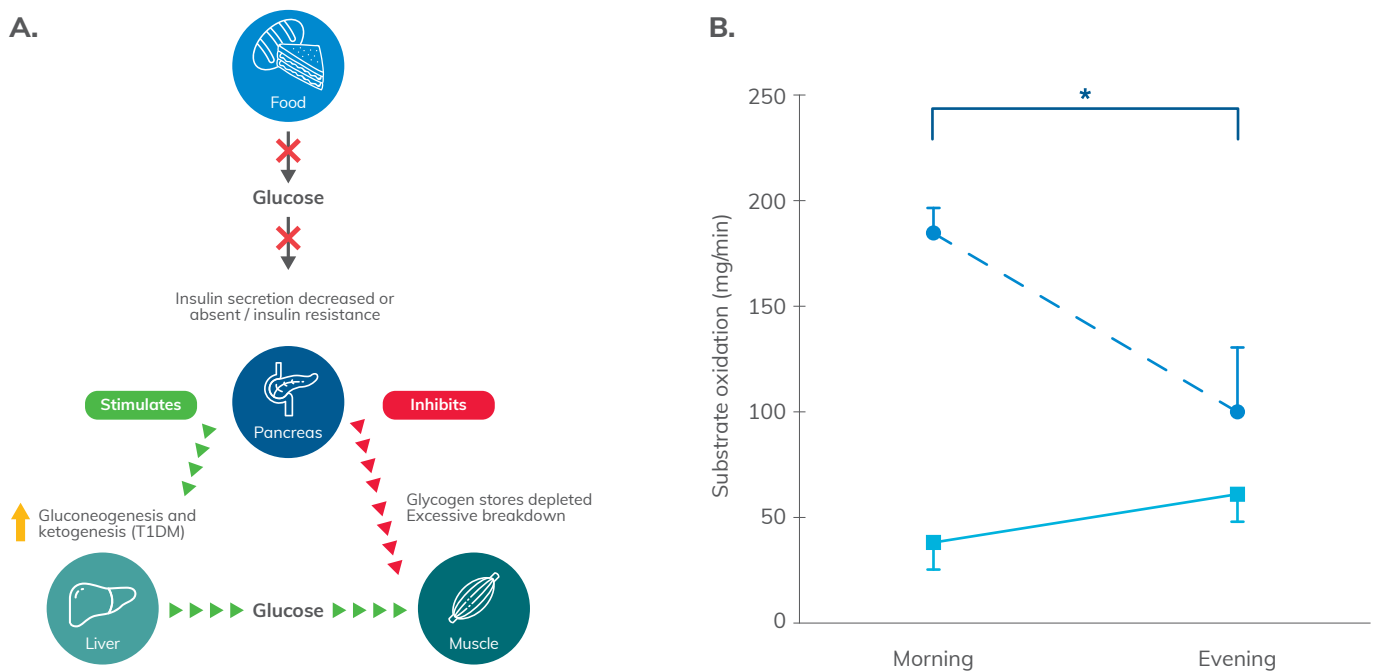


FIGURE 8

Pathophysiology of fasting in people with diabetes.

Panel A: Substrate oxidation as a function of daytime fasting, (Left). In individuals with diabetes, the underlying pathophysiology and the medications used to treat the condition both disturb glucose homeostasis. When fasting, insulin resistance/deficiency can lead to excessive glycogen breakdown and increased gluconeogenesis in people with T1DM and T2DM; in addition, in T1DM, augmented ketogenesis can occur.

Panel B: (Right) Recorded measurements of lipid and carbohydrate oxidation during Ramadan fasting. Substrate oxidation was measured by indirect calorimetry. Statistically significant time effects were observed ($p < 0.05$). Left: Adapted from Diabetes and Ramadan: Practical Guidelines International Diabetes Federation (IDF) [39]. Right: Adapted from Alsubheen et al.[36].

In addition, as a result of autonomic neuropathy, some people with T1DM may have a defective adrenaline response and therefore an inadequate response to hypoglycaemia [66]. The incidence of severe hyperglycaemia was also found to be increased during Ramadan (3-fold and 5-fold in people with T1DM and T2DM, respectively) [65].

10.1 Glycaemic control and glucose variability

Over the last few years, continuous glucose monitoring (CGM) studies have been performed in people with diabetes before and during Ramadan [43, 67-69]. As well as CGM, flash glucose monitoring (FGM) has also been available, and has been used to explore changes in glucose profiles during the RF. FGM is less invasive and more user friendly, and as such has been more



readily accepted by the fasting individual. Both FGM and CGM have limitations that have to be considered when interpreting results of studies using these techniques.

One such CGM study investigated glucose variability in Ramadan in 33 individuals. An increase in the mean amplitude of glycaemic excursions (MAGE), was seen in the early stages of Ramadan compared to that of before Ramadan ($p=0.006$) but not in late-Ramadan and post-Ramadan. The higher MAGE in early Ramadan was only seen in individuals on multiple (>2) anti-diabetic drugs and those on sulphonylureas. No significant changes were seen in coefficient of variation, time in range, time in hyperglycaemia, or time in hypoglycaemia. Aside from an initial increase in glucose variability, fasting during Ramadan for people with non-insulin treated T2DM was found not to cause any significant changes in glucose variability or time in hypoglycaemia during CGM recording days compared to non-fasting pre-Ramadan period [70].

A larger study involving 50 people with T2DM, and six people with T1DM reported no significant differences in markers of glycaemic control between Ramadan and non-Ramadan periods [43]. There were no significant differences in the number of high or low glucose excursions, time spent in euglycaemia, hypoglycaemia, and hyperglycaemia [43]. However, major intra- and inter-individual variability in CGM profiles were observed. A rapid rise in glucose levels after *Iftar* was seen (Figure 9). Possible contributing factors to changes in glucose profiles have been postulated and include changes in dietary behaviour and a shift to carbohydrate-rich meals at *Iftar*.

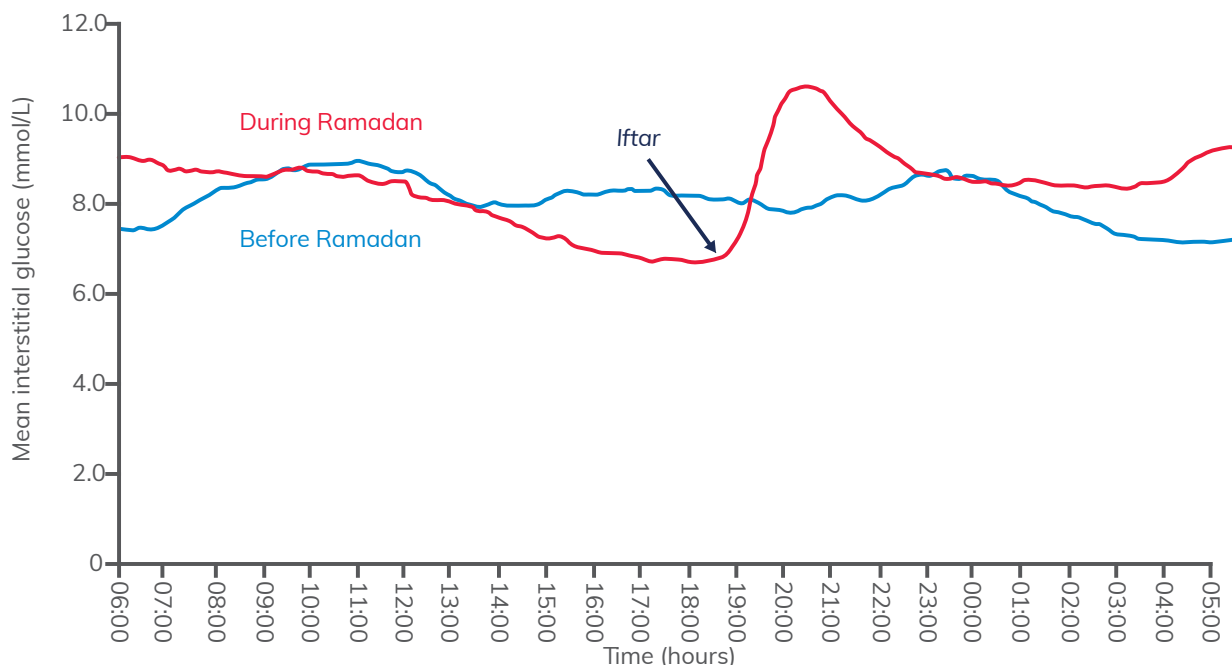


FIGURE 9

Mean continuous glucose monitoring (CGM) profiles from people with diabetes before and during Ramadan.

A rapid increase in blood glucose is observed at *Iftar* time; the intake of the carbohydrate-rich meals at *Iftar*, and the involvement of hormonal changes are possible contributing factors that may explain this pattern. Inappropriate timing and inadequate dosing of anti-diabetic medication may also be important contributors to this rise. Figure adapted from Lessan et al., [43].



10.2 Effect of Medication type

In the study by Lessan *et al.*, subgroup analyses by medication grouping (whether insulin, or sulfonylurea were part of the anti-diabetic regimen) showed a clear hierarchy in glycaemic profile outcomes with RF. Insulin-treated individuals showed the least favourable glucose profile with the highest AUC during Ramadan fasting, followed by those treated with sulfonylureas. Those treated with Metformin or not treated at all had the most favourable CGM profile. The risk of hyperglycaemia (high blood glucose index-HBGI) during Ramadan increased after *Iftar* in most groups and was highest in the insulin treated group. The risk of hypoglycaemia (low blood glucose index-LBGI) and MAGE were also higher in the insulin-treated group compared to other medication groups. A comparison of Ramadan glycaemic outcomes in different medication categories found the RF resulted in no deterioration in glycaemic profiles (mean glucose and glucose variability) among most individuals, although in a few people a deterioration or an improvement was seen, (**Figure 10**) [43].

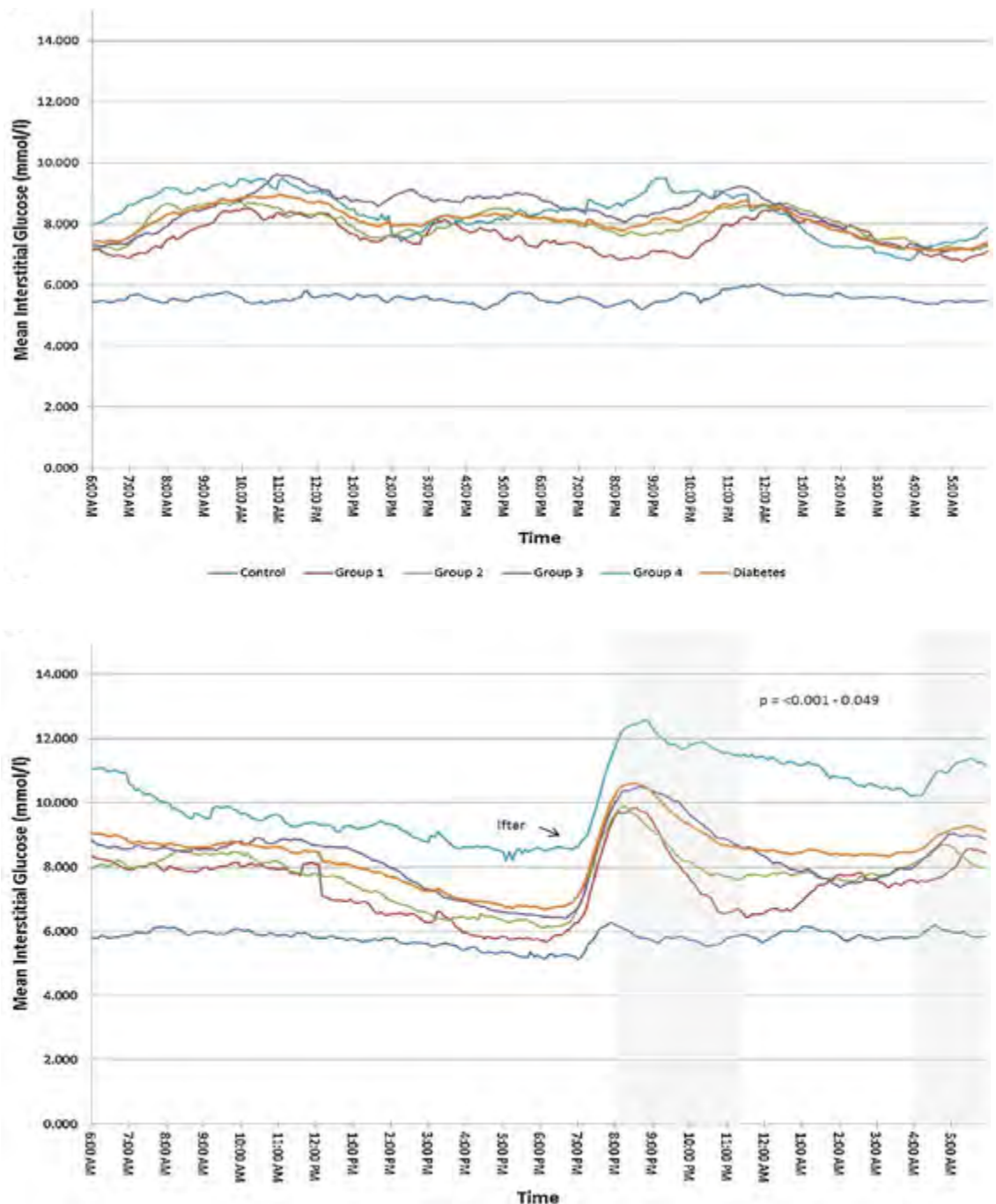
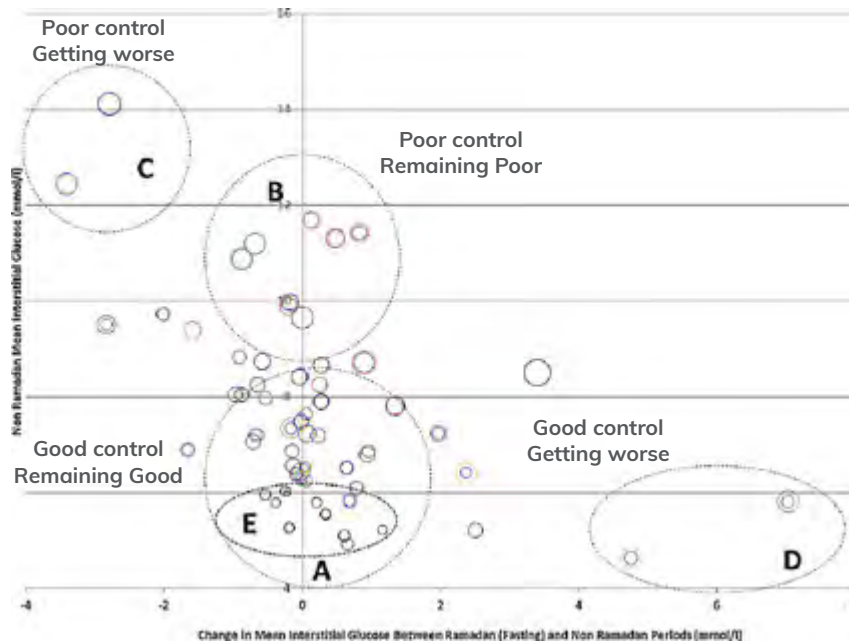


FIGURE 10

Pathophysiology of fasting in people with diabetes.

Panel A: Mean continuous glucose monitoring (CGM) recordings for people with diabetes and controls when not fasting (Top) and fasting (Bottom) by type of treatment: Group 1 diet with/without metformin; Group 2 gliptin with/without metformin; Group 3 sulphonylurea with/without other oral agent(s); Group 4 insulin with/without other oral antidiabetic agents (OADs). The difference between groups when compared to controls was statistically significant ($p < 0.05$, Wilcoxon's signed-ranked test) for mean interstitial glucose during Iftar and the predawn meal Suhoor (shaded areas in the bottom graph).

figure 10 continued on next page ►



*Size of bubble indicates glucose SD

FIGURE 10

Pathophysiology of fasting in people with diabetes.

Panel B: Mean interstitial glucose (IG) levels during non-Ramadan (blue circles) and Ramadan fasting derived from continuous glucose monitoring (CGM) data from the same individuals (concentric circles). Circle size corresponds to standard deviation (SD). Red circles: insulin-treated; orange circles: sulphonylurea-treated; purple circles: gliptins with/without metformin; green circles: no medication/metformin; and black circles: controls (no diabetes). Different trends were identified: A: good initial control with no significant change on fasting; B: poor initial control with no significant change on fasting; C: poor initial control with improvement on fasting; and D: good initial control with further improvement on fasting. In general, no significant SD changes were seen between non-Ramadan and Ramadan, indicating similar trends in overall glucose excursions during the two periods. The main outliers (D) were individuals taking insulin and sulphonylureas. Adapted from Lessan et al. [43].

11. RAMADAN FASTING AND OTHER MEDICAL CONDITIONS: RELEVANCE TO DIABETES

Several other common conditions can be affected by RF and many can be present in patients with diabetes. These include conditions such as hyperlipidaemias, hypertension, chronic kidney disease (CKD), ischaemic heart disease (IHD) and vitamin D deficiency. For some of these, only an adjustment of timing of medication during RF is needed. For others, such as CKD and IHD, advice from a specialist and if available multi-disciplinary management is recommended (see **chapter 5: Risk stratification of people with diabetes before Ramadan** and **chapter 13: Risks of fasting during Ramadan Cardiovascular, Cerebrovascular and Renal complications**).

11.1 Hypothyroidism

Hypothyroidism is a common endocrine condition and frequently seen in people with diabetes. There is no evidence of any significant changes occurring as a result of the RF in people with hypothyroidism as an underlying condition. However, changes to the timing of thyroxine ingestion are inevitable during the RF and in some individuals, this can lead to interference in



thyroxine absorption and therefore suboptimal control of hypothyroidism. Thyroxine should be taken at least half an hour before breakfast. Its absorption can also be delayed if taken on a full stomach. In particular, absorption can be slowed by the concurrent use of iron supplements and antacids. The RF presents a challenge for individuals with hypothyroidism since the usual breakfast time is changed to a time earlier (pre-dawn *Suhoor*) [71]. Importantly, *Suhoor* is often a period of rush and taking thyroxine half an hour before the meal can have practical issues. Likewise, taking thyroxine at *Iftar* and waiting half an hour before eating takes the positive social impact and satisfaction of eating with the rest of the family away. The optimal time to take thyroxine and possible dose adjustments during the RF is a matter of debate [72], with one advocated solution being to take thyroxine later at night with the proviso that no heavy food is taken between *Iftar* and late night.

11.2 Bariatric surgery

Bariatric surgery (BS) is the most efficacious treatment for obesity. It is frequently performed in people with T2DM — many of whom are also obese. Many Muslim individuals choose to continue with their normal practice of fasting after bariatric surgery and this is an issue that might be of concern to doctors and healthcare professionals. Specific concerns include the inability to consume large meals and, in theory, absorb certain macronutrients. Few studies have explored these issues. Al-Ozairi et al., conducted a telephone survey of 207 participants with a history of previous sleeve gastrectomy and reported a reduced calorie intake of around 20% and 17% in men and women, respectively, during Ramadan. Of these reduction in caloric intake, the corresponding protein reductions were around 45% in men and 32.5% in women. No changes in fluid intake with the RF were reported. Participants reported feeling less hungry during while fasting during Ramadan [73].

SUMMARY

- Fasting during the month of Ramadan can precipitate dramatic changes in meal schedules, fluid intake, sleep patterns and circadian rhythms.
- These changes can have an impact on hormone levels and their normal rhythms. In people with diabetes, these include:
 - Insulin resistance and increased glucagon levels.
 - A shift in cortisol circadian rhythm with a blunting of the morning to evening ratio.
 - Reduction in morning adiponectin levels.
 - Large increases to morning leptin levels.
 - Reductions to morning and evening growth hormone levels.
 - Modest reductions in testosterone in men have also been reported.
- Fasting during Ramadan can have a direct impact on the gut microbiota which could lead changes in health.
- Fasting during Ramadan can induce epigenetic changes to genes such as those controlling circadian rhythm.
- Ramadan fasting can be associated with favourable physiological changes among healthy individuals such as decreased body weight and favourable changes in lipid profile.
- In people with diabetes however, Ramadan fasting can be associated with certain risks due to the pathophysiology that disrupts normal glucose homeostatic mechanisms.
- People with hypothyroidism as a comorbidity to diabetes may require specialised advice in taking thyroxine during Ramadan.
- People with diabetes, and in particular those with T1DM, should seek medical advice before deciding to proceed with Ramadan fasting.

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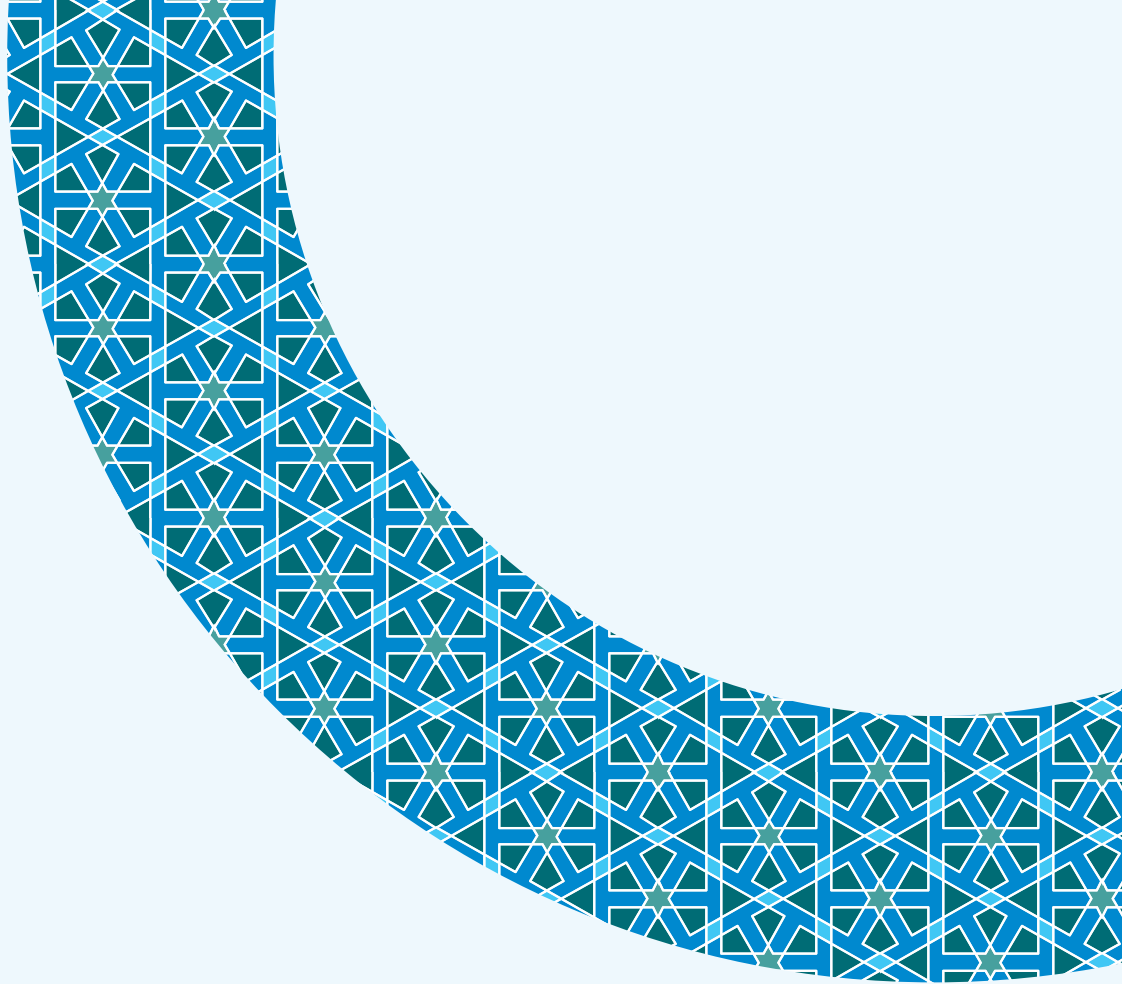


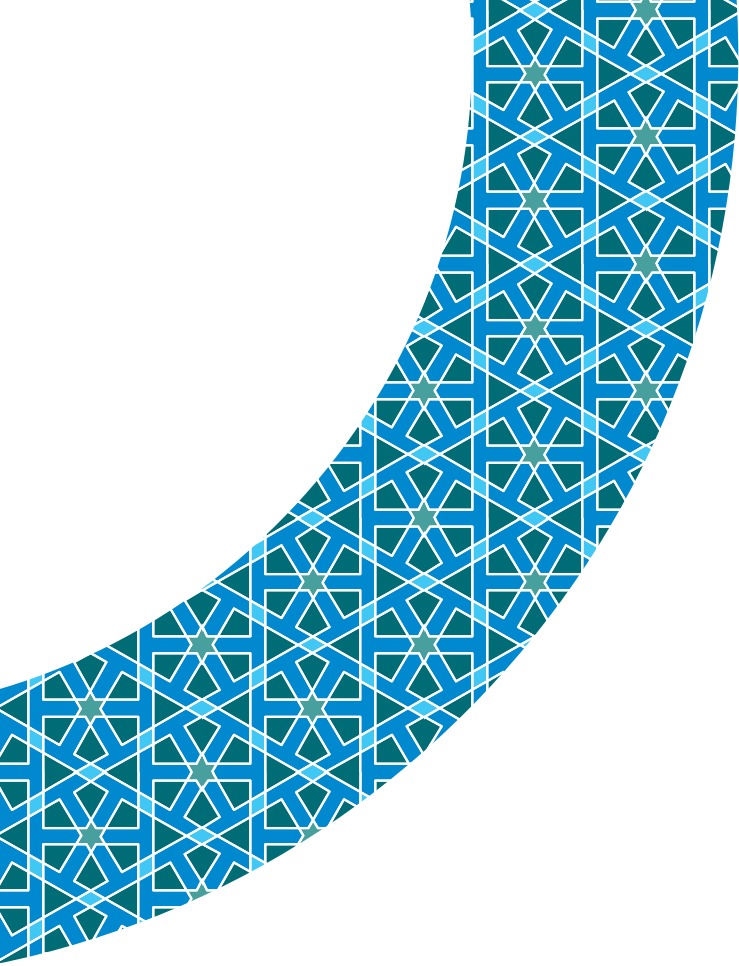
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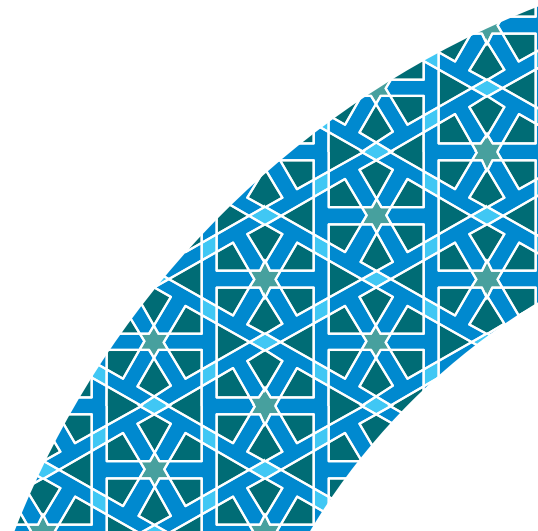


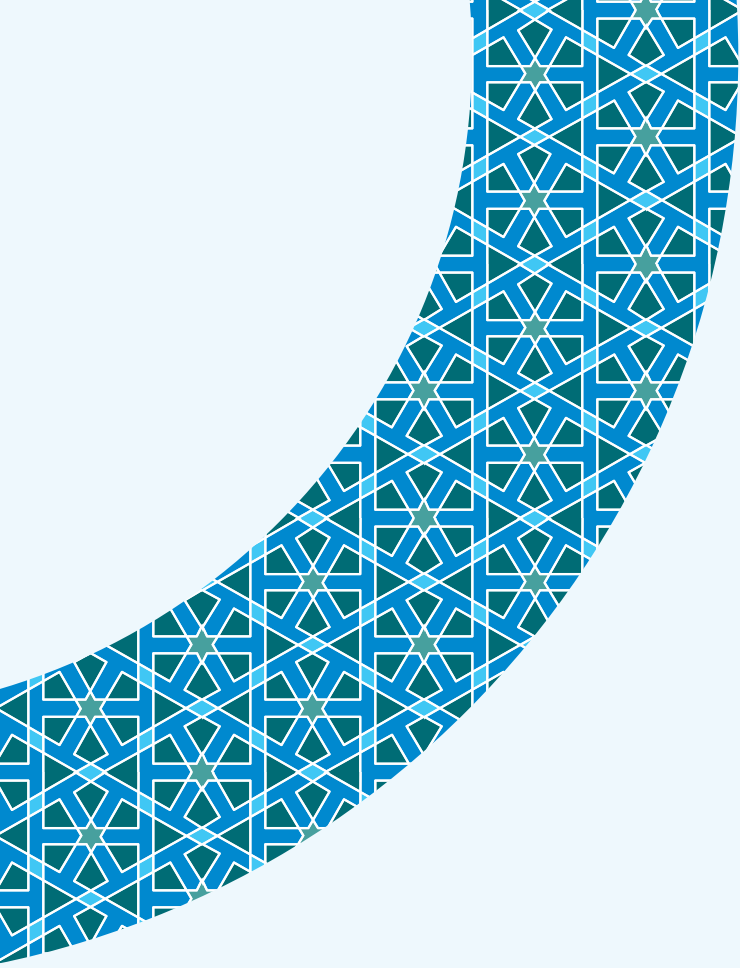
CHAPTER 4

The effects of fasting during
Ramadan on physical
and mental wellbeing

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CHAPTER 4

INDEX

1. INTRODUCTION	71
2. PHYSICAL EFFECTS OF FASTING DURING RAMADAN	72
2.1 Fatty liver disease	73
3. LIFESTYLE CHANGES THAT ACCOMPANY RAMADAN FASTING AND THEIR EFFECTS ON MENTAL WELLBEING	74
3.1 Dietary changes	74
3.2 Changes to physical activity	74
3.3 Changes to sleep	75
3.4 Cessation of Smoking	76
4. THE HOLISTIC IMPORTANCE OF RAMADAN	77
5. THE EFFECTS OF FASTING DURING RAMADAN ON MENTAL WELLBEING	78
5.1 The effect of intermittent fasting (IF) on mental wellbeing	79
6. OVERVIEW OF THE EFFECTS OF FASTING DURING RAMADAN ON WELLBEING	80
SUMMARY	82
REFERENCES	83



WHAT IS KNOWN?

- Ramadan is a holy month in which people do good deeds and enhance their spirituality.
- Fasting during Ramadan can lead to changes in lifestyle.
- Fasting during Ramadan in people with diabetes can present specific challenges such as the need to adapt meals and medications.

WHAT IS NEW?

- Fasting during Ramadan can have positive effects on one's physical and mental wellbeing.
 - This can include weight loss, improvements to metabolic markers, potential improvements to hepatic health and reductions to feelings of stress and anxiety.
- People with diabetes experience both negative and positive mental and psychological outcomes when fasting during Ramadan and in intermittent fasting (IF) outside of Ramadan
- The changes, benefits and risks to one's physical and mental wellbeing that can occur when fasting during Ramadan need to be considered when healthcare professionals (HCPs) provide guidance and when individuals with diabetes are making the decision to fast.

WHAT IS MISSING?

- There needs to be greater research into the effects of fasting during Ramadan and IF in people with diabetes
 - This research needs to include people with both type 1 diabetes mellitus (T1DM), type 2 diabetes mellitus (T2DM), people with diabetes that are elderly, pregnant and those with pre-existing physical and mental health comorbidities.
- There also needs to be greater research into the motivations of people that are considered high risk seeking to fast during Ramadan
 - This will help HCPs in understanding the needs of individuals and will lead to better and more individualised guidance.

1. INTRODUCTION

Practicing the fast during Ramadan can herald a sudden shift to one's usual lifestyle including to mealtimes, levels of physical activity, sleeping patterns and social interactions. The basic purpose of fasting during Ramadan is for an individual to change their usual behaviours to enhance their virtue of self-control, cleanse their body, be grateful to God, empathise with people that are less fortunate, and to carry out more good deeds. It is stated in the Qur'an that "O you who believe! Fasting is prescribed to you as it was prescribed to those before you so that you can learn Taqwa" [1] (good deeds and God-consciousness).

Ramadan, the holy month of fasting, disciplines the mind and body and is associated with improvements to both one's physical and mental wellbeing.

Fasting can be beneficial for many individuals, including healthy people, people with non-insulin treated diabetes and for people that have recovered from mild to severe psychological conditions [2, 3]. Over the last 30 years, there has been a significant increase in the number of studies investigating potential health-related issues of fasting during Ramadan reflecting increases in awareness and motivation [4, 5]. Research into this area can help to determine whether there are any effects of fasting during Ramadan on the physical or mental health of individuals that observe it.

The World Health Organisation (WHO) constitution defines 'health' as a state of complete physical, mental, and social wellbeing and not merely the absence of disease or immunity [6]. Assessing mental wellbeing includes looking at aspects of cognitive, emotional, and behavioural health (see **Figure 1**). Wellbeing can be measured through self-reported evaluations; for example, asking people whether they have a specific health conditions, or asking an individual to self-rate their wellbeing. These approaches enable individuals to self-reflect and think of ways to improve their wellbeing. Encompassing this is mental wellbeing – one's mental wellbeing is often viewed as the first step in achieving good health. Importantly, the opposite is also true where negligence of one's mental wellbeing can lead to health issues.



FIGURE 1

Basic factors of psychology which can affect one's wellbeing



There are many studies that have investigated the health implications of fasting during Ramadan and these have been explored in other chapters in these guidelines. In addition, specific studies have investigated the behavioural psychology of health in individuals that choose to fast [7-9]. It has also been reported that various types of fasting, including spiritual Ramadan fasting, can have positive health effects. It has even been suggested that fasting can be a complementary treatment method under the supervision of healthcare professionals (HCPs) [10].

There is a need to conduct more research on the effects fasting during Ramadan to shed light on the effects of physical and mental wellbeing. Findings to date suggest that through proper education, risk assessment and management, people with diabetes can safely fast during Ramadan. This chapter will first address the physical changes that can occur then consider the mental and psycho-social aspects of fasting during Ramadan.

2. PHYSICAL EFFECTS OF FASTING DURING RAMADAN

Fasting in general has been shown to be beneficial to health. Preclinical studies consistently show the efficacy of intermittent fasting in animal models on a wide range of chronic disorders, including obesity, diabetes, cardiovascular disease (CVD), cancer, and neurodegenerative brain diseases [11-15]. Fasting can also have positive mental and physical effects [16, 17]. Various studies have implicated beneficial metabolic outcomes in healthy individuals that fast during Ramadan. The positive physiological effects in healthy individuals include reductions in bodyweight and improvements in HbA1c, lipid, and blood pressure levels [18-23].

Differences in culture are also very important to consider when providing guidance to individuals seeking to fast during Ramadan. A study identified differences in the metabolic outcomes as a result of fasting during Ramadan across three different Islamic countries (Sudan, United Arab Emirates, and Pakistan). In this study, total cholesterol was significantly higher in the Pakistani population compared to that of the Sudanese and Emiratis at the end of Ramadan [24]. This may be due to the differences in eating patterns; these guidelines have provided individualised Ramadan Nutrition Plans so that people of different countries can receive tailored nutrition advice for fasting during Ramadan, please see **chapter 8: The Ramadan Nutrition Plan (RNP) for people with diabetes**.

A recent meta-analysis of 70 studies investigated some of the physical changes that can occur as a result of fasting during Ramadan. It was found that weight significantly reduced after Ramadan and this effect was also seen among different subgroups of body mass index (normal, overweight, and obese). Moreover, it was found that weight loss may be transient, whereby pre-Ramadan ranges returned around 2–5 weeks after Ramadan [25]. Another meta-analysis found similar results. However, the fasting duration, time in the year and country influenced the degree of weight loss [26].

The recent ABCD study showed that people with diabetes that fasted during Ramadan also had a modest reduction in weight after measurements were compared before and in the last week of Ramadan. It was shown that any changes to weight and other metabolic measures, such as HbA1c, HDL and LDL, returned back to normal within 12 weeks post Ramadan [27].

The multiregional CREED study found similar reductions to weight [28].

2.1 Fatty liver disease

The improvements in total body weight can translate into improvements to visceral adiposity. Various studies have demonstrated this in studying non-alcoholic fatty liver disease (NAFLD) [29-31]. NAFLD can present in different stages with hepatic steatosis being the earliest stage.

Hepatic steatosis is defined as an excessive accumulation of triglycerides (TG) in the hepatocytes (> 55 mg per g of liver) or as the presence of cytoplasmic TG droplets in more than 5% of hepatocytes [31]. Arabi *et al.* demonstrated, through studying individuals aged 18–65 years with NAFLD, that participating in fasting during Ramadan could reduce BMI, total cholesterol levels, fasting blood glucose levels and alanine aminotransferase [31].

Further, others have assessed the effects of fasting during Ramadan in people with NAFLD on measures of liver function, visceral adiposity index (VAI) and atherogenic index of plasma (AIP) values. Among those that fasted, there were improvements in liver enzymes and cholesterol levels in the period after Ramadan. There were also improvements in VAI and AIP after Ramadan but no differences among the fasting and non-fasting groups [30]. Another study investigating the effects of Ramadan fasting on people with NAFLD showed there were greater reductions in circulatory inflammatory markers, fasting blood sugar levels and serum insulin in people that fasted than those that did not fast [29].

However, greater research is still needed to fully understand the effects of Ramadan on people with NAFLD. These studies should ideally be in the form of randomised trials and also assessing people that have diabetes to provide specific guidance to people with diabetes.

All of these changes that can occur while fasting during Ramadan can have effects on one's mental wellbeing. It is very important that HCPs consider this when providing advice to ensure people with diabetes know what to expect and are fully prepared for fasting during Ramadan, this is particularly important in young and newly diagnosed individuals.



3. LIFESTYLE CHANGES THAT ACCOMPANY RAMADAN FASTING AND THEIR EFFECTS ON MENTAL WELLBEING

An individual's daily routine will change when fasting during Ramadan. These include changes to daily habits, eating patterns, sleeping schedules and physical activity patterns. In the context of people with diabetes this will lead to changes to the doses and regimens of medication and frequency of self-monitoring of blood glucose (SMBG) levels. These changes may seem uncomfortable or even unfeasible to some and will need to be considered by individuals when taking the decision to fast during Ramadan and by HCPs during the pre-Ramadan assessment.

3.1 Dietary changes

Though people with diabetes are exempt from fasting many will continue to do so. Fasting will significantly change the usual eating patterns and people with diabetes will need to be adequately prepared for this. Food cannot be eaten during the daylight hours; fasting occurs from dawn until sunset. The meal eaten pre-dawn (*Suhoor*) marks the beginning of the daily fast and then the meal at sunset (*Iftar*) marks the breaking of the fast. This means there is a short time period in which one can hydrate and eat food and careful planning is needed to achieve a safe and successful fast in healthy individuals, even more so in people with diabetes.

A healthy balanced diet is vital for overall wellbeing and mood. The gap in between meals will lead to changes in energy and this can lead to feelings of lethargy (see **chapter 3: What happens to the body? Physiology of fasting during Ramadan**). It is very important that any feelings of being unwell are recognised and that one regularly monitors their blood glucose levels to prevent any risks of hypoglycaemia.

Fasting during Ramadan can also help people learn how to conduct self-control and this may help with people who previously had bad eating habits. For further guidance on nutrition and diet during the Ramadan fast, please refer to **chapter 8: The Ramadan Nutrition Plan (RNP) for people with diabetes**.

3.2 Changes to physical activity

It is well established that exercise can cause the release of 'feel-good' chemicals called endorphins in the brain, which can lead to positive feelings and improve an individual's mental wellbeing. People might also use exercise as a coping mechanism to help deal with stress. During the month of Ramadan, however, physical activity and the frequency of exercise can decrease [32]. In people with diabetes this may be a precautionary measure to help avoid hypoglycaemia or due to the feelings of lethargy and being weak.

HCP's might inform people with diabetes to avoid excessive physical activity during the day and advise them to do light exercise after breaking the fast. In addition, during Ramadan many individuals will undertake the prayer of *Taraweeh*. While the participating in *Taraweeh* is a *Sunnah* (established customs and practices) and can provide an immense feeling of spiritual satisfaction there are the physical implications that need to be considered. In this prayer there could be more than 20 *raka'ahs* (iterations of movements in prayers) where a significant amount of energy can be expended. It has been demonstrated that people with type 2 diabetes mellitus (T2DM) that participated in the *Taraweeh* prayers achieved better outcomes such as reductions

in HbA1c and weight loss when compared to those that did not participate in *Taraweeh* prayers [33]. In all people with diabetes, especially those that are at relatively higher risks such as those that are pregnant, elderly or with comorbidities, there is a need to be cautious.

There will be a greater need to monitor blood glucose levels and stay on top of hydration requirements at Iftar if individuals are going to practice the Taraweeh prayer.

These changes to activity levels and exercise schedules will be dramatic to people that are used to regular routines and will need to be discussed with HCPs prior to Ramadan to ensure the best fitting plan is made for when Ramadan arrives in the calendar year.

Some studies assessing healthy athletic individuals have shown that feelings of depression, anger, anxiety, confusion, and a lack of concentration can occur during Ramadan due to the impacts of fasting upon normal exercise and training routines [34, 35]. These impacts on mental wellbeing may be different in people with diabetes and need to be investigated in further research.

3.3 Changes to sleep

In general, a lack of sleep is often associated with psychiatric disorders. Individuals with manic episodes and/or depression can go through periods of interrupted sleep and can often be in a sleep deprived state. Indeed, sleep has been used as therapy for severe cases of depression and can often help with feelings of fatigue or lethargy.

When fasting during Ramadan, normal sleep schedules will have to change in order to accommodate for the *Suhoor* meal which can often be very early in the morning (depending on the time of the year that Ramadan falls). Diet can have a direct effect on sleep quality during Ramadan. There is no limit on the amount of food that can be consumed at the two mealtimes during Ramadan and often people consume foods that are heavy in fats and sugar which can directly disturb sleep [36, 37]. This is even more important for people with diabetes; specific recommendations for an optimal diet for people with diabetes are mentioned in **chapter 8: The Ramadan Nutrition Plan (RNP) for people with diabetes**.

It is expected that participating in fasting during Ramadan will lead to a decreased total sleep time (TST), a delayed onset of sleep, a decrease in the duration of rapid eye movement (REM) sleep, a decrease in the proportion of REM sleep, and an increase in the proportion of non-REM sleep. These changes can affect mood [38], feelings of wakefulness, concentration and cognitive function. Indeed, these changes can also affect physiology and there could be physiological implications such as changes to the circadian rhythm [39], further information characterising these changes are available in **chapter 3: What happens to the body? Physiology of fasting during Ramadan**.



During Ramadan, social factors such as working/school hours and geographical factors such as location, can all affect the sleeping schedule of individuals and, therefore, also the overall experience of fasting [40].

It is particularly important for people with diabetes to get an adequate amount of sleep in order to prevent the expenditure of too much energy during the fasting hours. This will help to prevent the onset of hypoglycaemia alongside proper management. On the other hand, sleep itself can be affected due to periods of nocturnal hypoglycaemia, whereby blood glucose levels drop too low during periods of sleep.

HCPs working with people with diabetes, in particular insulin treated diabetes, must consider nocturnal hypoglycaemia when formulating eating plans and adjustments to medications.

It is recommended that sleeping schedules are thought of before Ramadan and adhered to during Ramadan. This will help alleviate any of the adverse effects associated with changes to sleep.

3.4 Cessation of Smoking

Smoking has a clear negative impact on one's physical and mental wellbeing. Smoking is a risk factor for many diseases such as cancer, obesity, diabetes, CVD, infections such as tuberculosis, problems of the immune system and many others. During Ramadan the sudden reduction of smoking can be very stressful [41] and lead to irritability [42], but the challenge is to maintain this for after the month of Ramadan. Faith based interventions for smoking cessation have been found to be effective for the post-Ramadan period [43].

The true observance of fasting during Ramadan provides an opportunity for all people to break patterns of smoking, and generally any addictive patterns, and can significantly improve wellbeing. HCPs can utilise the period of Ramadan to help put in place programmes and work with individuals to gradually break their addictive behaviours.

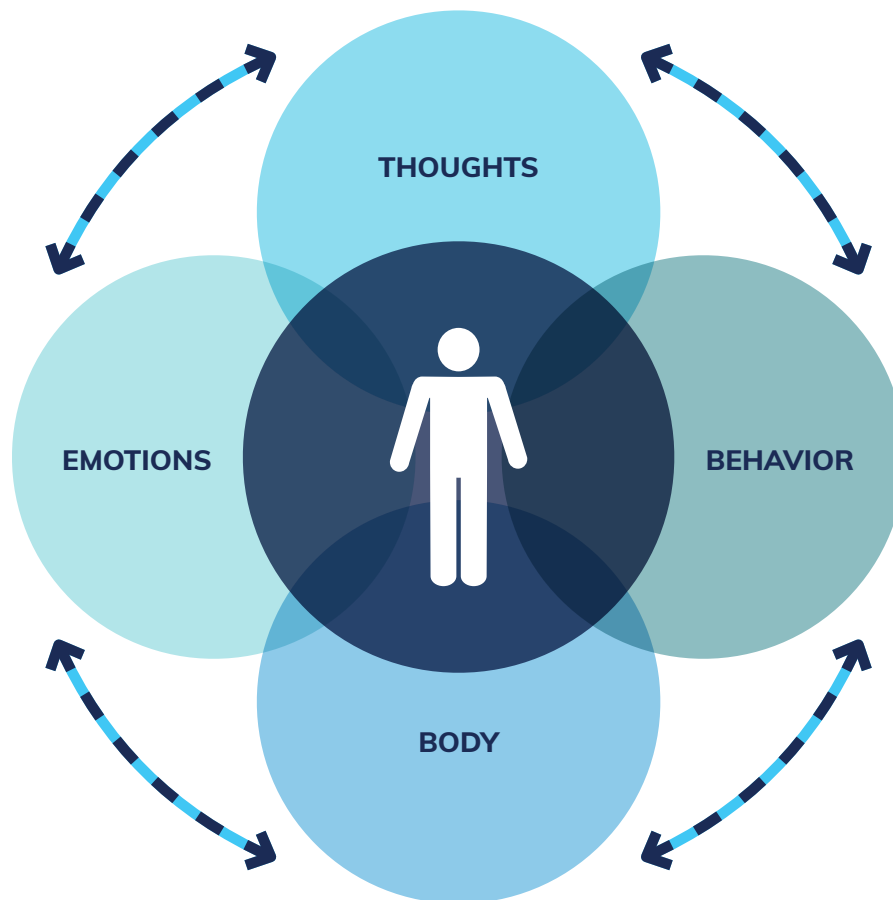


FIGURE 2

The interplay between the body and mind in the overall wellbeing

4. THE HOLISTIC IMPORTANCE OF RAMADAN

Fasting during Ramadan helps people to develop social and moral values such as the feeling of true compassion and empathy for people that are less fortunate. Moreover, Ramadan is a holy month in which people practice hospitality and do good deeds that help facilitate the feeling of happiness [44].

Equally important are the social aspects of Ramadan. People form closer bonds with family, friends and member of the community and generally enhance their social interactions [45]. Maintaining healthy relationships can fulfil an individual's need for contact, love and affection and can help people become more emotionally intelligent [2]. Ramadan is a time that a lot of people look forward to and mark on their calendars. Indeed, Ramadan is an important social time that facilitates interaction while combatting feelings of isolations and loneliness.

Likewise, the strong sense of community and social interaction during Ramadan can be harnessed in the implementation of guidance. Guidelines must target people that are wishing



to fast during Ramadan that have diabetes but also their support networks. Further information on the implementation of guidelines is available in **chapter 14: Identifying and overcoming barriers to guideline implementation.**

5. THE EFFECTS OF FASTING DURING RAMADAN ON MENTAL WELLBEING

There are many spiritual and mental benefits of Ramadan – the opportunity to self-reflect on aspects of life that need improving, and on doing good deeds, the ability to grow spiritually through prayers, and the chance to spend more time with loved ones and people within the community.

Islam teaches and empowers oneself to achieve a feeling of inner peace and tranquillity. During Ramadan, individuals build on their faith, read and listen to recitations of the Qur'an and participate in prayers and these have all been associated with declining rates of depression, anxiety, stress and improvements in memory [46, 47] and overall mental wellbeing [48]. However, these effects may not be the same for all — a systematic review by Pourabbasi *et al.*, found out that fasting may affect spatial memory, visual memory and attention in adolescents showing an, albeit temporary, but negative impact on their education [49].

Studies have also demonstrated that participating in fasting during Ramadan can provide benefits to mental wellbeing, including alleviating feelings of anxiety, depression, and reducing stress levels in healthy individuals [50-53] and people with diabetes [54]. Another study conducted in healthy graduate students showed that fasting led to improvements in self-acceptance, self-sufficiency, social relations and personal growth conducted among Muslim graduate students [48]. In a longitudinal study conducted in people with T2DM it was shown that fasting during Ramadan could help alleviate feelings of depression and that this could perhaps be linked to the spiritual and emotional benefits of fasting during Ramadan [55].

On the other hand, others found that pre-existing feelings of depression can lead to worse outcomes in diabetes such as poorer glycaemic control [56]. Moreover, Ovuyolu *et al.* reported that fasting during Ramadan could increase fatigue and negatively impact mental wellbeing [57]. Others also found that people who fasted during Ramadan experienced a reduction in mood, lower energy levels and greater irritability during the fast [58]. Deeb *et al.* reported that there was a fear of complications which may influence the experience of Ramadan and the initial decision to fast taken by younger individuals with T1DM or their parents/carers [59].

Further research is needed assessing people with diabetes in order to truly assess the psychological effects of fasting during Ramadan. In addition, research should ideally investigate people with type 1 diabetes mellitus (T1DM), T2DM and special populations such as the elderly, pregnant women and people with physical and mental comorbidities.

Altogether, the mental and psychological effects of fasting during Ramadan can be varied. Both healthy individuals and people with diabetes can experience opposing psychological outcomes for different reasons including the changes that accompany the practice of fasting

during Ramadan, the spiritual mental benefits of participating in the fast and aspects of their diabetes that can impact the experience of fasting during Ramadan (see **Figure 3**).

5.1 The effect of intermittent fasting (IF) on mental wellbeing

Intermittent fasting (IF) is a time restricted manner of eating or a method to restrict caloric intake, whereas fasting during Ramadan is abstaining from drinking and eating during the daylight hours for a month.

In Islam, there are other types of fasting that can occur (*Sunnah*) that involve IF outside of the month of Ramadan. Studies have investigated the effects of IF on mental wellbeing and, on the whole, fasting lead to improvements. In people that had to undergo laparoscopic cholecystectomy, IF was found to increase post-operative comfort and reduce levels of stress [60]. Moreover, Hussin *et al.* showed that people that underwent caloric restriction and fasting could enhanced their mood and significantly decreased levels of tension, feelings of anger and confusion compared to controls [61]. Indeed, IF has been associated with better pain management in people with chronic pain [62] and reductions in fear in people with fear related disorders [63]. Similarly, among the elderly IF has been shown to reduce levels of anxiety and stress and which could lead to an increased quality of life (QOL) [64]. Others have shown that IF can benefit the cardiovascular system and brain through brain derived neurotrophic factor (BDNF) signalling [65] and that IF could exert its benefits in a similar manner to exercise [66].

Others have found the opposite where IF has been shown to invoke stress but not affect mood, cognition or motor control when investigating overweight women [67]. Carey *et al.* identified an association between greater levels of discomfort and prolonged fasting [68].

As mentioned, further research is yet needed to fully elucidate the effect of IF on wellbeing. Currently, there are links with IF and fasting during Ramadan that can help improve mental wellbeing but these need to be confirmed through more randomised trials and in applicable study populations.



6. OVERVIEW OF THE EFFECTS OF FASTING DURING RAMADAN ON WELLBEING

Individuals and their HCPs need to consider the impact that Ramadan can have on one's lifestyle and physical and mental wellbeing. Individuals with diabetes that are seeking to fast should understand the potential negative effects that can occur so that there are no unexpected outcomes during Ramadan. Information on the negative effects of fasting during Ramadan can also be implemented in pre-Ramadan education programmes and risk stratification plans.

The benefits of Ramadan are also extremely important to understand and form the basis for why individuals that have been considered 'high-risk' or those previously considered "Very high risk" still participate in the fast. Through understanding these, HCPs can provide better guidance ensuring people with diabetes can fast safely while also experiencing the true mental and spiritual benefits of Ramadan (see **Figures 2** and **3**).

Health care providers, members of the community, individuals with diabetes alongside their family, friends and carers should be made aware that those that are high risk towards fasting can be exempt, but also receive spiritual rewards by alternative steps like donations of food or helping the poor with money (Fidya) [69].



LIFESTYLE CHANGES OCCURRING WHEN FASTING DURING RAMADAN	PHYSICAL AND MENTAL BENEFITS OF FASTING DURING RAMADAN	POTENTIAL ADVERSE PHYSICAL AND MENTAL EFFECTS OF FASTING DURING RAMADAN
<ol style="list-style-type: none">1. Sleeping schedules2. Meal plans and diet3. Physical activity patterns4. Reduction of vices such as smoking5. Medication adjustments	<ol style="list-style-type: none">1. Sense of fulfilment in participating in all aspects of Ramadan2. Improvements in weight or BMI3. Improvements in self-control and ability to resist temptations4. Greater sense of empathy with those less fortunate5. Participation in <i>Sunnah</i> practices for greater spiritual benefits6. Greater sense of community and an opportunity to strengthen relationships7. Reducing potentially harmful vices, such as smoking, for greater physical and mental wellbeing	<ol style="list-style-type: none">1. Sleep deprivation and disruption of circadian rhythm leading to an increase in fatigue and reduction in cognition2. Glucose excursions causing feelings of being unwell3. Greater feelings of lethargy,4. Heightened feelings of fear for diabetes related complications5. Temporary changes in weight6. Short term feelings of stress anxiety, irritability and agitation

FIGURE 3 Lifestyle, physical and mental changes that can occur during Ramadan



SUMMARY

- Ramadan is a time for Muslims to practice self-restraint and do good deeds.
- Fasting during Ramadan can lead to metabolic changes and changes to clinical measurements such as blood pressure and BMI and might help with fatty liver disease.
- Holistically fasting during Ramadan can have positive effects such as improving compassion, empathy and social interactions.
- Fasting during Ramadan can also:
 - lead to greater spirituality and mental wellbeing
 - bring both positive and negative psycho-social outcomes to feelings of stress, depression and mood.
- Intermittent fasting (IF) outside months of Ramadan may also be beneficial to one's mental wellbeing.
- The lifestyle changes that accompany Ramadan such as to eating times and diet, physical activity patterns and sleeping schedules can have effects on mental and physical wellbeing
- These should be considered by people with diabetes that are seeking to fast prior to Ramadan and by their HCPs that advise them.
- Further research is still needed to assess IF and fasting during Ramadan and their specific effects on mental wellbeing among people with diabetes and in special populations such as people with diabetes that are elderly, pregnant or with physical and mental comorbidities.

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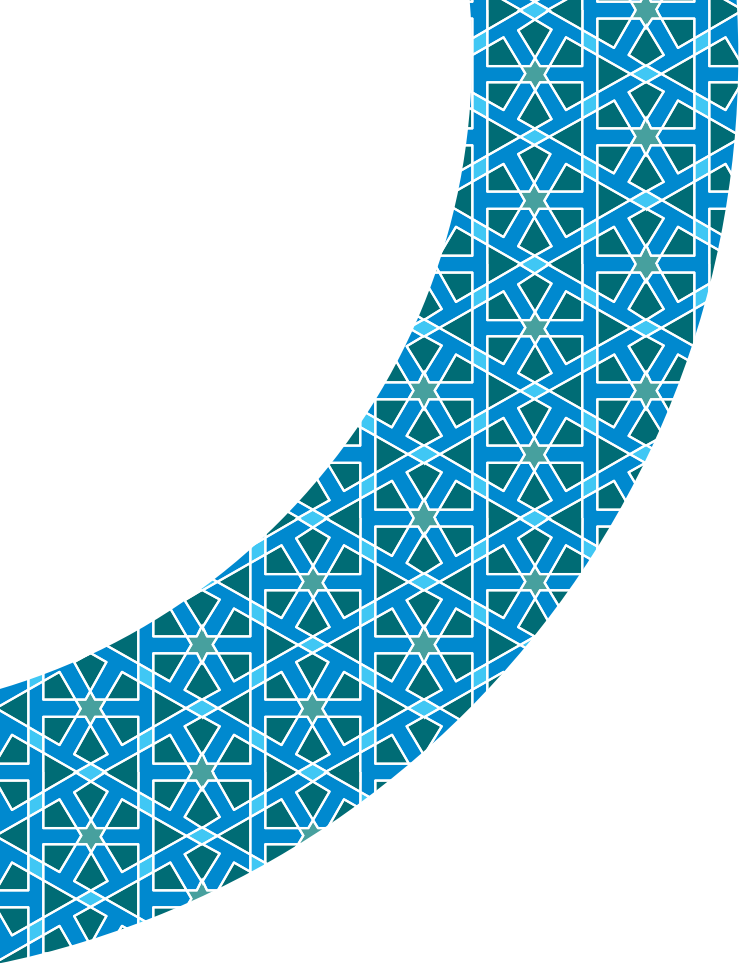
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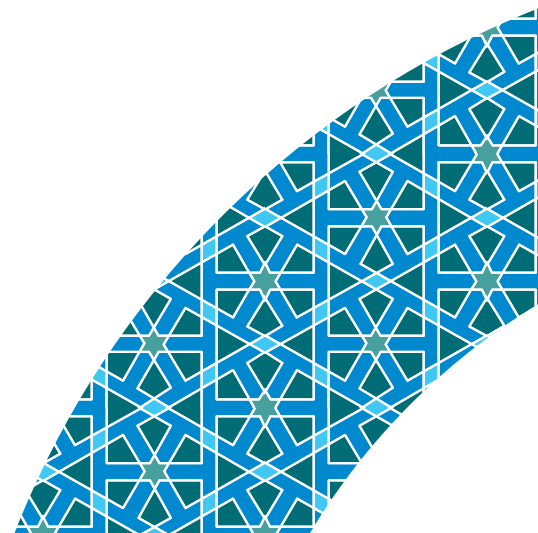


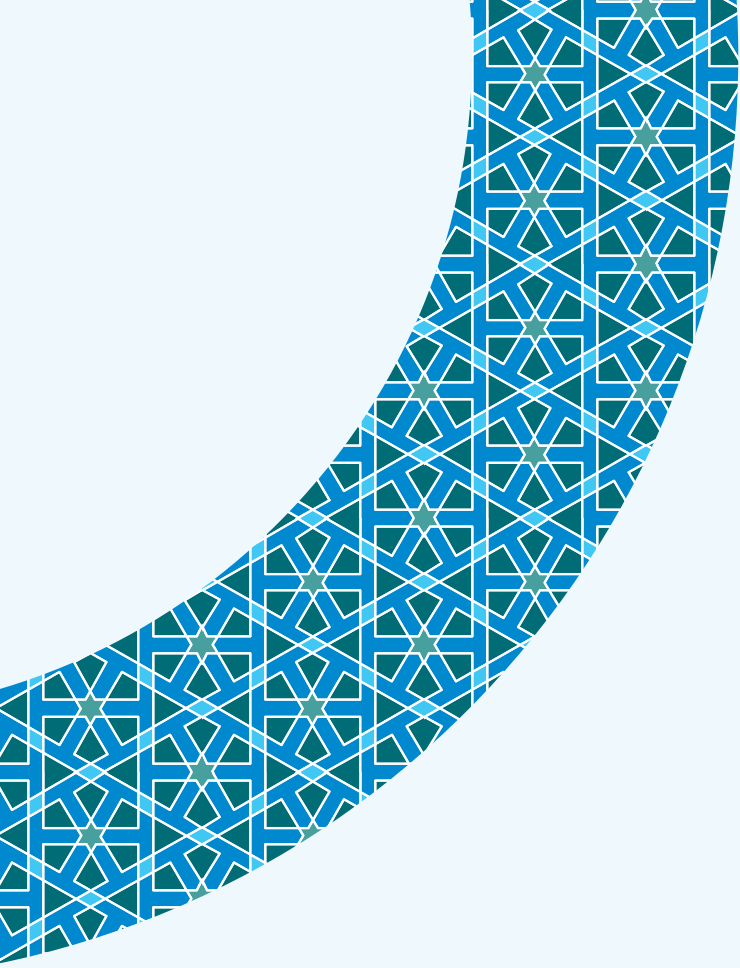
CHAPTER 5

Risk stratification of people with diabetes before Ramadan

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CHAPTER 5

INDEX

1. RISKS ASSOCIATED WITH FASTING IN PEOPLE WITH DIABETES	91
2. RISK STRATIFICATION	92
3. RISK LEVELS AND ASSOCIATED RECOMMENDATIONS	95
SUMMARY	96
REFERENCES	97



WHAT IS KNOWN?

- Different factors are used to classify people with diabetes into risk categories.
- Physicians may weight the risk factors differently.
- There is broad variation in risk stratification.
- Many high risk people with diabetes still insist on fasting.

WHAT IS NEW?

- Care must be highly individualised.
- A risk calculator with various risk variables is introduced.
 - There is flexibility in calculating an individual's risk.
 - This empowers physicians from all specialties to help categorise individuals that seek to fast.

WHAT IS MISSING?

- More research on the impact of different risk factors on the safety of fasting during Ramadan.
- Further research on the quality of life or patient reported outcomes of individuals that fast.
- An accessible easy to use tool to implement the use of this risk calculator.
- Prospective clinical trials on the effects of hypoglycaemia and hyperglycaemia during Ramadan on an individual's wellbeing.

1. RISKS ASSOCIATED WITH FASTING IN PEOPLE WITH DIABETES

Fasting during Ramadan for people with diabetes carries considerable challenges. However, despite these challenges many still insist on fasting [1]. The main risks reported with fasting are hypoglycaemia and hyperglycaemia [2]. Summer fasting periods can last between 15–18 hours per day and are often undertaken in hot and humid conditions which can lead to complications such as dehydration [3].

The major risks, hypoglycaemia and hyperglycaemia, are faced by people with diabetes on a daily basis; however, studies have shown that fasting may increase the chances of these events occurring [4-6]. Recently, the Diabetes and Ramadan-Middle East and North Africa (DAR-MENA) Type 1 Diabetes Mellitus (T1DM) study reported that 48.5% of participants fasted for the full month of Ramadan. The incidence of confirmed and severe hypoglycaemia was similar to that prior to Ramadan [7]. While in the DAR-MENA Type 2 Diabetes Mellitus (T2DM) study, it was shown that hypoglycaemia increased significantly during Ramadan when compared to before Ramadan, 10.4% - 4.9% respectively [8].

Many Muslims with diabetes who decide to fast during Ramadan face a number of challenges. Despite these challenges many still insist on fasting.

Similarly, higher hyperglycaemia rates have been reported during Ramadan. The EPIDIAR study showed that people with T2DM, with or without diabetic ketoacidosis (DKA), could have their rates of hyperglycaemia increase 5-fold [4]. Ahmedani *et al.*, found symptomatic hyperglycaemia in 33.3% and 15.4% of individuals with T1DM and T2DM, respectively [5]. The risk of these complications appears to be particularly high in people with T1DM. A recent global survey of 1054 individuals with type 1 diabetes found that 27% were able to fast for the whole of Ramadan and 39% reported no episodes of hypoglycaemia. Conversely, the study reported that 28% fasted 21 days or less due to diabetes related illnesses. The survey also found that 45% and 60% reported the incidence of hyperglycaemia and hypoglycaemia respectively, and 7% needed hospital admissions [9].

The incidence of DKA seems to be higher during Ramadan as observed in the EPIDIAR study as well as others [4, 10]. However, Beshyah *et al.* found DKA rates during Ramadan to be similar to that of other months [11].

In a narrative review, Afandi *et al.* discussed the individualised management of people with diabetes during Ramadan fasting and factors that influence the development of personalised care are shown in **Table 1** [12].



TABLE 1: RECOGNISED FACTORS THAT MAY INFLUENCE THE DEVELOPMENT OF PERSONALISED CARE FOR PEOPLE WITH DIABETES THAT FAST DURING RAMADAN

Ramadan related factors	Diabetes related factors	Factors concerning the individual
Length of fasting hours	Type of diabetes	Age (adolescents and elderly)
Season of fasting	Duration of diabetes	Gender
Weather	Diabetic complications	Occupation
Geographical location	Antidiabetic therapies	Pregnancy/Lactation
Social changes	Previous control	Meal pattern
Past experiences	Proneness to hypoglycaemia	Exercise nature/timing
	Hypoglycaemic unawareness	Motivation
	Access to care	Personal preferences

All of the factors mentioned in **Table 1** are thoroughly discussed in the various chapters of these guidelines. Healthcare professionals (HCPs) must be conscious of the potential dangers of fasting for some individuals with diabetes and should quantify and stratify the risks for every person individually in order to provide the best possible care.

Taking into account all the risks encountered during Ramadan it is easy to see why religious permissions and regulations, as well as medical recommendations, exist that allow exemption from fasting for some people with diabetes [2, 13-15]. However, for many it is a deeply spiritual experience, and they will insist on fasting, perhaps unaware of the risks they are taking.

HCPs managing high risk individuals that insist on fasting must be conscious of the potential dangers and should quantify and stratify the risks for every person on an individual basis.

2. RISK STRATIFICATION

Risk stratification is an essential aspect of all diabetes and Ramadan recommendations. Indeed, this has gradually evolved from the 4 tier categories in the 2005 and 2010 American Diabetes Association (ADA) recommendations to the three tier traffic light system in the IDF-DAR guidelines in 2016 as well as the recommendations of many other groups or diabetes societies [1, 12, 13], and guidelines including the Canadian guidelines [16] and the BMJ guidelines 2010 [17], IDF-DAR 2016 [18]. Furthermore, some of these recommendations have been endorsed by religious authorities such as the Islamic Organisation for Medical Sciences and the International Islamic Fiqh Academy who published a decree accepting and approving the ADA's risk categories, or the Mofty of Egypt where their recommendation was an integral part of the IDF-DAR guidelines of 2016. In general, the religious authorities gave their opinion according to medical advice [15].

Despite, all these recommendations, many people with diabetes that are categorised as high risk were still fasting. HCPs welcomed the guidelines and stated that it was their go to source of advice [6]. In the CREED study, 62.6% of physicians referred to guidelines for the management of fasting and of these 39.0% reported using the ADA 2005 recommendations and 41.2% consulted the 2010 guidelines [6]. However, in light of emerging evidence highlighting the ability of some high risk individuals to fast when provided with the right circumstances, many felt that the current scoring system was too rigid. Surprisingly, the numbers of days fasted by the highest and the lowest risk group only differed by 3 days. There is a clear need to reconsider the risk categories and to provide a flexible means of taking into account an individual's circumstances and an individualised plan that would help people with diabetes and their HCPs to make better decisions about fasting during Ramadan.

For instance, almost all guidelines categorise people with T1DM as high risk, however, as mentioned earlier, several studies have demonstrated that some individuals with T1DM are able to fast safely and, indeed, others are more prone to developing hypoglycaemia or hyperglycaemia necessitating Emergency Room (ER) or hospital admission. This sort of blanket grouping needs to be disaggregated.

Consequently, in this chapter we have looked into the various risks in people with diabetes that choose to fast during Ramadan and have assigned a score for every risk element in accordance with the available evidence in the literature and from our clinical judgement. Furthermore, we have developed several clinical case scenarios and have presented them in a survey to 300 experienced physicians from across many countries within the regions of North Africa, Middle East, South Africa, Gulf region, Indian subcontinent, South East Asia and UK. The case scenarios were purely focused on the risk categories in relation to fasting during Ramadan. Details of this survey will be published soon, however, preliminary results from the survey indicate a wide variation in practices among physicians even from within the same country. This is perhaps due to a difficulty in quantifying some risk factors or in part due to differences in experience and resources or cultural factors. Indeed, this is also evident in the wider variations of fasting practices among many countries. It should be remembered that, while medical based evidence is scarce in the field of risk categorisation in relation to fasting during Ramadan, the safety of the individual with diabetes is of the utmost importance. Further, this approach matches the essence of the religious regulations of Islam.

The scoring system was designed considering the various factors that were deemed to influence fasting (**Table 2**). Some of the factors are discussed in **4.1** whereas the other factors are discussed in the other chapters of these guidelines.

For a given individual, each risk element should be assessed, and the score should be totalled. The resulting score will determine the overall risk level for an individual with diabetes that is seeking to fast during Ramadan (see **Figure 1**).

The following table includes the new IDF-DAR elements for risk calculation and the relevant risk score.



TABLE 2: ELEMENTS FOR RISK CALCULATION AND SUGGESTED RISK SCORE FOR PEOPLE WITH DIABETES MELLITUS (DM) THAT SEEK TO FAST DURING RAMADAN

Risk Element	Risk Score	Risk Element	Risk Score
1. Diabetes type and duration		8. MVD Complications/Comorbidities	
Type 1 diabetes	1	Unstable MVD	6.5
Type 2 diabetes	0	Stable MVD	2
2. Duration of Diabetes (years)		No MVD	0
A duration of ≥ 10	1	9. Renal Complications/Comorbidities	
A duration of < 10	0	eGFR < 30 mL/min	6.5
3. Presence of hypoglycaemia		eGFR 30–45 mL/min	4
Hypoglycaemia unawareness	6.5	eGFR 45–60 mL/min	2
Recent Severe hypoglycaemia	5.5	eGFR >60 mL/min	0
Multiple weekly Hypoglycaemia	3.5	10. Pregnancy*	
Hypoglycaemia less than 1 time per week	1	Pregnant not within targets*	6.5
No hypoglycaemia	0	Pregnant within targets*	3.5
4. Level of glycaemic control		Not pregnant	0
HbA1c levels > 9% (11.7 mmol/L)	2	11. Frailty and Cognitive function	
HbA1c levels 7.5–9% (9.4–11.7 mmol/L)	1	Impaired cognitive function or Frail	6.5
HbA1c levels < 7.5% (9.4 mmol/L)	0	> 70 years old with no home support	3.5
5. Type of treatment		No frailty or loss in cognitive function	0
Multiple daily mixed insulin Injections	3	12. Physical Labour	
Basal Bolus/Insulin pump	2.5	Highly Intense physical labour	4
Once daily Mixed insulin	2	Moderate Intense Physical Labour	2
Basal Insulin	1.5	No physical labour	0
Glibenclamide	1	13. Previous Ramadan Experience	
Gliclazide/MR or Glimepride or Repaglanide	0.5	Overall negative experience	1
Other therapy not including SU or Insulin	0	No negative or positive experience	0
6. Self-Monitoring of Blood Glucose (SMBG)		14. Fasting hours (location)	
Indicated but not conducted	2	≥ 16 hours	1
Indicated but conducted sub-optimally	1	< 16 hours	0
Conducted as indicated	0		
7. Acute complications			
DKA/ HONC in the last 3 months	3		
DKA/ HONC in the last 6 months	2		
DKA/ HONC in the last 12 months	1		
No DKA or HONC	0		

DKA — Diabetic Ketoacidosis
HONC — Hyperglycaemic Hyperosmolar Nonketotic Coma
eGFR — Estimated glomerular filtration rate
CVD — Cardiovascular disease

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



FIGURE 1
Risk score and risk categories

The risk factors were graded in relation to safety during the fast as follows:

Low risk was a score 0 to 3; moderate risk if they score 3.5 to 6; and high risk when they score > 6. It should be noted that individuals previously deemed “very high risk” have the same recommendations as those that were categorised as high risk.

The strategies to ensure the safety of individuals that are fasting in all risk categories include:

- Ramadan focused medical education
- A pre-Ramadan medical assessment, including a robust assessment of hypoglycaemia awareness
- Following of a healthy diet and a physically active lifestyle
- Frequent SMBG or continuous glucose monitoring (CGM)
- Modifications to treatment regimens

3. RISK LEVELS AND ASSOCIATED RECOMMENDATIONS

It is worth highlighting that the initial risk assessment can change, for example if the risk is modifiable such as glycaemic control, frequency of SMBG or with the development of a new complication; in these circumstances the risk level will need to be adjusted accordingly. An individual’s Ramadan experience may vary every year and, therefore, there is a need for a renewed risk stratification annually to make it a safe and happy experience for all.

Individuals who are in the high risk category should not fast.

These individuals are of high-very high risk of developing complications when fasting during Ramadan. We recommend that these individuals do not fast. If they do still insist on fasting the utmost care and monitoring should be provided alongside the strategies and recommendations mentioned above and in the other chapters of these guidelines.

Those at the moderate risk level are advised not to fast.

As previously mentioned, many of these patients will choose to fast anyway. This important personal decision should be made after consideration of the associated risks in consultation with HCPs. They also need to be aware of the techniques or strategies to decrease this risk. If individuals choose to fast, then they would need to be cautious and discontinue fasting if any problems arise.

Those at the low risk level should be able to fast.

These individuals are at a lower risk of in terms of complications arising when fasting during Ramadan. However as mentioned, circumstances can change leading to a change in the risk scoring. Therefore, risk stratification should be conducted annually to review the level of risk in advance of Ramadan.

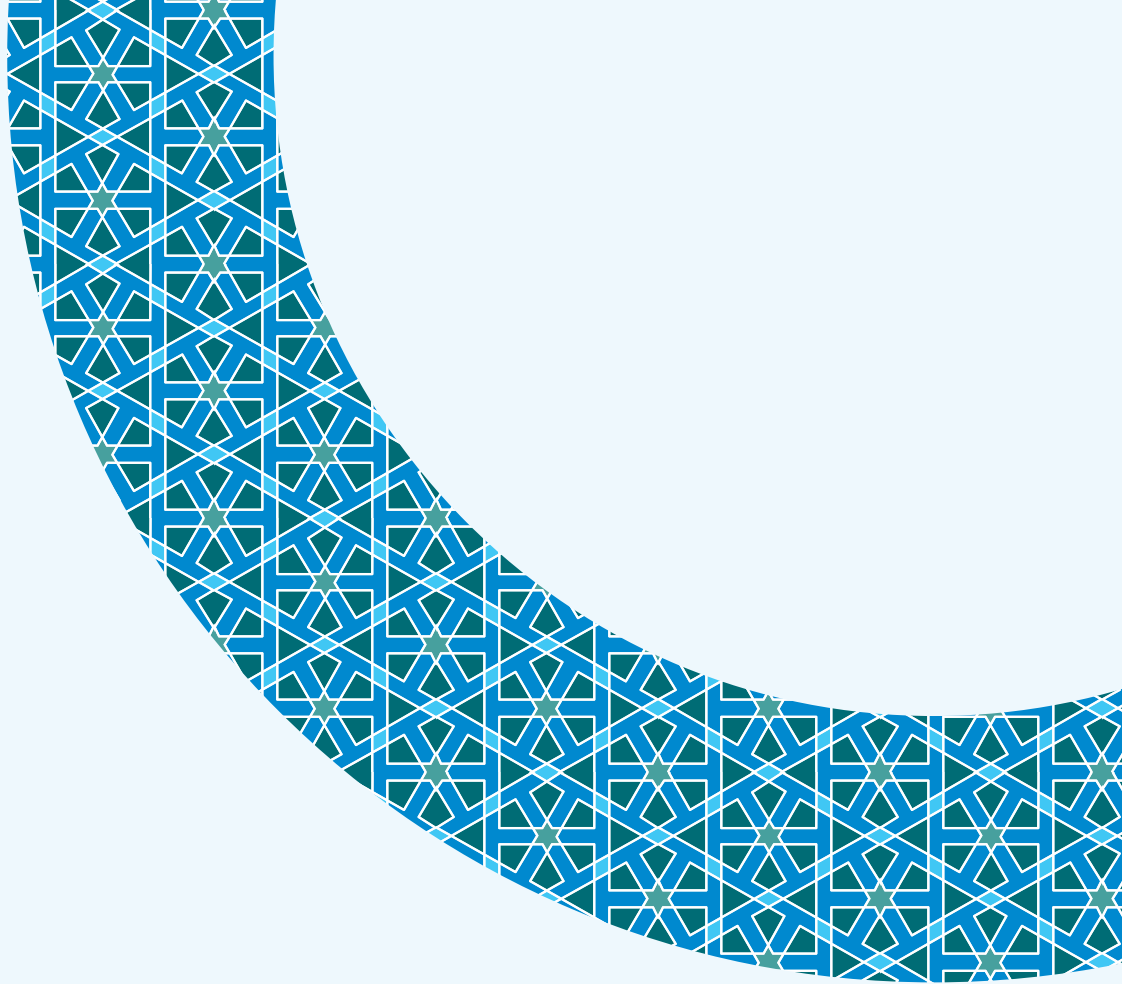


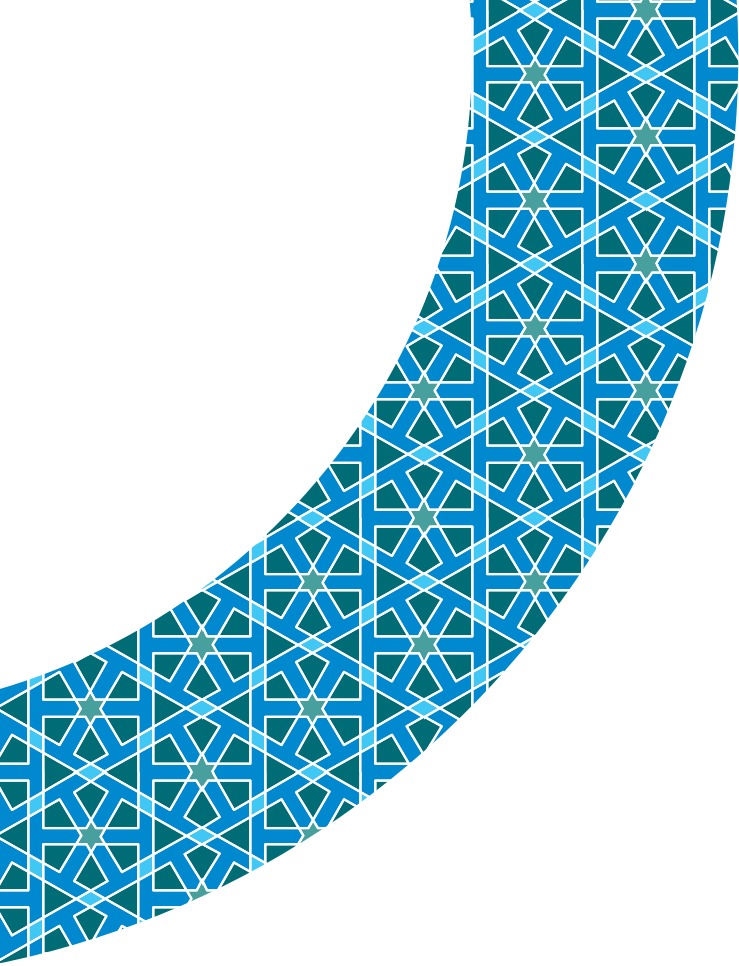
SUMMARY

- The risks of fasting include hypoglycaemia, hyperglycaemia, DKA and dehydration.
- Physicians must quantify these risks and stratify each individual accordingly.
- With the correct guidance, many people with diabetes can fast during Ramadan safely but they must be under the close supervision of HCPs and made aware of the risks of fasting.
- The new IDF-DAR risk stratification defines three risk categories and provides a risk score that includes multiple factors that plays an important role in the fasting decision recommended for each.
- Individuals who fast against the advice provided by their healthcare professionals should follow expert and detailed guidance to avoid the development of serious complications.

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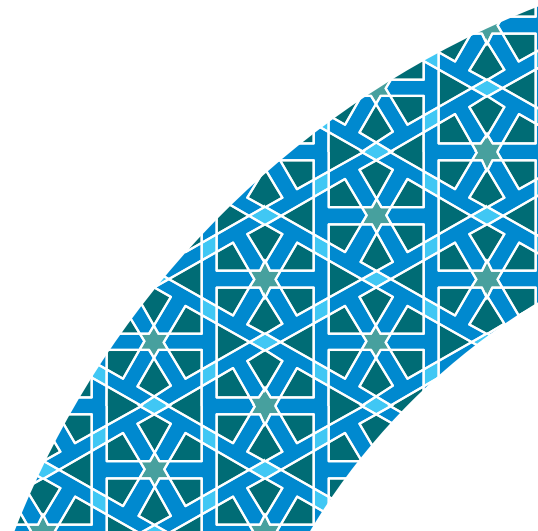


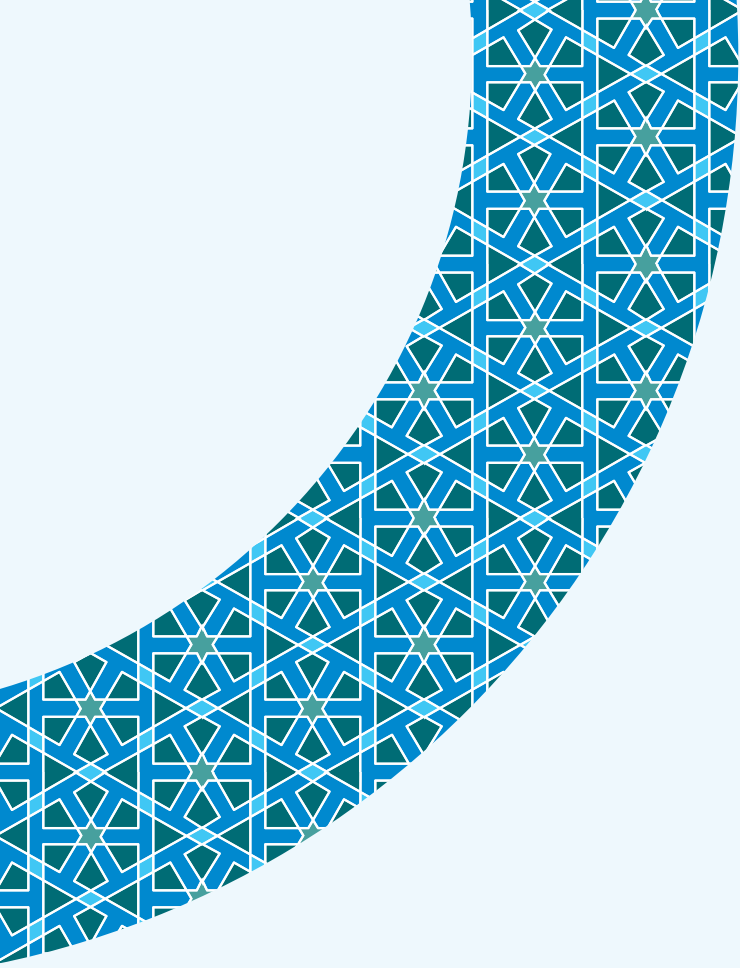
CHAPTER 6

Diabetes and Ramadan: A Medico-Religious Perspective

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CHAPTER 6

INDEX

1. INTRODUCTION	103
2. SIGNIFICANCE OF RAMADAN	103
3. FASTING AND ILLNESS	103
4. PRACTICAL GUIDELINES FOR THE MANAGEMENT OF DIABETES DURING RAMADAN	104
5. RELIGIOUS OPINION OF THE MOFTY OF EGYPT	107
SUMMARY	109
REFERENCES	110
APPENDIX	
Religious opinion from the Mofty of Egypt	111



WHAT IS KNOWN?

- Fasting during the month of Ramadan is a religious obligation to all Muslims, however Islamic regulations allow for people who are ill or unwell to be exempted.
- There needs to be a strong harmony between the medical and religious advice and guidance is desperately needed to ensure that people with diabetes can safely fast during Ramadan.

WHAT IS NEW?

- The new IDF-DAR risk stratification defines three risk categories and provides a risk score that includes multiple factors that play an important role in the fasting recommendation for each category.
- Individuals who decide to fast against the advice provided by their healthcare professionals should follow expert and detailed guidance to avoid the development of serious complications.

WHAT IS MISSING?

- There needs to be greater efforts made in aiming to improve communication between the medical experts and religious scholars are needed in order to ensure that guidance is best received by the public.

1. INTRODUCTION

Ramadan fasting is one of the five pillars of Islam. It is incumbent upon every Muslim once puberty is attained, and thereafter, to keep fast during this month. The Holy Quran says: “O you who believe! Fasting is prescribed to you as it was prescribed to those before you so that you may attain self-restraint” [1] and “Whoever witnesses the month (of Ramadan) then he/she should fast. But, if any of you is ill or travelling – then he or she is exempted from fasting” [1].

As stated, certain categories of individuals – including children, the sick, travellers, women during menses, pregnancy or breastfeeding, and anyone with reduced mental capacity – are exempt from fasting [1]. The missed days of fast should be made up later when the individual is of sound health in cases where the cause of missing fasting was a temporary.

2. SIGNIFICANCE OF RAMADAN

Muslims believe that Ramadan is a blessed month, it was honoured by the fact that the Quran was revealed to the Prophet Muhammad, peace be upon him, during it, and it is the month of fasting when Allah’s rewards for any good deeds are much higher than in any other time. This generally creates an intense and passionate desire to do one’s utmost in order to seek the nearness and pleasure of God. In addition to fasting, Muslims engage in various other forms of devotion to a far greater degree in the month of Ramadan.

It is therefore not surprising that many Muslims who fall in the exempt categories, which would include those with illness, are loath to take advantage of this concession. The reasons for such determination to keep the fast are not difficult to guess or conclude. Perhaps a major factor is that the ill person feels that he or she would not be discharging his/her duty as a Muslim, notwithstanding the fact that he/she is aware of the exemption granted in the event of such a disease. On the other hand, many scholars, in awareness of the possible serious health risk for some people with medical conditions, feel that those who insist on fasting against medical advice are performing a seriously wrong action from a religious point of view as they could be jeopardising their health. Indeed, collaborative work between medical and religious experts is essential to ensure that those who do not fast due to their medical condition understand that they are indeed equally rewarded like those who fast and that they should not feel guilty.

It is essential to ensure that those who do not fast due to their medical condition understand that they are indeed equally rewarded like those who fast and should not feel guilty.

3. FASTING AND ILLNESS

The Quran clearly states that if one is ill, “the missed fast should be completed at another time”, because “Allah intends ease for you and does not intend to put you in difficulty” [1]. But what constitutes an illness justifying such an exemption? Religious scholars have depended



on the specific personal advice of an “expert Muslim physician to decide illnesses in which fasting may make conditions worse or delay healing” [2]. In contrast, doctors have often used medical jargon such as ‘indications’ and ‘contraindications’ and have offered varying opinions. This disparity is not helpful to either the individual that is fasting or the healthcare professional (HCP) responsible for their care. People with diabetes can present with a range of complications and comorbidities all of which have an impact on the risk that fasting may impose on the individual. It should be acknowledged that not all individuals will seek advice from an HCP prior to Ramadan. In fact, there is evidence to suggest that some people with diabetes prefer to discuss fasting with their local imam rather than their physician [3, 4]. A study has shown that imams are willing to include diabetes education within their teachings [5] and it is, therefore, important to have unification between HCPs and religious leaders on who should fast and who should seek exemption.

It is important to have unification between HCPs and religious leaders on which individuals with diabetes should fast and who should seek exemption.

4. PRACTICAL GUIDELINES FOR THE MANAGEMENT OF DIABETES DURING RAMADAN

Guidelines for the management of diabetes during Ramadan were first published by the American Diabetes Association (ADA) in 2005 [6]. Within these guidelines were recommendations for the classification of people with diabetes into one of four risk categories: very high, high, moderate and low depending on the type of diabetes, medical history, glycaemic control, type of medication, presence of comorbidities and the individual’s personal circumstances [6]. In 2009, at The Council of International Fiqh (the study of Islamic regulations) Academy of The Organisation of Islamic Conference (19th session), and as a result of deliberations by Islamic scholars and medical experts, the Fiqh Academy accepted the expert opinion expressed in the ADA Ramadan recommendations [2]. It was decided that those individuals considered as very high and high risk should not fast while those in the remaining two categories could fast. With such recommendations in place, it is perhaps surprising that they were not always consulted.

Analysis of people with type 2 diabetes (T2DM) enrolled on the CREED study found that around one third of the physicians involved in their care did not consult guidelines for the management of diabetes during Ramadan [7].

When looking at the whole study population, including people with type 1 diabetes (T1DM), the average number of days fasted by the highest and lowest risk groups only differed by three days [7]. This could suggest that either HCPs are not stratifying the patients correctly or that patients are ignoring the advice given to them by their physician and fasting even when told not to. A recent study involving nearly 200 physicians, mainly from the Middle East and North Africa, revealed that a majority of stratified people with diabetes in accordance with the

categories defined in the ADA recommendations, but not all the risks of fasting, were identified by their care providers during Ramadan [8]. Hence, there is a clear need to reconsider the various risk categories and to provide a level of flexibility that would help the individual with diabetes and HCPs to make better decisions regarding fasting during Ramadan.

As part of these IDF-DAR Practical Guidelines, experts from the International Diabetes Federation (IDF) and the Diabetes and Ramadan (DAR) International Alliance have updated the risk classifications for fasting. As described in detail in **chapter 4: The effects of fasting during Ramadan on physical and mental wellbeing**, three categories are proposed, based on the most recent available information from science and practice during Ramadan fasting. These risk categories take into account a more practical approach while recognising the need to consider the everyday practice of many people with diabetes. Importantly, these recommendations are approved by the Mofty of Egypt, the highest religious regulatory authority in Egypt as well as being a scholar of Al-Azhar, one of the globally renowned Islamic academic organisations. The religious opinion on fasting for the three categories is outlined in **Table 1**. All individuals with diabetes are instructed to follow medical advice and should not fast if the probability of harm is high. A **copy of the approval** by the Mofty of Egypt is available as an appendix to this document in Arabic language. It should be noted that this opinion may not reflect the religious rulings in all countries so further regional discussions are needed.

The new diabetes and Ramadan fasting risk categorisations described in these IDF-DAR Practical Guidelines have been approved by the Mofty of Egypt.

The scoring system was designed considering various different factors that were deemed to influence fasting (these have been considered in the **chapter 5: Risk stratification of people with diabetes before Ramadan**). Some of the factors are discussed in 4.1 whereas the other factors are discussed in the other chapters of these guidelines.

For a given individual, each risk element should be assessed, and the score should be totalled. The resulting score will determine the overall risk level for an individual with diabetes that is seeking to fast during Ramadan (see **Figure 1**).



TABLE 1: ELEMENTS FOR RISK CALCULATION AND SUGGESTED RISK SCORE FOR PEOPLE WITH DIABETES MELLITUS (DM) THAT SEEK TO FAST DURING RAMADAN

Risk Element	Risk Score	Risk Element	Risk Score
1. Diabetes type and duration		7. Pregnancy	
Type 1 diabetes	1	Pregnant not within targets	4
Type 2 diabetes	0	Pregnant within targets	2
A duration of ≥ 10	1	Not pregnant	0
A duration of < 10	0	8. Frailty and Cognitive function	
2. Presence of hypoglycaemia		Impaired cognitive function	4
Hypoglycaemia unawareness	5	Frail	3
Recurrent/severe hypoglycaemia	4	> 70 years old with no home support	1
Daily mild hypoglycaemia	3	No frailty or loss in cognitive function	0
Hypoglycaemia 1–6 times per week	2	9. Physical Labour	
Hypoglycaemia less than 1 time per week	1	Intense physical labour	1
No hypoglycaemia	0	No physical labour	0
3. Characteristics of glycaemic control		10. Previous Ramadan Experience	
HbA1c levels $> 9\%$ (11.7 mmol/L)	2	Overall negative experience	1
HbA1c levels 7.5–9% (9.4–11.7 mmol/L)	1	No negative or positive experience	0
HbA1c levels $< 7.5\%$ (9.4 mmol/L)	0	11. Fasting hours (location)	
4. Self-Monitoring of Blood Glucose (SMBG)		≥ 16 hours	1
Indicated but not conducted	2	< 16 hours	0
Indicated but conducted sub-optimally	1	12. Diabetes treatment	
Conducted as indicated	0	Multiple daily mixed insulin Injections	3
5. Acute complications		Basal Bolus/Insulin pump	2.5
DKA/ HONC in the last 3 months	3	Once daily Mixed insulin	2
DKA/ HONC in the last 6 months	2	Basal Insulin	1.5
DKA/ HONC in the last 12 months	1	Glibenclamide	1
No DKA or HONC	0	Gliclazide/MR or Glimepride or Repeganide	0.5
6. Chronic Complications/Comorbidities		Other therapy not including SU or Insulin	0
Unstable angina/Heart failure/eGFR < 30 mL/min	6	DKA—Diabetic Ketoacidosis	
eGFR 30–45 mL/min	4	HONC—Hyperglycaemic Hyperosmolar Nonketotic Coma	
Stable CVD/eGFR 45–60 mL/min	2	eGFR—Estimated glomerular filtration rate	
No CVD and normal eGFR	0	CVD—Cardiovascular disease	



FIGURE 1
Total risk score and risk categories

5. RELIGIOUS OPINION OF THE MOFTY OF EGYPT

According to document from The Egyptian Official Fatwa Authority, produced on January 11, 2021, religious recommendations for individuals with diabetes planning to fast the holy month of Ramadan were based on two principles: avoiding hardship and eliminating potential physical harm to all patients. The recommendations emphasise the importance of pre-Ramadan expert medical evaluation for individual patients and recognise their specific circumstances and needs. They confirm that the ability of some patients to fast with potential harm to their body is not justified.

Furthermore, the religious advice of the Mofty of Egypt stresses that where obvious contraindications are present, it behoves the doctor to give categorical advice against fasting and highlights the importance of accepting this advice by the person with diabetes. Indeed, such individuals should be reminded of the Quranic injunction: “Let not your own hands throw you into destruction” [9]. Moreover, there is a Hadith (Prophetic teaching) wherein he stated: “God has a right over you. Your body has a right over you ...”. (For further religious advice from the Mofty of Egypt please see the **appendix**).

The document commends that fasting should be interrupted in case of hypoglycaemia <70mg/dl, hyperglycaemia > 300mg/dl, or symptoms of hypo or hyperglycaemia or during the presence of symptoms of acute illness such as fever, diarrhoea, vomiting, and/or exhaustion.

The document states that fasting is obligatory for low risk patients, however, patients with low risk may consider not to fast if concerned about safety or wellbeing or to take prescribed medications. Conversely, patients in the high-risk group should not fast since it is potentially harmful.

For patients classified as moderate risk fasting is generally preferred and patients must follow medical recommendations with regards to glucose monitoring and medications modifications. Patients with moderate risk have the right not to fast if concerned about their safety or wellbeing (**Table 2**).

TABLE 2: MEDICAL & RELIGIOUS RISK SCORE RECOMMENDATIONS

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

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



With medical and religious experts in agreement it is important that these recommendations are disseminated and implemented. For this to happen the following ideals should be realised:

- Doctors should be briefed with an acceptable knowledge of Fiqh provisions on this subject
- Religious scholars should instruct people with diabetes to consult those doctors who understand the medical and religious aspects of fasting and are God fearing
- Imams need to acquaint themselves with these regulations and with the risks of diabetes when they are advising any Muslim person with diabetes with regards to fasting regulations
- All efforts need to be made using media and other communication avenues to ensure that people with diabetes are aware of these regulations; this should help to increase the level of acceptance of the medico-religious decision in the event that it is to refrain from fasting.

In recognition of the sincere efforts made in this regard by experts in their specialty, all doctors and patients should comply with the joint medical and religious recommendations. There is also a need for continued scientific research in this area to build up practical experiences that will in turn lead to more accurate decisions. However, it is important to clarify some points that are of concern for people with diabetes who intend to fast during Ramadan:

- The religious feelings and psychological state of people with diabetes must not be overlooked, as most of them find psychological and physical comfort in fasting and will insist on the performance of this duty despite medical advice to not fast. Many will have observed fasting before with no apparent harm to their health. As psychological satisfaction is important, it is the duty of their specialist doctor to make every effort to help people with diabetes fast unless they find a real medical risk. It is also essential to educate such individuals to help them avoid dramatic changes in their blood glucose while fasting and to give them strict instructions to break their fast if they need to.
- It should be emphasised that people who have had diabetes for many years are more prone to the chronic complications of this disease and even if they were classified as low risk one year, they should not assume they are still low risk the following year.



SUMMARY

- Fasting during the month of Ramadan is a religious obligation for all healthy adults. However, Islamic regulations have exempted those afflicted with illness from this obligation.
- Harmony between medical and religious advice is essential to ensure safe fasting for people with diabetes. Indeed, the risk stratification groups defined in these IDF-DAR Practical Guidelines have been endorsed by the highest religious regulatory authority of Egypt.
- HCPs, religious authorities, as well as people with diabetes, need to be made aware of these regulations through all possible avenues.



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APPENDIX

Religious opinion from the Mofty of Egypt



جمهورية مصر العربية
وزارة العدل
دار الإفتاء المصرية
مكتب المفتي

﴿ فَسَلُوا أَهْلَ الذِّكْرِ إِنْ كُنْتُمْ لَا تَعْلَمُونَ ﴾ [النحل: ٤٣]

(الحمد لله وحده والصلاة والسلام على من لا نبي بعده سيدنا محمد رسول الله وعلى آله وصحبه ومن تبعه باحسان إلى يوم الدين)

اطلعنا على الطلب المقدم من / بشار الأفندي ومحمد حسنين بتاريخ: ٢١/١٢/٢٠٢٠م،
المقيد برقم ٤٠٧ لسنة ٢٠٢٠م، والمتضمن: طلب الرأي الشرعي في ربط مشروعية الصوم ورخصة
الإفطار في رمضان لمرضى السكري بتقييم عوامل خطورة المرض؛ حيث كان تقييم عوامل الخطورة
لمرضى السكري عند صيام شهر رمضان في السنوات الماضية يعتمد على عوامل قليلة ومحددة، ومنها نوع
المرض وشدته ووجود الاختلاطات المرافقة، وكان الأطباء يقومون بالتخمين بطريقة غير منظمة، مما
تسبب بإعطاء تقييمات مختلفة لنفس المرضى، أكد ذلك دراسة جديدة قننا بها وأظهرت تبايناً واضحاً
في تقييم الأطباء لنفس الحالات، ويبدو أن هذا يتعلق باختصاص الطبيب وخبرته ومكان عمله.
لا شك بأن المرضى يختلفون كثيراً، وبطرق مختلفة، ولا شك بأن هناك الكثير من العوامل التي
تجب دراستها عند تقييم وضع المرضى، ومدى استعدادهم الصحي لصيام الشهر الكريم، لذلك،
ولتوحيد طريقة تقييم المرضى وتبسيطها، سعينا في التقييم الجديد إلى حصر كل العوامل المدروسة
سابقاً، بالإضافة إلى الكثير من العوامل الهامة التي لم تدرس بشكلٍ كافٍ بعد.

قننا بإعداد برنامج جديد يحتوي على كل العوامل، وإعطائها نقاطاً مختلفة حسب أهميتها، بشكل
متناسب مع وضع كل مريض، ويقوم الأطباء بمراجعة حالة المريض بالتفصيل، وتضاف النقاط
حسب المعلومات (عوامل الخطورة تتحدد بناءً على مدة المرض، ونوعه، ونوع العلاج، والمضاعفات
الحادة من الحمض الكيتوني وارتفاع السكر الشديد مع الجفاف، والمضاعفات المزمنة، وهبوط
السكر، وخبرة الصوم السابق، والصحة الذهنية والبدنية، ونقص السكر الذاتي، ومعدل السكر

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٤٦٢٠٥

التراكمي، وساعات الصيام، والعمل اليومي والجهد البدني، ووجود الحمل).
ويتم بعدها جمع النقاط لكل مريض لتحديد مستوى الخطورة في حال قرر صيام رمضان كما يلي:
من ٠ : ٣ = خطورة خفيفة، ومن ٣ : ٥ = خطورة متوسطة، وأكبر من ٥ = خطورة مرتفعة.
نصائح وإرشادات:

أولاً: يجب تقديم النصائح الطبية لكل المرضى مهما كان مستوى الخطورة عندهم، وتعديل العلاج الدوائي بما يناسب كل حالة.

ثانياً: يجب تقديم النصائح والمتابعة الدقيقة لكل المرضى، حتى في حال الإصرار على الصيام ضد نصيحة الطبيب.

ثالثاً: يُنصح المرضى الذين يقدر وضعهم على أنه مرتفع الخطورة بعدم الصيام مع توضيح احتمالات الضرر عليهم.

رابعاً: في حال المرضى متوسطي مستوى الخطورة، يتم التشاور بين الطبيب والمريض ومراجعة الوضع الصحي وخبرات المريض السابقة وأدويته، ويجب توضيح احتمال الخطورة المرافق، بشكل عام يسمح للمريض بالصيام مع الانتباه لضرورة المراقبة المستمرة لمستوى السكر في الدم حسب تعليمات الطبيب، وفي حال خوف المريض الشديد، دون وجود سبب طبي مقنع يتم اللجوء إلى الاستشارة الدينية.

خامساً: في حال مستوى الخطورة المنخفض، يشجع المرضى على الصيام، مع ضرورة المراقبة الطبية الموصوفة.

سادساً: يجب على كل المرضى الذين قرروا الصيام بنصيحة طبية أو حتى ضد النصيحة الطبية معرفة ضرورة التوقف عن الصيام في الحالات التالية:
حدوث ارتفاع السكر إلى أكثر من ٣٠٠ مع/دل.
انخفاض السكر أقل من ٧٠ مع/دل.
وجود أعراض الانخفاض أو الارتفاع الشديدة.

وجود أمراض حادة تسبب حدوث الحرارة أو الإسهال أو التعب أو الإرهاق العام.
الخلاصة: يجب على الأطباء مراجعة كل عوامل الخطورة المذكورة عند مرضاهم للوصول إلى تحديد مستوى الخطورة الصحيح، وستساعد هذه الوسيلة في تقييم خطورة الصيام عند المرضى في الوصول إلى تقييمات حقيقية للمرضى، حتى وإن اختلف الأطباء واختصاصاتهم، وستساعد الأطباء الأقل خبرة في الوصول إلى تقييم أقرب إلى الدقة.



الجواب:

جاءت الشريعة الإسلامية بالتيسير ورفع الحرج عمن يصعب عليه الامتثال، أو يوقعه في مشقة أو يعرضه لضرر، فقال تعالى: ﴿يُرِيدُ اللَّهُ بِكُمُ الْيُسْرَ وَلَا يُرِيدُ بِكُمُ الْعُسْرَ﴾ [البقرة: ١٨٥]، وقال سبحانه: ﴿وَمَا جَعَلَ عَلَيْكُمْ فِي الدِّينِ مِنْ حَرَجٍ﴾ [الحج: ٧٨].

والرخص الشرعية من مظاهر سعة الشريعة الإسلامية ورحمتها، حيث أباحت للمكلف مخالفة الأصل بفعل ما كان محظوراً أو ترك ما كان واجباً، وذلك إذا كان في أدائه حرج أو مشقة؛ بل جعلت الأخذ بالرخص في مثل ذلك مما يحبه الله تعالى كمحبة الأخذ بالعزائم في مواطنها. فعن عبد الله بن عمر رضي الله عنهما قال: قال رسول الله صلى الله عليه وآله سلم: «إِنَّ اللَّهَ يُحِبُّ أَنْ تُؤْتَى رُخْصُهُ كَمَا يُحِبُّ أَنْ تُؤْتَى عَزَائِمُهُ» أخرجه الإمام أحمد والبخاري في "المسند"، وابن أبي شيبة في "المصنف"، والبيهقي في "السنن"، وابن خزيمة وابن حبان في "الصحیح".

وقد جاءت نصوص الشرع الشريف بالرخصة للمريض بالإفطار في شهر رمضان، فقال تعالى: ﴿فَمَنْ كَانَ مِنْكُمْ مَرِيضًا أَوْ عَلَى سَفَرٍ فَعِدَّةٌ مِنْ أَيَّامٍ أُخْرٍ وَعَلَى الَّذِينَ يُطِيقُونَهُ فِدْيَةٌ طَعَامُ مِسْكِينٍ فَمَنْ تَطَوَّعَ خَيْرًا فَهُوَ خَيْرٌ لَهُ وَأَنْ تَصُومُوا خَيْرٌ لَكُمْ إِنْ كُنْتُمْ تَعْلَمُونَ﴾ [البقرة: ١٨٤].

والمعنى: إناطة رخصة الإفطار في رمضان بالمرض والقضاء عند زواله؛ لأن تعليق الحكم بالمشتق مؤذن بعلة ما منه الاشتقاق، وقد نفع الفقهاء المناط في المرض الذي يصلح أن يكون مرخصاً في الفطر؛ فإن الذي عليه جماهير علماء الأمة: أن المقصود بالمرض هنا: "هو الذي يؤدي إلى ضرر النفس أو زيادة في العلة"؛ كما يقول الإمام الرازي الشافعي في "مفتاح الغيب" (٦٣/٥، ط. دار الكتب العلمية)، خلافاً للظاهرية وبعض السلف؛ فالرخصة عندهم حاصلة بكل مرض.

والموافق للأصول والقواعد: أنه إذا كان المرض يسيراً لا يتضرر صاحبه بالصوم؛ بحيث لا يزيد به مرضه، ولا يتأخر بسببه برؤه؛ فلا يجوز له الفطر، بل ربما كان الصوم مفيداً للمريض في شفائه. قال الإمام النووي الشافعي في "المجموع" (٢٥٨/٦، ط. دار الفكر): [وأما المرض اليسير الذي لا يلحق به مشقة ظاهرة: لم يجز له الفطر بلا خلاف عندنا] اهـ.

وقال الإمام ابن قدامة الحنبلي في "المغني" (٣/١٥٥-١٥٦، ط. مكتبة القاهرة): [والمريض المبيح للفطر: هو الشديد الذي يزيد بالصوم أو يخشى تباطؤ برئه.. والمرض لا ضابط له؛ فإن الأمراض تختلف، منها ما يضر صاحبه الصوم، ومنها ما لا أثر للصوم فيه؛ كوجع الضرس، وجرح في الإصبع، والدمل، والقرحة اليسيرة، والحب، وأشباه ذلك، فلم يصلح المرض ضابطاً، وأمكن اعتبار الحكمة، وهو ما يخاف منه الضرر فوجب اعتباره] اهـ.

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العنوان : حديقة الخالدين - الدرامه - القاهرة
التلفون : ١٠٧ / الفاكس : ٢٥٩٦٦٤٢ - ٢٠٢٢

وهذا هو الذي عليه المذاهب الأربعة المتبوعة، وهو الذي عليه العمل في الأمة عبر العصور؛ فليس كلُّ مرضٍ يصيب المكلَّفَ مرخصاً له في الإفطار، بل نصوا على أن من الأمراض ما ينفع معها الصوم في شفاء مرضها؛ فيكون الصوم حينئذٍ خيراً لحم من الإفطار.

وإنما تكون رخصة الفطر في المرض الذي يزداد بالصوم شدةً أو مدةً أو يسبب الماء أو مشقةً غير محتملين، بإخبار الطبيب المختص الحاذق، أو بتجربة المريض في الصوم السابق، أو لا يستطيع المريض معه الصوم، أو يستطيعه بمشقة شديدة، وربما كان الإفطار في بعض الحالات واجباً، إذا كان الضرر بالغاً وكان احتمال حصوله غالباً. وعلى من أفطر أن يقضي ما أفطره عند القدرة.

فتنقيح المناط في المرض المرخص للفطر: أنه ما تنشأ بسبب الصوم علته، أو تزداد به شدته، أو تطول معه مدته، أو يتسبب في ألم تشقُّ وطأته، أي حين يكون ترك الدواء أو الغذاء أو الماء: سبباً في حصول المرض في الابتداء، أو تأخير الشفاء، أو زيادة الداء، أو ما يشق تحمله من الألم والعناء. قال الإمام السرخسي في "المبسوط" (٢٤٨/٣، ط. دار الفكر): [وإذا خاف الرجل وهو صائم إن هو لم يفطر تزداد عينه وجعاً، أو تزداد حماه شدة: فينبغي أن يفطر] اهـ.

وقال العلامة الكاساني الحنفي في "بدائع الصنائع" (٩٤/٢، ط. دار الكتب العلمية):

[الأعذار المسقطه للإثم والمؤاخذه: هي المرض، والسفر، والإكراه، والحبل والرضاع، والجوع والعطش، وكبر السن، لكن بعضها مرخص، وبعضها مبيح مطلق لا موجب؛ فما فيه خوف زيادة ضرر دون خوف الهلاك: فهو مرخص، وما فيه خوف الهلاك فهو مبيح مطلق بل موجب. فنذكر جملة ذلك فنقول: أما المرض: فالمرخص منه هو الذي يخاف أن يزداد بالصوم، وإليه وقعت الإشارة في "الجامع الصغير"؛ فإنه قال في رجل خاف إن لم يفطر أن تزداد عيناه وجعاً، أو حماه شدة: أفطر، وذكر الكرخي في "مختصره": أن المرض الذي يبيح الإفطار هو ما يخاف منه الموت، أو زيادة العلة كائناً ما كانت العلة.. والمبيح المطلق بل المرجح: هو الذي يخاف فيه الهلاك؛ لأن فيه إلقاء النفس في التهلكة لا لإقامة حق الله تعالى، وهو الوجوب، والوجوب لا يبقى في هذه الحالة وأنه حرام، فكان الإفطار مباحاً بل واجباً] اهـ.

وقال القاضي ابن العربي المالكي في "أحكام القرآن" (٨٩/١، ط. دار إحياء التراث العربي):

[من لا يطيق الصوم بحال، فعليه الفطر واجب، ومن يقدر على الصوم بضرر ومشقة؛ فهذا يستحب له الفطر، ولا يصوم إلا جاهل] اهـ بتصرف.

وقال الإمام ابن جزّي الغرناطي المالكي في "القوانين الفقهية" (ص: ٢٢٠، ط. دار ابن حزم):
[وأما المريض فله أحوال ثلاثة]



الأولى: ألا يقدر على الصوم أو يخاف الهلاك من المرض أو الضعف إن صام: فالفطر عليه واجب.
 والثانية: أن يقدر على الصوم بمشقة: فالفطر له جائز، وقال ابن العربي: يستحب.
 والثالثة: أن يقدر بمشقة ويخاف زيادة المرض: ففي وجوب فطره قولان.
 والرابعة: ألا يشق عليه ولا يخاف زيادة المرض: فلا يفطر عند الجمهور، خلافاً لابن سيرين [اهـ].
 وقال العلامة الخطيب الشربيني الشافعي في "مغني المحتاج" (١٦٩/٢، ط. دار الكتب العلمية):
 [ويجب الفطر إذا خشي الهلاك؛ كما صرح به الغزالي وغيره، وجزم به الأذرعي] اهـ.
 وقال الإمام ابن قدامة الحنبلي في "المغني" (١٥٦/٣): [إن تحمل المريض وصام مع هذا، فقد فعل مكروهاً؛ لما يتضمنه من الإضرار بنفسه، وتركه تخفيف الله تعالى، وقبول رخصته، ووضح صومه ويجزئه؛ لأنه عزيمة أبيض تركها رخصة، فإذا تحمله أجزاءه] اهـ.
 وقال الشيخ ابن تيمية الحنبلي في "مجموع الفتاوى" (٤٣٩/٨، ط. مجمع الملك فهد): [الاستطاعة الشرعية المشروطة في الأمر والنهي؛ لم يكتف الشارع فيها بمجرد المكنة ولو مع الضرر، بل متى كان العبد قادراً على الفعل مع ضرر يلحقه، جعل كالعاجز، في مواضع كثيرة من الشريعة] اهـ.
 أما تحقيق مناط الأخذ برخصة الفطر في المرض فمرجه إلى إدراك حال المريض، ومعرفة أثر الصوم على مرضه بخصوصه؛ في الواقع والمتوقع؛ فإن السكري من الأمراض المزمنة المختلفة وطأتها شدة وضعفاً، ومعرفة أحكام صوم مرضاه متوقفة على معرفة مدى تعرضهم للضرر أو الخطورة حال صومهم.

وذلك مبني - كما قرر أهل الاختصاص - على عوامل الخطورة وما يصاحب المرض من أمراض وأعراض يتعرض لها المريض إذا صام، وهذا شأن الأطباء المتخصصين، وشأن المرضى بما يجدونه من أنفسهم وما عايشوه من تجارب الصوم في حال المرض، والمظنة تنزل في ذلك منزلة المنة؛ لأن ما قارب الشيء أخذ حكمه.

ومن مظاهر ذلك: تقييم عوامل الخطورة التي حددها الأطباء المتخصصون، حسبما أظهرته الأبحاث والتجارب الطبية؛ فإنها سهلت تحقيق مناط الأخذ بالرخصة؛ حيث ترجمت ذلك إلى إجراءات عملية، وقياسات محددة، لمدة المرض، ونوعه، ونوع العلاج، والمضاعفات الحادة من الحمض الكيتوني وارتفاع السكر الشديد مع الجفاف، والمضاعفات المزمنة، وهبوط السكر، وخبرة الصوم السابقة، والصحة الذهنية والبدنية، ونقص السكر الذاتي، ومعدل السكر التراكمي، وساعات الصيام، والعمل اليومي والجهدي البدني، ووجود الحمل.



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 الفاكس: ٢٥٩٢٦١٢٤ - ٢٠٢
 الهاتف: ١٠٧ /

٤٦٢٠٢

وبناء على ذلك: فلهي مرض السكرى مع الصوم أربع حالات كما أفاد المختصون:
الحالة الأولى: إذا كانت الخطورة متحققة؛ بحدوث ارتفاع السكر إلى أكثر من ٣٠٠ مع/دل، أو انخفاضه لأقل من ٧٠ مع/دل، أو وجود أعراض الانخفاض أو الارتفاع الشديدة، أو وجود أمراض حادة تسبب حدوث الحرارة أو الإسهال أو التعب أو الإرهاق العام؛ حسبما أفاد التقرير الطبي: فإنه يجب الفطر حينئذ؛ أي أن رخصة الفطر واجبة باتفاق العلماء؛ لأن المريض يكون بذلك عرضة للهلاك والضرر الشديد، والله تعالى يقول: ﴿وَلَا تُلْقُوا بِأَيْدِيكُمْ إِلَى التَّهْلُكَةِ﴾ [البقرة: ١٩٥]، ومقصد الحفاظ على النفس هو أول المقاصد الكلية العليا في الشريعة، وهو مقدم على ما عداه عند التعارض.

الحالة الثانية: إذا كانت الخطورة مرتفعة؛ بوصول معدلاتها إلى أكثر من ٦ نقاط حسبما جاء في السؤال: فالأخذ برخصة الفطر حينئذ واجب؛ لأن المريض يكون بذلك على حافة الخطر، وغلبة الظن كاليقين في الحكم، والمتوقع كالواقع، وما قارب الشيء أخذ حكمه، والمظنة تنزل منزلة المثنة، وقد نص الفقهاء على أن توقع المرض مبيح للفطر؛ إذا كان ظناً غالباً، وخطراً معتبراً؛ له شواهد التشخيصية ودلائله الطبية، التي يعرفها الأطباء المتخصصون، أو يدركها صاحبها بتجربة سابقة.

الحالة الثالثة: إذا كانت الخطورة متوسطة؛ بتراوح معدلاتها بين ٣,٥ إلى ٦ نقاط: فالصوم أفضل، مع جواز الأخذ برخصة الفطر حينئذ، خاصة في حال خوف المريض، لكن بشرط مشاورة الطبيب ومراجعة الوضع الصحي وخبرات المريض السابقة وأدويته وتوضيح احتمال الخطورة، وإذا أراد المريض الصوم فعليه بالمراقبة المستمرة لمستوى السكر في الدم والأخذ بإرشادات الطبيب.

الحالة الرابعة: إذا كانت الخطورة منخفضة؛ بتراوح معدلاتها بين صفر إلى ٣ نقاط: فالصوم حينئذ واجب، ولا يجوز الترخيص بالإفطار، ما لم تحصل مشقة بالصوم، وما لم يحتاج المريض لتناول الدواء أو الغذاء أو الماء.

والله سبحانه وتعالى أعلم

شوقي إبراهيم علام



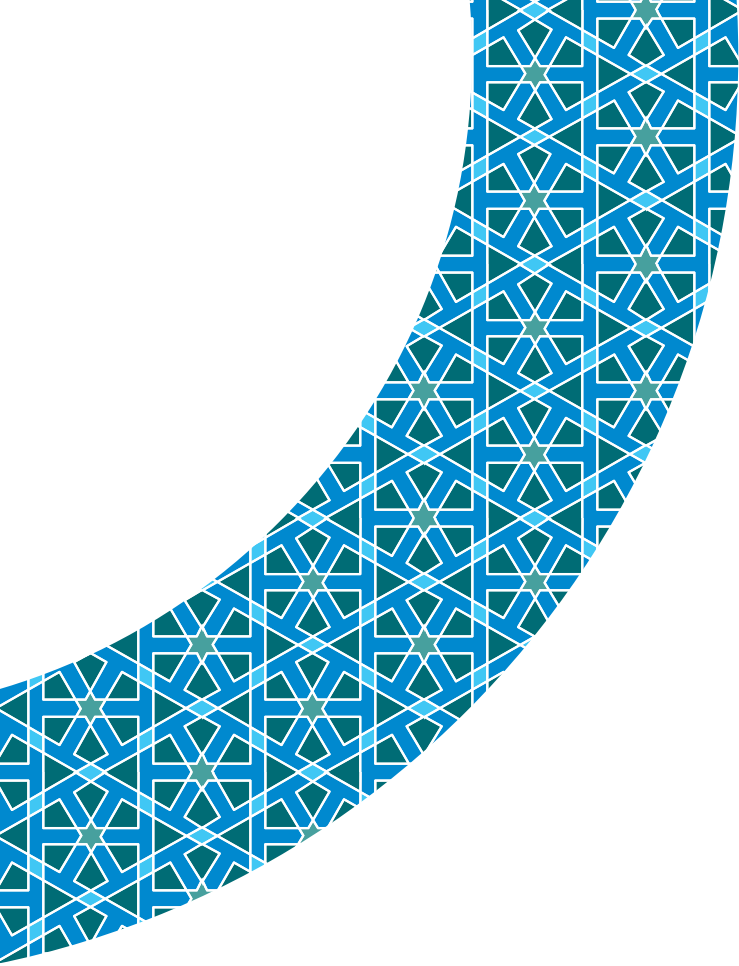
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مفتي جمهورية مصر العربية
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٢٠٢١/١/١١

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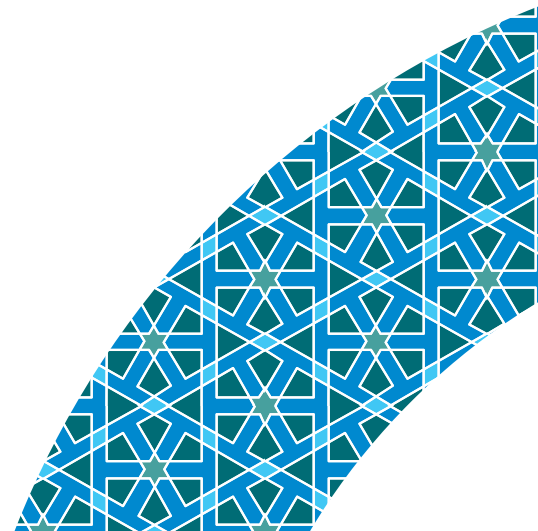


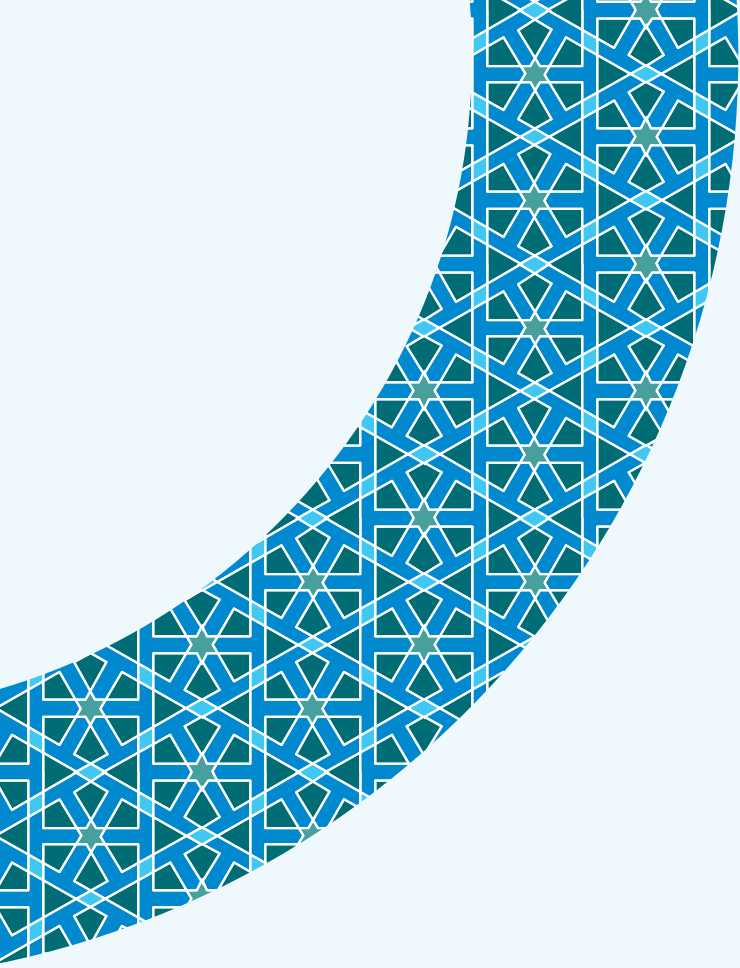
CHAPTER 7

Pre-Ramadan Assessment and Education

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CHAPTER 7

INDEX

1. THE PRE-RAMADAN ASSESSMENT	121
2. EDUCATION AS A CORNERSTONE FOR DIABETES MANAGEMENT DURING RAMADAN	123
3. TARGETS OF RAMADAN-FOCUSED DIABETES EDUCATION	123
3.1 The general public	124
3.2 Healthcare professionals	125
3.3 People with diabetes	125
4. KEY AREAS OF PRE-RAMADAN DIABETES EDUCATION	125
4.1 Risk quantification	126
4.2 Self-monitoring of Blood Glucose (SMBG)	126
4.3 Fluids and dietary advice	128
4.4 Exercise	129
4.5 Medication adjustments during fasting	129
4.6 When to break the fast	130
4.7 Role of education through technology	130
4.8 Role of educators in pre-Ramadan diabetes education	131
5. EVIDENCE OF THE BENEFITS OF RAMADAN-FOCUSED DIABETES EDUCATION	132
5.1 Prospective research studies from 2010 onwards	132
5.2 Other research studies from 2010 onwards	134
SUMMARY	136
REFERENCES	137



WHAT IS KNOWN?

- Pre-Ramadan education is crucial for safe fasting during Ramadan.
- Education programmes should target people with diabetes, Healthcare Professionals (HCPs), and the general public.
- Education on fasting and diabetes management is helpful beyond Ramadan.

WHAT IS NEW?

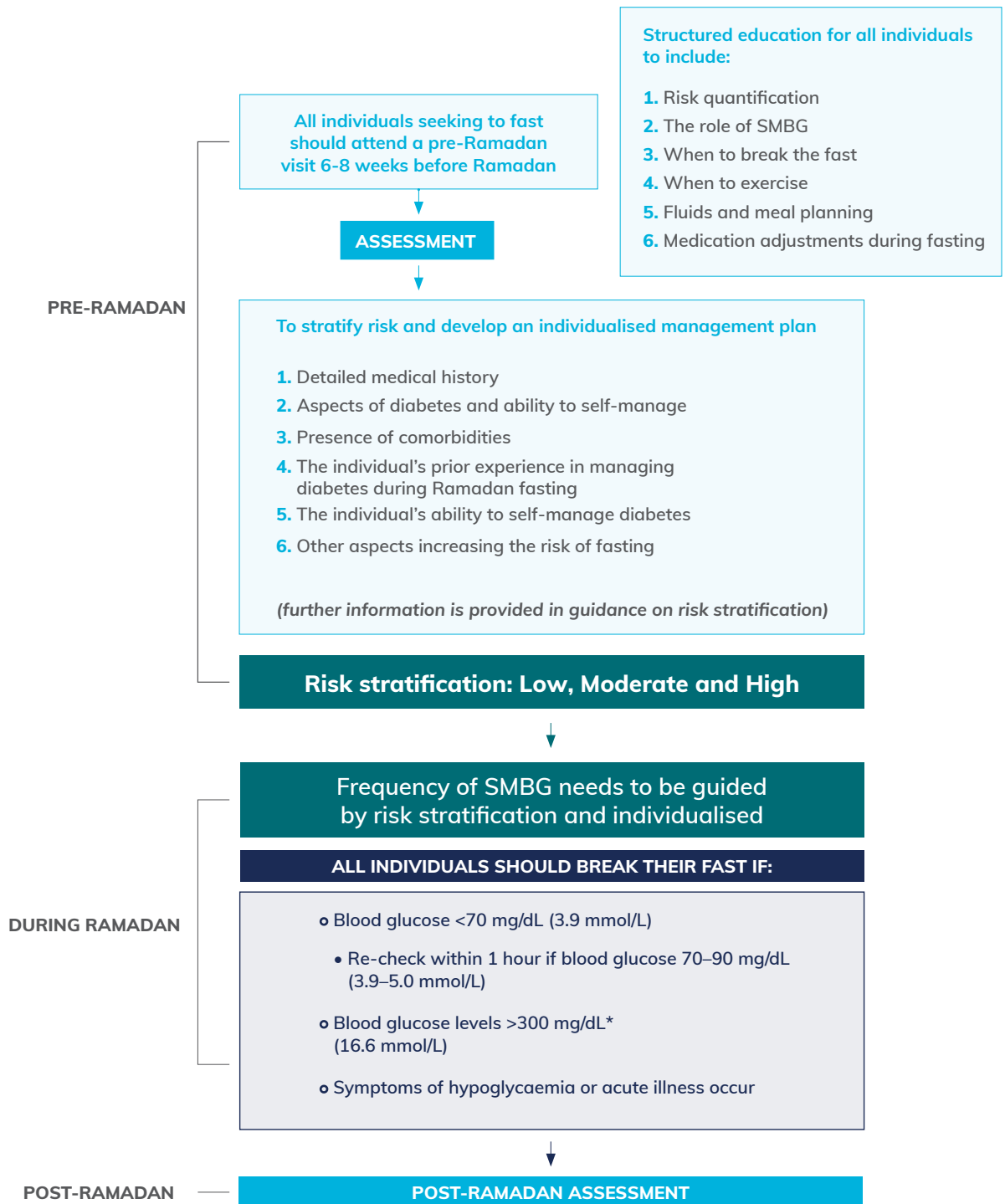
- More evidence has emerged supporting the use of pre-Ramadan education to achieve safe fasting during Ramadan.
 - This allows for better understanding for the requirements in pre-Ramadan educational programmes and their specific benefits.
- Pre-Ramadan education helps people with diabetes recognise the symptoms of mild or more severe complications when fasting to allow them to break their fast if necessary.
- The use of telehealth technology is beneficial when physical contact is limited and provides a model for future education.

WHAT IS MISSING?

- Further research on education in high-risk populations and how programmes can be tailored to specifically meet their needs.
- Further research on educational programmes aimed at adolescents and children with diabetes and how these can help improve outcomes during Ramadan.
- Further research on the use of online educational content and their benefits.

1. THE PRE-RAMADAN ASSESSMENT

A pre-Ramadan assessment needs to take place, ideally, 6–8 weeks before the start of Ramadan. Here, HCPs will be able to obtain a detailed medical history and perform a risk assessment. This risk assessment will form the basis on all recommendations thereafter; these include advice on whether fasting is safe (low or moderate risk scores) or not (high risk score), strategies for dose modifications and treatment regimen adjustments, the provision of Ramadan focused education and nutrition advice. Following this, individuals that decide to fast will need to adhere to guidance on the management of their diabetes during RF including changes to glycaemia monitoring schedules and dosing adjustments of medication. Finally, after Ramadan ends it is advised that a post-Ramadan follow up is performed. A follow up after Ramadan will help HCPs obtain crucial information about the individual's successes and challenges during RF and will ensure that RF the following year can be more successful. This process must be undertaken each Ramadan as successful fasting one year does not guarantee success the next year.



SMBG, self-monitoring blood glucose

*This applies for those with sudden rise in blood glucose level, individualisation of care is advisable

FIGURE 1
Assessment flowchart

2. EDUCATION AS A CORNERSTONE FOR DIABETES MANAGEMENT DURING RAMADAN

Structured diabetes education is about giving people the knowledge to make informed decisions regarding their behaviour and enabling them to effectively self-manage their condition [1]. Ramadan-specific diabetes education is an extension of this and provides additional knowledge on the necessary adjustments needed for the month of Ramadan [2-6].

The pivotal Epidemiology of Diabetes and Ramadan (EPIDIAR) study demonstrated that approximately only two-thirds of people with diabetes have received recommendations from their healthcare professionals (HCPs) regarding the management of their condition during Ramadan. Thus, more widespread targeted education is necessary prior to fasting [2]. In the subsequent CREED study, 96% of physicians provided advice to fasting individuals although only 63% based their advice on guidelines or recommendations [7]. Despite this, previous studies have revealed that only 30%–67% of physicians used a Ramadan-focused educational programmes [3, 8], and only 47.5% of patients attended such programmes [9].

The objective of Ramadan-focused education is to raise awareness of the risks associated with diabetes and fasting and to provide strategies to minimise them [9, 10]. Education should be simple, engaging, and delivered in a culturally sensitive manner by well-informed individuals [10, 11]. Individuals who have received Ramadan-focused education were reported to be better at following Ramadan diabetes management recommendations [9].

Ramadan-focused educational programmes have been successful in enabling people with diabetes to maintain and improve glycaemic control during and after fasting [10, 12-14] and to experience fewer hypoglycaemia episodes [15, 16]. Recent studies have also found evidence of improved glycaemic control in high and very high-risk individuals with the implementation of these educational programmes [17-20]. Moreover, the pairing of structured education and advanced glucose monitoring can allow for safe fasting during Ramadan [21].

3. TARGETS OF RAMADAN-FOCUSED DIABETES EDUCATION

Ramadan-focused diabetes education should primarily be targeted at people with diabetes, and the Healthcare Professionals (HCPs). Additionally, educational campaigns must target the wider public who serve as the support network for people with diabetes. An all-encompassing approach must be used [22] (Figure 2).



FIGURE 2

Targets of Ramadan-focused diabetes education

3.1 The general public

Educational campaigns targeting the general public should aim to raise the awareness of issues and misconceptions surrounding diabetes and Ramadan. An emphasis should be placed on the importance of maintaining good glycaemic control during fasting. In addition to medical advice, religious regulations should be included in these educational efforts.

For example, it should be made clear that individuals may be exempt from fasting during Ramadan if they are ill, and they can either make up for missed fasting days when they are better or donate food or money to the poor as an alternative (*fidya*).

In particular, campaigns should be aimed at religious and community leaders as they are valued and trusted members within the target community and may be turned to for advice in place of or in addition to HCPs [23, 24]. It is important, therefore, that these individuals are themselves well-informed. Providing clear advice that aligns with both medical and religious perspectives can improve and encourage communication between healthcare services and the Muslim community.

In circumstances where physical distancing is necessary or in areas in which access and contact is limited, the use of other methods such as video technology and social media should be considered.

3.2 Healthcare professionals

A lack of knowledge and awareness about fasting and diabetes could mean that advice and guidance provided by HCPs may be inappropriate or lacking, particularly in Muslim-minority countries.

For example, in a survey of HCPs in the US, only one-third of physicians actively enquired whether their Muslim patients intended to fast during Ramadan, and many did not feel comfortable managing these patients [25]. Similarly, in France, a lack of medical knowledge surrounding Ramadan fasting and diabetes led to inappropriate advice being given to patients, together with inadequate patient education [26]. Ensuring HCPs are knowledgeable and adequately trained is therefore vital for the provision of appropriate advice and optimal diabetes care [10, 21]. Cultural competency is essential for effective education and patient care, impacting how both are given and received [27, 28].

HCPs should be trained to recognise and understand the different cultural and religious aspects of fasting and how these may impact on the management of diabetes [28]. Understanding these impacts enables HCPs to appreciate the spiritual significance of fasting during Ramadan for people with diabetes who insist on fasting despite having an illness that could potentially exempt them.

Among people with type 2 diabetes (T2DM), culturally appropriate health education has proven more effective than 'usual' health education in improving glycaemic control and knowledge about diabetes and its management in the short-to-medium term [29]. This is particularly relevant in the context of recommendations for Ramadan practice for Muslim-minority countries [10]. HCPs should have the skills and confidence to deliver advice in a culturally sensitive manner in order to encourage communication, improve the patient-doctor relationship, and provide better overall care [30-32].

3.3 People with diabetes

Pre-Ramadan education can greatly benefit people with diabetes in terms of maintaining glycaemic control and preventing weight gain [12, 13].

Education programmes can provide the knowledge and tools for individuals to effectively manage their condition during Ramadan by making key changes to their behaviour and lifestyle in order to minimise the risks [12, 13].

Educational programmes can be provided as group sessions [10, 13] or as one-on-one consultations [13, 33], given in a medical or community setting by physicians, dieticians and/or community link workers. The support of religious leaders is vital, particularly in Muslim-minority countries where culturally sensitive workers are not always available.

4. KEY AREAS OF PRE-RAMADAN DIABETES EDUCATION

Pre-Ramadan-focused education is of paramount importance to effectively manage diabetes during the holy month. Education on the timing of blood glucose monitoring in order to



minimise the risk of severe hypoglycaemia events and to improve quality of life for people with diabetes is essential [18, 33, 34]. Recent studies have reported that attending adapted structured small-group education programmes can improve confidence in diabetes management and also psychosocial factors when fasting [34, 35].

The main areas of diabetes education that should be provided prior to Ramadan are discussed below (Figure 3).

- Risk quantification and exemptions, and removing misconceptions
- Blood glucose monitoring
- Fluids and dietary advice
- Physical activity and exercise advice
- Medication adjustment and test fasting
- When to break the fast
- Recognition of hypoglycaemia and hyperglycaemia symptoms

FIGURE 3

Key Components of a Ramadan-focused Educational Programme

4.1 Risk quantification

All people with diabetes should attend a pre-Ramadan assessment with their HCP 6–8 weeks before the start of Ramadan. In the assessment, the risks to people with diabetes who intend to fast should be quantified [36]. Factors that contribute to the risk include the type of diabetes, current diabetes medication, individual social and work circumstances, individual hypoglycaemic risk, self-management capabilities and the presence of any complications and/or comorbidities. Individuals can then be stratified according to their potential risk and an individualised approach to disease management provided to ensure optimal care is delivered (see **chapter 4: The effects of fasting during Ramadan on physical and mental wellbeing**). Although existing recommendations advise that individuals who fall in the high risk category do not fast, it should be acknowledged that many Muslims will still wish to do so and these individuals should be provided with the appropriate knowledge and support to minimise the risks they face [16, 37, 38].

4.2 Self-monitoring of Blood Glucose (SMBG)

There is a misconception held by some Muslim communities that pricking the skin for blood glucose testing invalidates the Ramadan fast [39]. It should be strongly emphasised in educational programmes that this is not the case. Indeed, checking blood glucose levels is

an essential component of diabetes care, and individuals should be provided with the tools and knowledge to carry out self-monitoring of blood glucose (SMBG) [40]. Having these skills can empower people to effectively self-manage their disease and better identify and prevent episodes of hypoglycaemia [14, 21, 41] and hyperglycaemia during Ramadan. This is particularly important during Ramadan when changes in diet and lifestyle can increase the incidence of these events. Also, by regularly measuring blood glucose, people with diabetes may become more conscious of their eating habits and the impact on their blood glucose levels, potentially curbing damaging behaviours.

Having the skills to self-monitor blood glucose levels can empower people with diabetes with diabetes to effectively self-manage their disease

The frequency of SMBG depends on many factors including the type of diabetes and current medications but should be carried out regularly by all. For those at moderate or low risk, this may be once or twice a day. Those at high or very high risk should check their blood glucose levels several times a day (see **chapter 8: The Ramadan Nutrition Plan (RNP) for people with diabetes**). There is evidence that optimal monitoring of blood glucose along with pre-Ramadan-focused education could be a vital factor for reducing complications in those deemed to be high-risk [17]. Similarly, individuals on insulin and/or sulphonylureas may choose to monitor their blood glucose levels more frequently because of the increased risk of hypoglycaemia associated with these medications. The data generated are also useful for guiding dose titration (see **chapter 8: The Ramadan Nutrition Plan (RNP) for people with diabetes**) [42]. It is important for all people with diabetes to measure blood glucose levels after iftar to detect postprandial hyperglycaemia [40, 43, 44]. Furthermore, individuals should check their blood glucose levels whenever they experience symptoms of hypoglycaemia, hyperglycaemia, or feel unwell, and understand when they should immediately break the fast (see **Figure 5**). Monitoring blood sugar levels several times a day while fasting has become a vital component of successful educational programmes implemented in the studies described in **section 5** [12, 13]. An example SMBG guide is shown below.

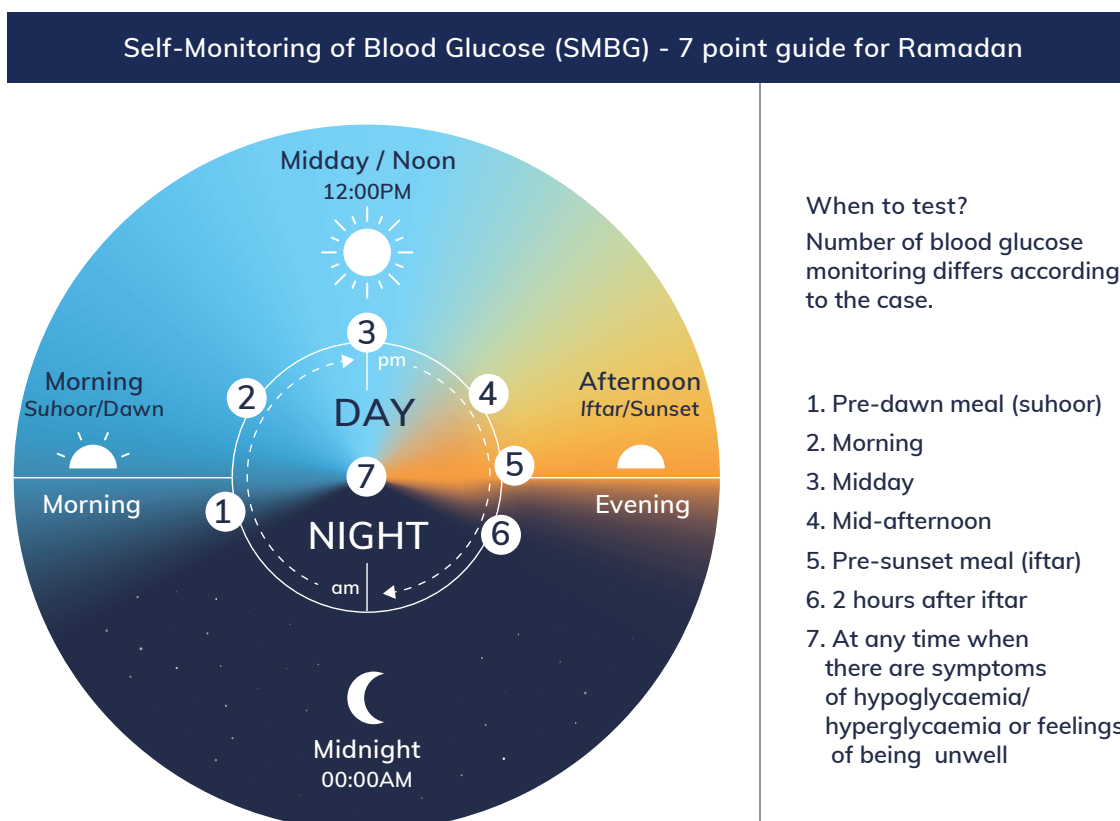


FIGURE 4

A seven point blood glucose monitoring guide for people with diabetes fasting during Ramadan

4.3 Fluids and dietary advice

The fasting and feasting nature of Ramadan can encourage the consumption of large, carbohydrate-heavy meals, and sugary drinks and treats that can impact blood glucose levels potentially increasing the risk of complications in people with diabetes [45].

Complex carbohydrates are recommended for the Suhoor meal while simple carbohydrates are recommended for the Iftar meal.

Providing dietary advice and meal planning can help people with diabetes to follow a healthy balanced diet during Ramadan, reducing the likelihood of these complications. It may also lead to lifestyle changes that favour weight loss that may continue once fasting has stopped. Key dietary advice that should be followed during Ramadan is shown in **Table 1**.

TABLE 1: DIETARY ADVICE FOR PEOPLE WITH DIABETES FASTING DURING RAMADAN

Divide the daily calories between <i>Suhoor</i> and <i>Iftar</i> , plus one to two snacks if necessary.	
Ensure meals are well balanced	<ul style="list-style-type: none"> • 45% - 50% complex carbohydrates E.g., barley, wheat, oats, millet, semolina, beans, lentils • 20% - 30% protein • <35% fat (preferably mono- and polyunsaturated)
Include low glycaemic index, high-fibre foods that release energy slowly before and after fasting	<ul style="list-style-type: none"> • E.g., granary bread, beans, rice
Include plenty of fruit, vegetables and salads	
Minimise foods that are high in saturated fats	<ul style="list-style-type: none"> • E.g. ghee, samosas, pakoras
Avoid sugary desserts	
Use small amounts of oil when cooking	<ul style="list-style-type: none"> • E.g., olive, canola oil, rapeseed
Keep hydrated between sunset and sunrise by drinking water or other non-sweetened beverages	
Avoid caffeinated and sweetened drinks	

4.4 Exercise

Rigorous exercise should be avoided, particularly during the last hours of fasting (before sunset) because it may lead to an increased risk of hypoglycaemia and/or dehydration [46]. People with diabetes should be encouraged to maintain their normal physical activity during Ramadan; they should be reminded that the physical exertions involved in *Taraweeh* prayers, such as bowing, kneeling, and rising, should be considered part of their daily exercise activities. Individuals are more likely to achieve HbA1c targets and reduce body weight when more nightly prayers are performed [11].

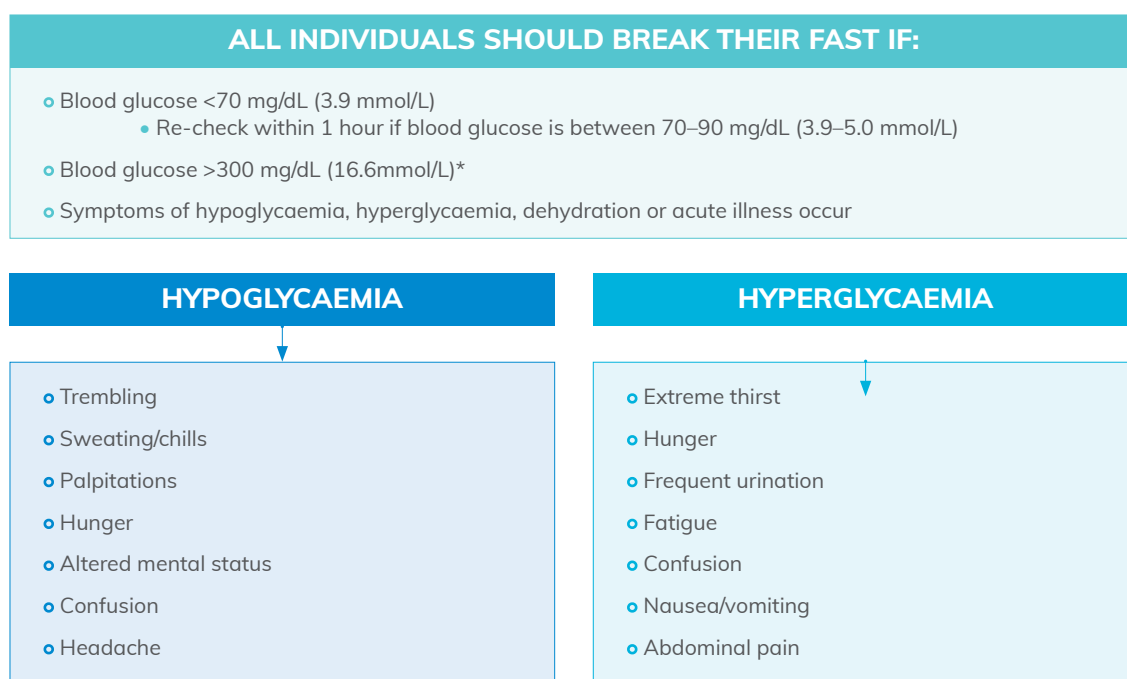
4.5 Medication adjustments during fasting

The change in lifestyle and eating patterns during Ramadan places people with diabetes at an increased risk of hypoglycaemia during the daytime and hyperglycaemia at night. The type of diabetes medication may also impact this risk; therefore, proper education on self-adjusting drug dosage and timing has become an essential guideline for diabetes management in people with diabetes during Ramadan [47]. The type of diabetes medication can also impact this risk. In the pre-Ramadan assessment, the HCP may adjust the dose, timing or the type of medication to minimise the risk to the patient. Recommendations on treatment modifications are discussed in detail in **chapter 8: The Ramadan Nutrition Plan (RNP) for people with diabetes**.



4.6 When to break the fast

Individuals should be educated to recognise the symptoms of hypoglycaemia and hyperglycaemia [48] and be advised to test their blood sugar regularly whenever any of these complications (or an acute illness) occur; they must also be prepared to break the fast if necessary (Figure 5). When breaking the fast because of hypoglycaemia, individuals should consume a small amount of a fast-acting carbohydrate e.g. a small carton of juice, and retest their blood glucose levels after 15–20 minutes [49].



*Consider individualisation of care

FIGURE 5

When to break the fast

4.7 Role of education through technology

The post COVID-19 world presents new challenges for HCPs in arranging face-to-face interactions for clinical follow-ups. Telephones and mobile phones are convenient modes of communication and may become a standard method for future consultations [50]. Teleconsultation, telemedicine, and telemonitoring have all been identified as effective modes of managing the needs of people with diabetes [51-53] and have been shown to enhance education and SMBG [10].

Recent studies have demonstrated that delivering online educational courses via smartphone applications (apps) and short messaging service (SMS) texts could be a preferred mode of educating individuals about their diabetes and interacting directly with HCPs; these can also help reduce the need for making multiple visits to clinics. Moreover, the ability to obtain the latest diabetes education, by certified diabetes educators, more conveniently is a huge benefit [54-57].

A combination of continuous glucose monitoring (CGM) technology with education before Ramadan could result in better glycaemic control during Ramadan [21], even in individuals deemed to be high-risk [17]. This technology has the ability to track glucose fluctuations at any time throughout the day and night. This helps to reinforce the decision to fulfil the spiritual fast through safer behaviours.

4.8 Role of educators in pre-Ramadan diabetes education

At times, it might seem overwhelming for people with diabetes to manage their disease. Diabetes education specialists play an increasingly important role in delivering personalised care to develop a management plan that fits the lifestyle behaviours, culture, and beliefs of their patients [58-60].

During Ramadan, the role of the diabetes educator is to assist people living with diabetes that are seeking to fast by providing Ramadan-focused guidance on:

- how often to monitor their blood glucose during the day
- the importance of looking out for signs of low blood sugar
- how to alter drug dosage and timing
- diet and fluid intake
- the importance of avoiding strenuous physical activity

If people with diabetes understand the risks and know how to manage them accordingly, they may be able to fast safely without any complications [61].

Ramadan-focused diabetes education should provide information on how to use certain types of devices such as insulin pens, meters, continuous glucose monitoring devices, and pumps. The use of devices allows educators to monitor individuals, close to real-time, via smartphone applications and can provide valuable data on previous activity. Interestingly, studies have also demonstrated that the use of glucose sensors together with daily phone helpline follow-ups with diabetes educators reduces the risk of hypoglycaemia during Ramadan [62-64]. In these studies, the helpline service provided regular treatment advice, alerts and reminders to achieve good glycaemic control during Ramadan. It is clear that increasing awareness of the symptoms of hypoglycaemia and hyperglycaemia can help people with diabetes in deciding whether to break or continue their fast. Overall, better results of clinical and metabolic parameters were observed in patients who were compliant with Ramadan-focused education recommendations [65]. Working closely with their HCP or diabetes educator is important to minimise the risk of complications [66].

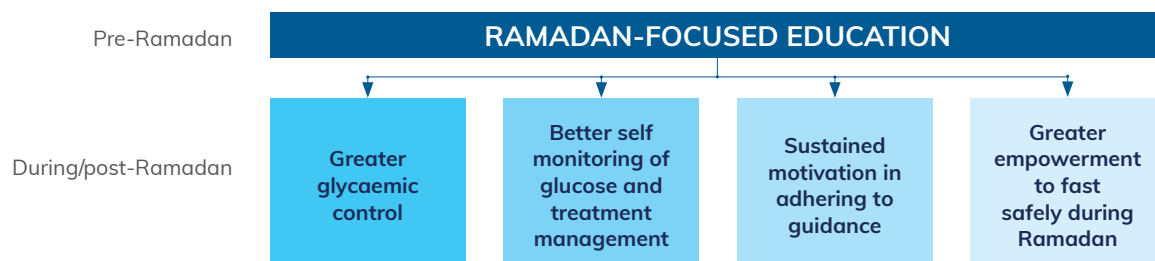


FIGURE 6

The positive impacts of Ramadan-focused education

5. EVIDENCE OF THE BENEFITS OF RAMADAN-FOCUSED DIABETES EDUCATION

5.1 Prospective research studies from 2010 onwards

The Ramadan Education and Awareness in Diabetes (READ) study was conducted in the UK; general practitioners based in London attended an educational Ramadan and diabetes workshop to gain understanding of the issues surrounding diabetes and fasting. Participants then provided a 2-hour pre-Ramadan educational programme to patients with T2DM (n=57). Patients attended group sessions (led by a specialist dietician and a diabetes specialist nurse practitioner) which included both general and Ramadan-specific diabetes information on dietary advice and meal planning, physical activity, blood glucose monitoring, recognising and managing complications, and dosing and timing of medications [12].

Patient weight and the incidence of hypoglycaemic events before and after Ramadan were compared with that of a control group of 54 patients with T2DM who did not attend the educational programme. One month after Ramadan, those who attended the programme demonstrated a significant loss in weight compared with before Ramadan (mean -0.7 kg, $p < 0.001$) whereas there was a significant weight gain in the control group (mean +0.6 kg, $p < 0.001$). There was also a significant decrease in the number of hypoglycaemic events in the group that received diabetes education (from nine events pre-Ramadan to five during Ramadan), compared with an increase (from nine to 36 events) in the control group. The study also demonstrated sustained glycaemic control in patients one year after attending the programme which was not evident in the control group [12].

In 2012, the Ramadan Diabetes Prospective Study investigated people with type 1 diabetes and T2DM (N=110). Participants were recruited to attend two educational sessions held on a one-to-one basis at the outpatient department of the Baqai Institute of Diabetology and Endocrinology in Pakistan. In one session, given by a doctor, the physical well-being and glycaemic control of the patient was evaluated and any necessary adjustments to drug dosing and timing were made. Patients were advised to record their blood glucose readings twice a day for at least 15 days during Ramadan and were educated about the warning signs of complications. In the other session, the diet and lifestyle of the patient was assessed by a dietician and adjusted for optimal energy consumption during Ramadan. The impact of this programme on the occurrence of diabetes complications during Ramadan was assessed [13].

The study demonstrated a downward trend in symptomatic hypoglycaemic episodes from week 1 to week 4 of Ramadan with only one patient experiencing a severe hypoglycaemic event. No individuals developed diabetic ketoacidosis or hyperglycaemic hyperosmolar state. The authors concluded that altering drug dosage, dietary counselling and patient education, together with regular blood glucose monitoring enabled patients to fast without major complications [13].

In 2015, McEwen *et al* performed a multicentre study in 772 people with T2DM in Egypt, Iran, Jordan and the Kingdom of Saudi Arabia. Pre-Ramadan education was given to 515 participants and usual care to 259. The educational intervention took place 2 months prior to Ramadan. On average each participant in the intervention group received 2 individualised 30 minute – 1-hour educational sessions delivered by appropriately trained dietitians, diabetes specialist nurses or community link workers. Those who received the educational programme were statistically more likely to modify their treatment plans, perform SMBG, know the signs and symptoms of hypoglycaemia, and have better clinical outcomes, compared to those who received usual care. The participants that received the education programme were also more likely to report mild and moderate hypoglycaemic events, but fewer reported severe hypoglycaemic events during Ramadan compared with those who received usual care [24].

In 2018, El Toony *et al*, conducted a prospective interventional study involving 320 Muslim people with T2DM in Egypt. A total of 120 people in the intervention group received focused individualised education sessions before Ramadan and 200 people in control group received usual care. Those in the intervention group received individual education sessions lasting 20–30 minutes, 6–8 weeks prior to Ramadan. This study found that, irrespective of group, fasting blood glucose levels during and after Ramadan decreased significantly. Importantly, the incidence of hypoglycaemia was reduced, and a greater number of individuals achieved HbA1c levels below 7% (53 mmol/mol) in those receiving education compared to those with usual care. Moreover, those receiving education prior to Ramadan also displayed improvements in HDL and LDL levels. The authors concluded that dietary modifications, drug dose adjustments and regular blood glucose monitoring were key to successful safe fasting during Ramadan [14].

In 2019, Al-Ozairi *et al*, studied people with T1DM who received multiple daily injections or continuous subcutaneous insulin infusions in a prospective observational study in Kuwait. Structured education training in the form of Dose Adjustment for Normal Eating (DAFNE) was given to the study participants, and basal insulin adjustments were administered with the use of an advanced monitoring device. The DAFNE education programme has been described elsewhere [67]. The authors were able to show that the incidence of hypoglycaemia was significantly reduced during Ramadan compared with before Ramadan. No episodes of severe hypoglycaemia, DKA, acute kidney injury, or hospitalisation occurred during Ramadan. There was also no evidence of glucose variability during Ramadan. Taken together, it was concluded that the pairing of pre-Ramadan education and advanced monitoring systems can help people with uncomplicated T1DM safely fast during Ramadan [21].

In 2019, M Hassanein *et al*, performed a prospective interventional study in 169 high-risk individuals including people with T1DM or T2DM receiving insulin, gestational diabetes, patients with stage 3 CKD, and patients with ischemic heart disease at the Dubai Health



Authority. All were given optimal care, which included Ramadan-focused education, a continuous glucose monitoring device, and medication dose adjustments. The education took place 4-6 weeks prior to Ramadan and each individual received 90 minutes of focused Ramadan education. The authors were able to show an improvement in glycaemic control during fasting with no significant changes in biometric and biochemical measurements. There was evidence of an increase in non-severe hypoglycaemia during fasting. It was concluded that optimal care could be the key for reducing the complications of fasting in high-risk people with diabetes [17].

A two-arm prospective observational study conducted in 2020 investigated people with T2DM in Egypt. A total of 1008 people T2DM were offered a culturally adapted Pre-Ramadan Education Program (PREP) in addition to usual care two months before Ramadan. The educational sessions lasted 2 hours. Retrospective interviews were conducted one month after Ramadan to compare the fasting experiences of the PREP attendees (470 patients) to those receiving usual care (538 patients). Together, fasting was found to be beneficial for people with T2DM, where the number of fasting days was associated with reduced HbA1c levels. Those that received PREP had lower HbA1c levels and also showed reductions in weight when compared with those receiving usual care, even after accounting for the number of fasting days. Furthermore, those receiving PREP performed more *Taraweeh* night prayers and more night prayers were associated with greater declines in HbA1c levels and weight. Crucially, PREP improved perception and response to hypoglycaemia e the provision of low doses of antidiabetic medications, particularly insulin [11].

5.2 Other research studies from 2010 onwards

Ahmedani *et al*, conducted a multicentred, multinational retrospective observational study in 2014 conducted across seven countries: Pakistan, Bangladesh, Afghanistan, the Kingdom of Saudi Arabia, Oman, Egypt and Sri-Lanka. A total of 6610 fasting people with diabetes participated, of whom 3142 (47.5%) received Ramadan-specific diabetes education, 4371 (66.1%) received medication adjustments, and 4636 (70.1%) received dietary advice before Ramadan. Those that received Ramadan specific diabetes education received it through one of three modes, i.e., one-to-one (1994; 18.1%), group (581; 8.8%) or written sessions (8.6%). The people with diabetes who received pre-Ramadan education (through any mode) reported greater levels SMBG and broke their fast upon developing symptoms of hypoglycaemia or hyperglycaemia and had less serious complications. Compliance to management recommendations in people who received education was significantly better than that in people who did not receive any form of education. It was also shown that one-to-one education was better than group education in terms of SMBG and recognising hypoglycaemia symptoms [9].

A recent systemic review and meta-analysis looking into studies conducted from 1990—2019 in people with T1DM and T2DM that fasted during Ramadan. Meta analyses showed that Ramadan-focused diabetes education led to a decrease in HbA1c levels (see **Figure 7**) and LDL but an increase in TG and weight during Ramadan. The authors noted that there was a risk of reporting bias but there was evidence that can be beneficial to people with Diabetes that fast during Ramadan [65].

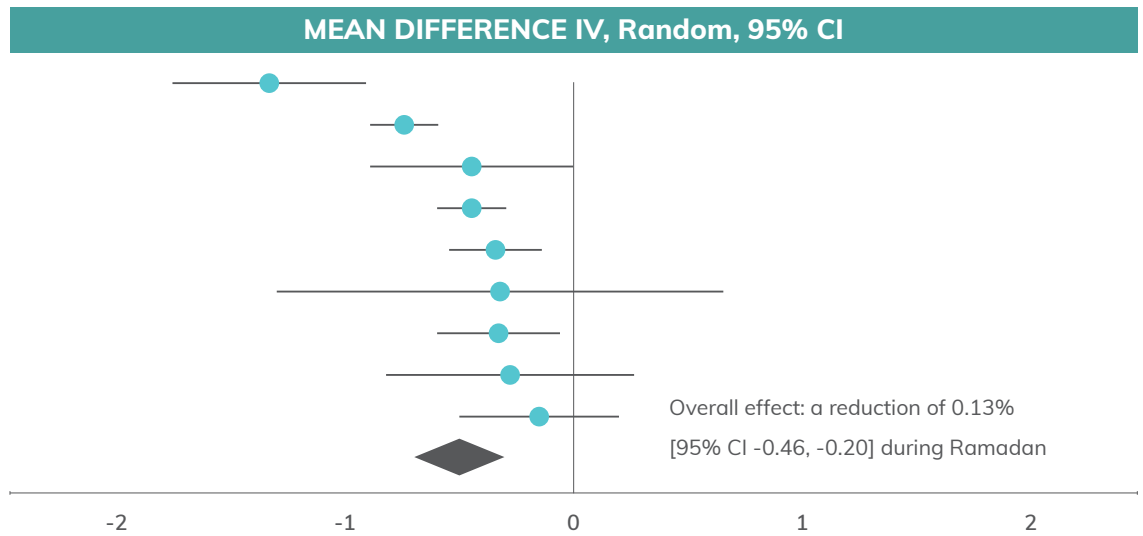


FIGURE 7

A Forest plot showing the effect of pre-Ramadan education on HbA1c levels during Ramadan from 9 studies, adapted from Gad et al. (2020) [65]



SUMMARY

- Pre-Ramadan education is a key component of safe fasting during Ramadan for people living with diabetes.
- Pre-Ramadan educational programmes should target people with diabetes, HCPs, and the general public that serves as the support network.
- Pre-Ramadan educational programmes should be carefully planned to be culturally sensitive and include community and religious leaders to align the medical and religious messages.
- Structured education programmes should include information on risk quantification, removing misconceptions, SMBG, diet, exercise and physical activity, medication adjustments and dose testing, recognition of the symptoms of complications, and when to break the fast to avoid harm.
- The beneficial effects of pre-Ramadan education on adequate nutrition and meal intake, adjustments medication dosages, and healthy lifestyle behaviours can guide individuals to fast in a safe and healthy manner.
- Glucose monitoring technology played a key role in managing diabetes, predicting severe hypoglycaemia, and achieving HbA1c targets.
- Studies have demonstrated clear benefits of Ramadan-focused educational programmes on glycaemic control, weight loss, and improving the risk of hypoglycaemia, potentially even in higher risk individuals.
- The positive outcomes of these programmes may also extend beyond the month of Ramadan fasting.

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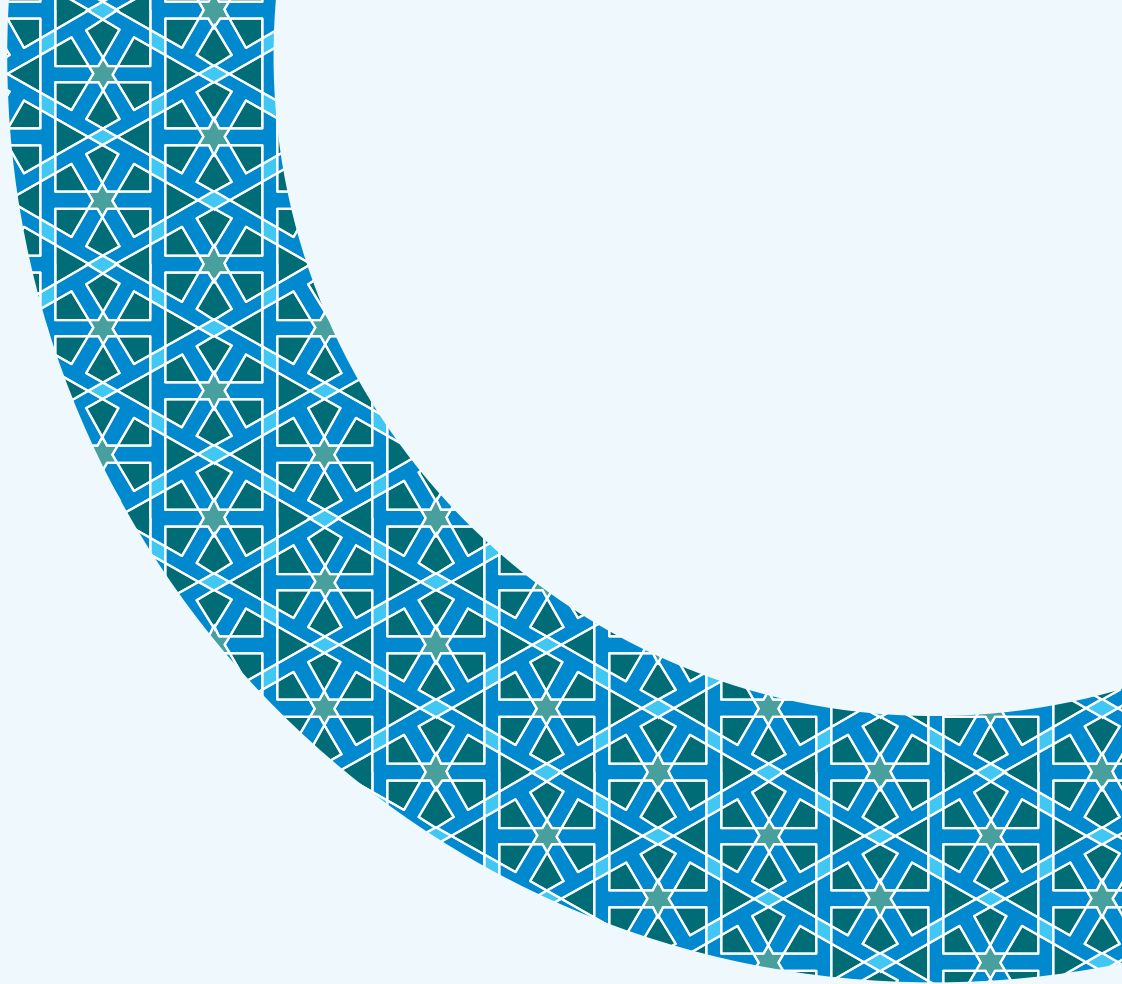


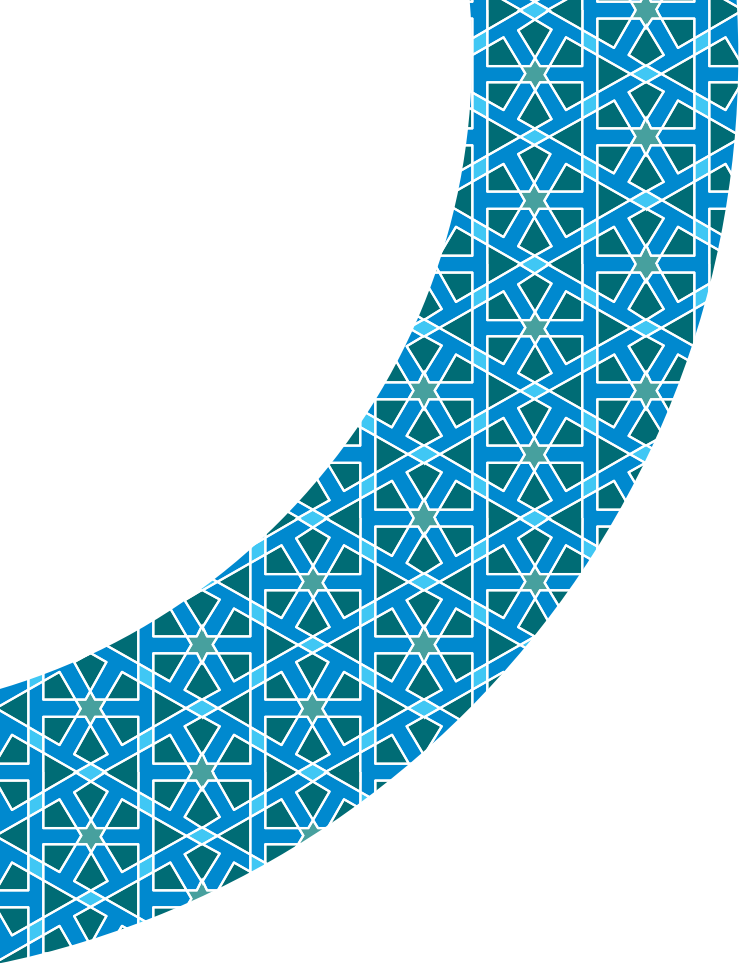
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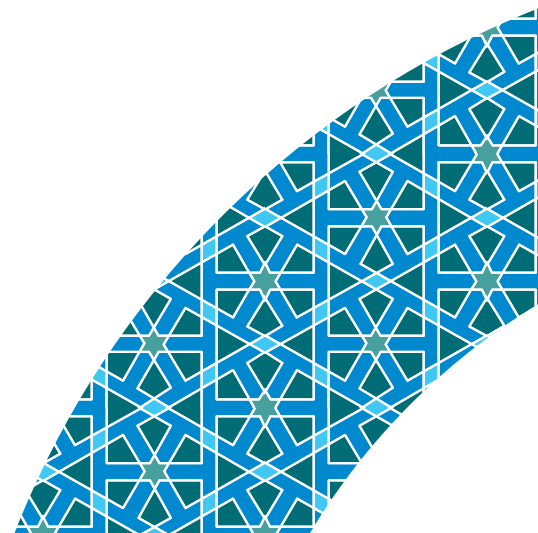


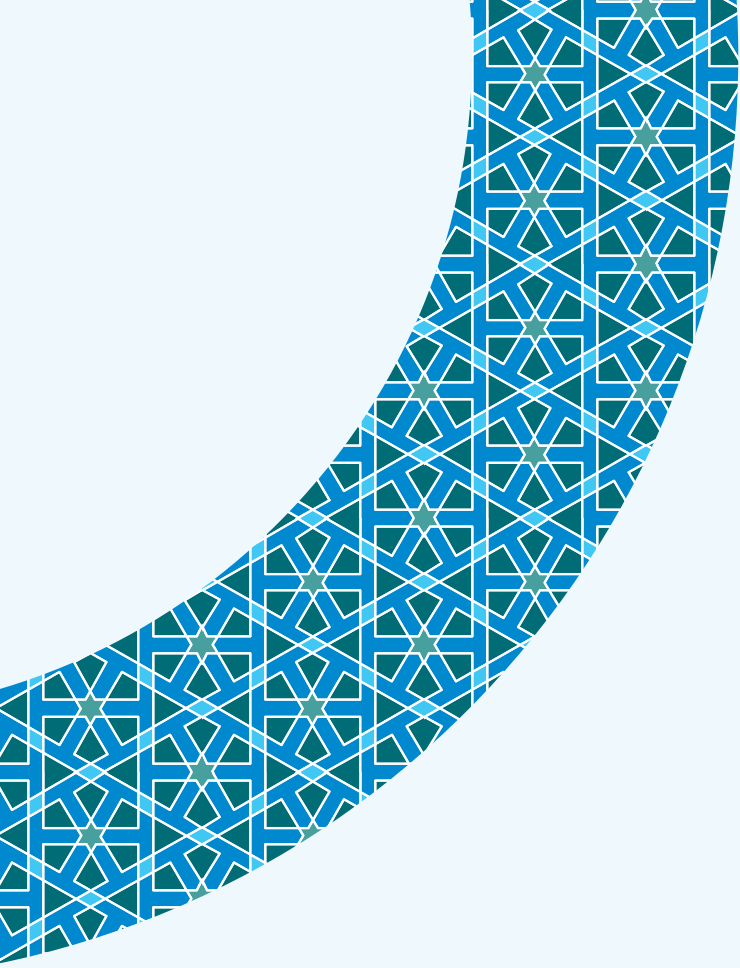
CHAPTER 8

The Ramadan Nutrition Plan (RNP) for people with diabetes

Chapter lead:
Osama Hamdy

Authors:
Barakatun-Nisak Mohd Yusof
Salma Maher







CHAPTER 8

INDEX

1. INTRODUCTION TO THE RAMADAN NUTRITION PLAN	147
2. THE PRE-RAMADAN VISIT	148
3. RISK AVOIDANCE DURING RAMADAN	149
4. HEALTH ISSUES DURING RAMADAN	149
5. WEIGHT MAINTENANCE AND WEIGHT REDUCTION DURING RAMADAN FASTING	150
6. THE 10 PRINCIPLES OF THE RNP	151
7. THE RNP: A TRANSCULTURAL APPLICATION	154
SUMMARY	154
REFERENCES	155



WHAT IS KNOWN?

- Creating a plan for nutrition during Ramadan is essential to ensure safe and confident fasting.
- Ramadan Nutrition Plan (RNP) menus have been developed for several countries and help to provide contextualised nutrition advice and guidance for people with diabetes that seek to fast during Ramadan.

WHAT IS NEW?

- New RNP menus and meal examples have been developed for different countries.
- Greater evidence is available to provide more up to date nutrition advice to people with diabetes that are seeking to fast during Ramadan.

WHAT IS MISSING?

- More Healthcare professionals should contribute to the RNP at www.daralliance.org so that people around the world that are seeking to fast during Ramadan can receive contextualised guidance for nutrition and achieve safe fasting.

1. INTRODUCTION TO THE RAMADAN NUTRITION PLAN

The Ramadan Nutrition Plan (RNP) is a mobile and web-based application designed to help healthcare professionals (HCPs) individualise medical nutrition therapy (MNT) for people with diabetes who are observing Ramadan fasting [1]. The RNP provides a platform that includes the diabetes nutrition plan and education [2] and can be a useful resources for individuals with diabetes who do not have access to HCPs [1].

The role of MNT is vital when fasting during Ramadan, not only in achieving optimal diabetes control but also in helping overweight and obese individuals with type 2 diabetes (T2DM) in improving their lifestyle and losing weight [2-4]. In fact, Ramadan provides an ideal opportunity for individuals to channel the strength and discipline required to comply with MNT; this in turn helps them to maintain optimal glycaemic control beyond the month of Ramadan [5]. Structured MNT for Ramadan has been shown to improve fasting blood glucose levels, triglycerides, and the rate of self-monitoring blood glucose (SMBG) pre-dawn and pre-bed when compared to standard care in people with T2DM [6]. Moreover, structured MNT for Ramadan includes pre-Ramadan education and individualised energy and macronutrient prescriptions with the incorporation of a diabetes-specific formula of at least 1 serving/day during *Suhoor* or a snack (if needed) to improve the adequacy of nutrient intake [6].

The RNP is based on the principles of optimal MNT [7] and provides examples of meal plans for different countries and regions across the globe [1]. However, dietary recommendations should be individualised and tailored to an individual's lifestyle requirements, age, comorbidities, and other medical needs [2, 4, 6]. The RNP is a work in progress and would benefit from further contributions by HCPs of different nationalities, based on the structural framework provided in this chapter. This will lead to the production of a comprehensive global menu resource [1].

The main aims of MNT during Ramadan fasting are to ensure that:

1. Individuals with diabetes consume an adequate amount of calories, with balanced proportions of macronutrients, during the non-fasting period (i.e., sunset to dawn) to prevent hypoglycaemia during the fasting period.
2. Individuals with diabetes equally distribute their carbohydrate intake among meals to minimise postprandial hyperglycaemia.
3. Individuals with diabetes and HCPs give consideration to comorbidities such as hypertension and dyslipidaemia when formulating MNT plans.

The meal plan using the RNP framework has been adopted for use in many countries. When accessing the RNP website [1], the HCP can select their country of practice from the "Ramadan Nutrition Plan map" to gain country-specific MNT recommendations (website example shown in **Figure 1**). A Ramadan Nutrition plate and meal (example shown in **Figure 3**) for each country is also included to visualise the structured RNP meal plan.

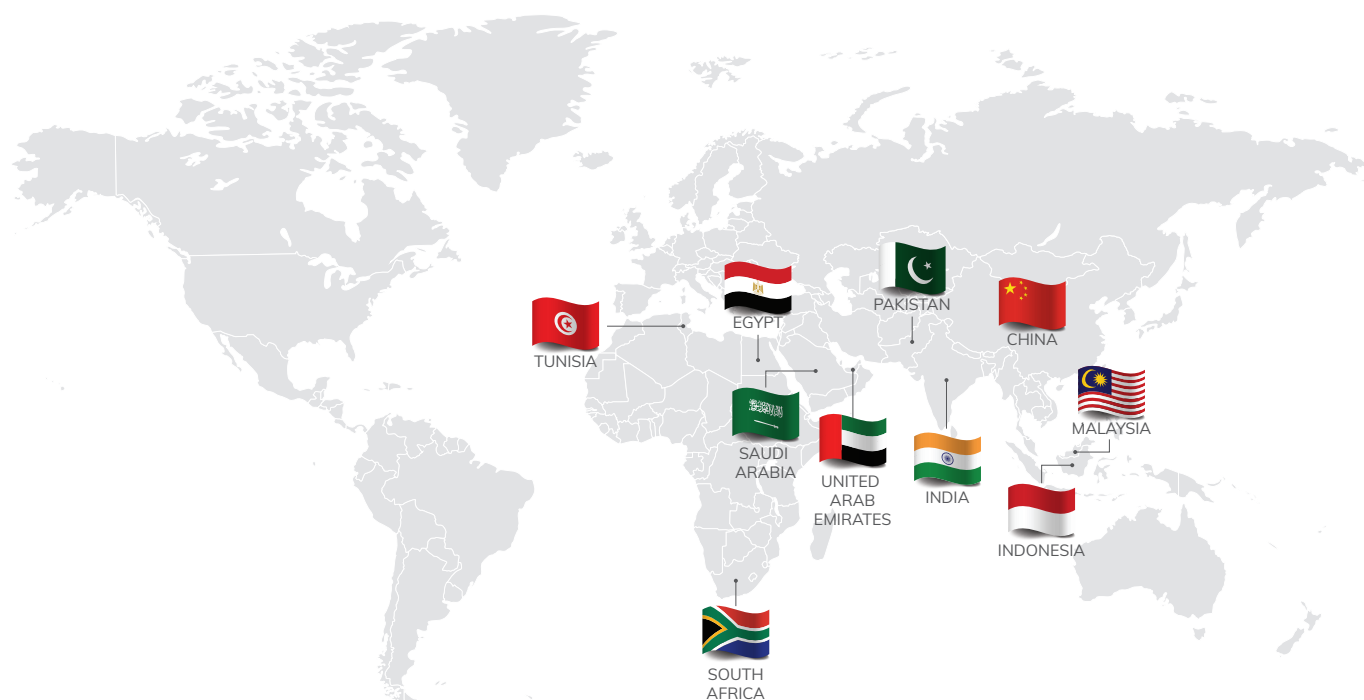


FIGURE 1

Ramadan Nutrition Plan Map

Access the online version at www.daralliance.org and then click on your country in the online map to view a full nutrition plan (example map above). The nutrition plan should be printed and handed to individuals that are seeking to fast during Ramadan.

2. THE PRE-RAMADAN VISIT

The nutrition assessments should be part of a pre-Ramadan visit and scheduled around 6–8 weeks before the start of Ramadan. A pre-Ramadan visit provides an opportunity for HCPs to advise individuals with diabetes about the necessary dietary modifications that should be adopted when fasting during Ramadan [8]. It may also help those individuals who choose to fast for a few days during the 2 months preceding Ramadan (*Sha'ban*).

The main aims of a pre-Ramadan visit are to:

1. Provide individuals with diabetes with a modified nutrition plan that improves glycaemic control while fasting during Ramadan.
2. Provide individuals with MNT that may help overweight and obese people to successfully and safely lose weight during the Ramadan fast.
3. Adjust anti-diabetic medications in line with the individual changes in nutrition that can occur during the Ramadan fast [9].
4. Encourage proper and safe levels of exercise and physical activity while fasting during Ramadan.
5. Provide education to help individuals recognise the warning symptoms of dehydration, hypoglycaemia, and other possible acute complications.
6. Enforce the importance of blood glucose and body weight monitoring during Ramadan.

3. RISK AVOIDANCE DURING RAMADAN

For people with diabetes, there are potential risks associated with prolonged fasting. Therefore, it is crucial to increase the awareness of these risks to all people with diabetes seeking to participate in Ramadan fasting so that they can do so safely.

Many diabetes-related risks can be minimised through proper nutrition [6, 9, 10], including:

1. Hypoglycaemia, especially during the late period of fasting before *Iftar*;
2. Severe hyperglycaemia after each of the main meals;
3. Dehydration, especially in countries with longer fasting hours and hot climates;
4. Significant weight gain due to an increased caloric intake and a reduction in physical activity;
5. Electrolyte imbalances;
6. Acute renal failure in individuals prone to severe dehydration, particularly the elderly and those with impaired kidney function.

4. HEALTH ISSUES DURING RAMADAN

When fasting during Ramadan, there is a dramatic change in dietary patterns in comparison to the other months of the year. Health issues can arise due to improper eating habits and reduced physical activity [11, 12].

Unhealthy nutrition habits that commonly develop during Ramadan include:

1. The consumption of unusually large meals at *Iftar* (frequently containing more than 1500 calories), which may result in severe postprandial hyperglycaemia and weight gain.
2. The consumption of significant amounts of highly processed carbohydrates and sugar at *Iftar*, or between *Iftar* and *Suhoor*, which may also cause severe hyperglycaemia.
3. Eating desserts loaded with sugar after *Iftar*, which can lead to a prolonged period of postprandial hyperglycaemia.
4. The consumption of large portions and frequently eating snacks between the two main meals, which can again contribute to extended periods of hyperglycaemia.
5. Eating at fast speeds, which frequently leads to over-eating (satiety signals usually take around 30 minutes to reach the brain from the start of eating).
6. Skipping meals at *Suhoor* or consuming meals for *Suhoor* too early, which may result in hypoglycaemia before *Iftar*, especially when fasting hours are longer than usual.
7. The consumption of large portions of high glycaemic index (GI) carbohydrates at *Suhoor*, which can lead to postprandial hyperglycaemia [3, 12].
8. Eating fried foods too frequently, which is incredibly unhealthy particularly when trans-fat margarine or oils rich in saturated fat are consumed (e.g., palm oil and coconut oil).
9. Changing physical activity and sleeping patterns, which can affect metabolism and contribute to weight gain [13].



5. WEIGHT MAINTENANCE AND WEIGHT REDUCTION DURING RAMADAN FASTING

Weight gain during Ramadan should be avoided. People with T2DM who are overweight or obese may find that Ramadan provides a good opportunity to lose weight. Weight loss may significantly improve glycaemic control and may reduce cardiovascular disease (CVD) risk [14-16]. An optimal target is a modest and gradual weight reduction of 0.5–1 kg per week. To achieve weight loss or avoid weight gain, the intake of calories should be controlled and kept within a specified target based on height and gender [14, 16] (see **Table 1**). It is also recommended to proportionally distribute carbohydrate and total caloric intake between *Suhoor* and *Iftar* [6, 16], (see **Table 2**). The caloric target algorithm guides the HCPs in choosing the appropriate number of calories for an individual person with diabetes. On the RNP website, an algorithm provides guidance for selecting appropriate caloric targets for individuals and the subsequent effects of achieving those targets – i.e. weight maintenance or weight reduction [1] (see **Figure 2**).

TABLE 1: CALORIC TARGETS FOR MEN AND WOMEN WHEN FASTING DURING RAMADAN




	Weight Maintenance	Weight Reduction
 Men	1800 - 2200 kcal/day	1800 kcal/day
 Women > 150 cm tall	1500 - 2000 kcal/day	1500 kcal/day
 Women < 150 cm tall	1500 kcal/day	1200 kcal/day

TABLE 2: CALORIE AND CARBOHYDRATE DISTRIBUTIONS FOR THE RAMADAN NUTRITION PLAN

	Percentage of calories	Carbohydrate distributions
Suhoor	30 – 40%	3 - 5 exchanges
Iftar Snack	10 – 20%	1 - 2 exchanges
Iftar Meal	40 – 50%	3 - 6 exchanges
Healthy Snack (if necessary)	10 – 20%	1 - 2 exchanges

1 Carbohydrate exchange = 15 g Carbohydrates





DAILY CALORIC INTAKE	1200 kcal/day	1500 kcal/day	1800 kcal/day	2000 kcal/day
EFFECT	Weight reduction for women < 150 cm tall	Weight maintenance for women < 150 cm tall & weight reduction for women > 150 cm tall	Weight maintenance for women > 150 cm tall & weight reduction for men	Weight maintenance for women > 150 cm tall and form men
				

FIGURE 2

RNP caloric guide for weight reduction and weight maintenance (RNP algorithm 1)**6. THE 10 PRINCIPLES OF THE RNP**

Based on the goal of achieving optimal MNT during Ramadan, the principles of the RNP [2] is based on the following:

1. The consumption of an adequate amount of daily calories. Calories should be divided between *Suhoor* and *Iftar* and 1-2 healthy snacks can also be consumed if necessary (see **Tables 1** and **2**).
2. Meals should be well balanced, with total carbohydrates comprising around 40–50% and preferably of a low GI source; the protein content (legumes, pulses, fish, poultry, or lean meat) should comprise 20–30%; and fat should comprise 30–35% (with mono and polyunsaturated fats preferred) (see **Table 3**). Saturated fat should be limited to < 10% of the total daily caloric intake.
3. The “Ramadan plate” method should be used for designing meals (see **Figure 3**).
4. Sugar-heavy desserts should be avoided after *Iftar* and between meals. A moderate amount of healthy dessert is permitted — for example a piece of fruit.
5. Carbohydrates that are low on the GI should be selected, particularly those high in fibre (preferably whole grains). The consumption of carbohydrates from vegetables (cooked and raw), whole fruits, yogurt, milk and dairy products are encouraged. The consumption of carbohydrates from sugar and highly processed grains (wheat flour and starches like corn, white rice, and potatoes) should be avoided or minimised.
6. Maintaining an adequate level of hydration by drinking enough water and non-sweetened beverages at, or between, the two main meals is essential and should be encouraged (diet beverages may be consumed). Sugary drinks, syrups, canned juices, or fresh juices with added sugar should be avoided. The consumption of caffeinated drinks (coffee, tea as well as cola drinks) should be minimised as they act as diuretics which can lead to dehydration.



7. Take *Suhoor* as late as possible, especially when fasting for longer than 10 hours.
8. Consume an adequate amount of protein and fat at *Suhoor* as foods with higher levels of these macronutrients and lower levels of carbohydrates usually have a lower GI value than carbohydrate-rich foods. Foods such as these do not have an immediate effect on postprandial blood glucose. Foods rich in protein and good quality fat can better induce satiety than foods rich in carbohydrates [17].
9. *Iftar* should begin with plenty of water to overcome dehydration from fasting, and 1-3 small dried or fresh dates to raise blood glucose levels.
10. If needed, a healthier snack such as one piece of fruit, a handful of nuts, or vegetables may be consumed between meals. Generally, each snack should be 100–200 calories, but this may be higher depending on an individual’s caloric requirements. Some individuals may have a snack (*Iftar* snack) to break their fast, followed by the Maghrib prayer, and then eat the *Iftar* meal later in the evening.

TABLE 3: MACRONUTRIENT MEAL COMPOSITION

A meal should be complete and balanced in macronutrients [2, 4, 7].

The “Ramadan Plate Method” is advised as a guide in designing meals (Figure 3)

CARBOHYDRATES	Amount	<ul style="list-style-type: none"> The total daily intake of carbohydrates should be at least 130 g/day and ideally about 40-45% of total caloric intake Intake should be adjusted to meet the cultural setting and food preferences of each individual
	Recommended	<ul style="list-style-type: none"> Carbohydrates with a low glycaemic index and glycaemic load should be selected. These include whole grains, legumes, pulses, temperate fruits, green salad, and most vegetables High fibre foods such as unprocessed food, vegetables, fruits, seeds, pulses, and legumes should be consumed. It is recommended to consume about 20-35g/day (or 14g /1000 kcal). Fibre helps to provide satiety during <i>Iftar</i> and to delay hunger after <i>Suhoor</i>
	Not recommended	<ul style="list-style-type: none"> The consumption of foods rich in sugar, refined carbohydrate or processed grains, and starchy foods should be limited; especially sugary beverages, traditional desserts, white rice, white bread, low fibre cereal and white potatoes
PROTEIN*	Amount	<ul style="list-style-type: none"> Protein intake should not be less than 1.2g/kg of adjusted body weight[^] and usually accounts for 20-30% of the total caloric intake. Protein is essential as it enhances satiety and the sensation of fullness. Protein helps to maintain lean body mass [17]
	Recommended	<ul style="list-style-type: none"> Fish, skinless poultry, milk and dairy products, nuts, seeds, and legumes (beans) are recommended
	Not recommended	<ul style="list-style-type: none"> Sources of protein with a high saturated fat content such as red meat (beef, lamb) and processed meats should be minimised as they increase the risk of CVD Although high-fat dairy products contain saturated fats, a study has shown, increasing dairy consumption to ≥ 3 servings/day compared with < 3, while maintaining energy intake, servings/day does not affect HbA1c levels, body weight, body composition, lipid profile, or blood pressure in patients with T2DM [18].

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TABLE 3: MACRONUTRIENT MEAL COMPOSITION

A meal should be complete and balanced in macronutrients [2, 4, 7].
The “Ramadan Plate Method” is advised as a guide in designing meals (Figure 3)

FAT	Amount	<ul style="list-style-type: none"> • Fat intake should be between 30–35% of the total calorie intake. The type of fat is more important than the total amount of fat in reducing the risk of CVD. • Limit saturated fat to < 7%. PUFA and MUFA should comprise the rest of the fat intake. • Limit dietary cholesterol to < 300 mg/day or < 200 mg /day if LDL cholesterol > 2.6 mmol/L
	Recommended	<ul style="list-style-type: none"> • Consume fat from PUFA and MUFA (e.g., olive oil, vegetable oil, or blending oil (PUFA and Palm oil)). Oily fish (e.g. such as tuna, sardines, salmon, and mackerel) as a source of omega 3-fatty acids are also recommended.
	Not recommended	<ul style="list-style-type: none"> • Minimise the intake of foods high in saturated fat, including red meat (beef and lamb), ghee and foods high in trans-fats (e.g., fast foods, cookies, some margarines).

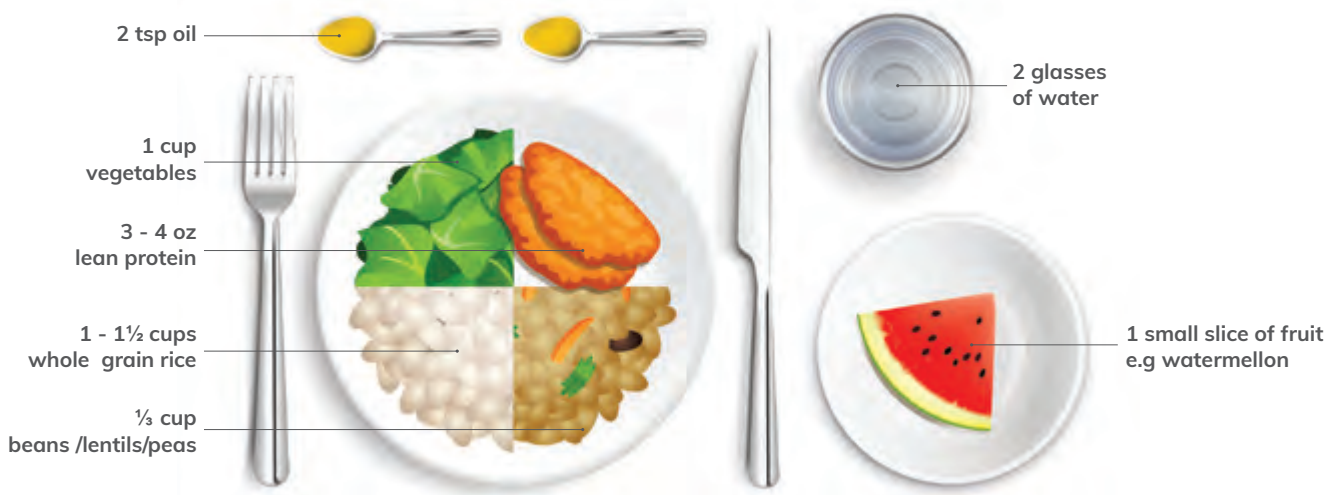
PUFA: Polyunsaturated fats; MUFA: Monounsaturated fats; CVD: cardiovascular disease

^Adjusted body weight = Ideal body weight (IBW) + 0.25 (Current weight – IBW)

*Individuals with renal issues should receive individualised advice as their protein requirements may be untypical

This meal provides ~ 500 kcal/meal (45% carbs (3-4 exchanges of carbohydrates), 20% protein and 35% fat

*Each person may have different plate depending on the daily calorie target



Transcultural Ramadan Nutrition App. (Toolkit) (Algorithm 2), provides meal plans for four caloric levels and are available online at <https://www.daralliance.org/daralliance/> to support nutrition needs for each patient with diabetes.

These meal plans are designed for each country to provide a transcultural experience

FIGURE 3
Ramadan Nutrition Plate* (examples of Suhoor or Iftar Meals)



7. THE RNP: A TRANSCULTURAL APPLICATION

In the RNP, an algorithm and a toolkit provide meal plans for the four caloric targets (1200, 1500, 1800, and 2000 kcal/day) according to the individual needs. Meal plans have been tailored for different countries, providing a transcultural user experience. Examples include countries like Egypt, Malaysia, Pakistan and China as shown at the **end of this chapter**. Other samples for other Muslim regions around the globe are also available online to support the nutrition needs of people with diabetes who are fasting during Ramadan [1].

The RNP is a work in progress, and HCPs of different nationalities are encouraged to contribute menus to the RNP at www.daralliance.org [1]. Healthy menus, based on the structure provided in this chapter, can be submitted online for review and, if accepted, will subsequently be posted on the RNP platform.

SUMMARY



- The RNP is a web-based application designed to help HCPs individualise and implement MNT for people with diabetes that fast during Ramadan. It also helps individuals that may not have access to HCPs to construct a healthy eating plan.
- The RNP helps people with diabetes plan a daily caloric target that may help them maintain their body weight if they are lean or to lose weight if they are overweight or obese.
- The RNP helps people with diabetes to minimise the risks associated with Ramadan fasting, such as hypoglycaemia, hyperglycaemia, and dehydration.
- The RNP provides examples of meal plans within the target caloric levels based on individual needs and tailored for use in different countries.
- The RNP website is designed to capture menus from across the globe that match the framework and structure provided in this chapter.

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FIGURE 4
Examples of Ramadan Meal plans from different countries*



RAMADAN NUTRITION CARE PLAN ALGORITHM 2			TOOL KIT SAMPLE RAMADAN NUTRITION PLAN FOR ASIA & MIDDLE-EAST	
Target Daily Calories	Nutrients Composition and Lifestyle Recommendations	Calories and Carbohydrate Distributions	 1500 kcal/day Pakistan	 1800 kcal/day Egypt
1200 kcal/day Weight reduction for woman < 150 cm height	Carbohydrates 40 - 50% • Recommend low GI, GL, whole grains and high fibre Protein 20 - 30% • Recommend lean meat, legumes, pulses and vegetable protein Fat < 35% • Recommend SFA < 7% and choose less fat cooking methods (grilled, baked and steamed) Lifestyle Recommendations • Begin Iftar with plenty of water to overcome dehydration from fasting • Keep physically active • Do not sleep for longer than usual	Suhoor 30-40% (3-5.5 CHO exchanges)	450-600 kcal/meal • Omelette, 2 egg • Roti (wholemeal), 1 small • Milk/Lassi, 1 glass • Salad (tomatoes/onions), 1 small bowl • Water, 2 glasses (500kcal; CHO exchange =3)	540-720 kcal/meal • Beans (foul), Ful: 1.5 cups • Yoghurt; 1 tub, • Cheese, 2 Oz/ 2 slices • Small olives, 5 and Salads (cucumber/ tomatoes) with 1 egg • Whole grain bread, 2 thin slices • Water/ Unsweetened drink (670kcal; CHO exchange =5)
1500 kcal/day Weight maintenance for women < 150 cm tall and weight reduction for women > 150 cm tall		Iftar Snack 10-20% (1-2 CHO exchanges)	150-240 kcal/meal • Fruit, 1 piece @ dates, 1-3 small pieces • Water/unsweetened drinks, 2 glasses (60kcal; CHO exchange =1)	150-300 kcal/meal • Fruit, 1 piece @ dates, 1-3 small pieces • Water/unsweetened drinks, 2 glasses (60kcal; CHO exchange =1)
1800 kcal/day Weight maintenance for women > 150 cm tall and weight reduction for men		Iftar Meal 40 – 50% (3-5.5 CHO exchange)	500-750 kcal/meal • Chicken roast, 1 palm size • Daal/lentil curry, 1 cup • Vegetable curry, 1 cup • Cooked rice (brown rice), ¾ cup • Dhali ballah (plain yoghurt with bhundi and vegetables), 1 small bowl • Side salads • Water/unsweetened drinks, 2 glasses (663 kcal CHO exchange =4.5)	620-900 kcal/meal • Salad (Tomatoes, cucumber, greens peas with lemon/vinegar dressing) 1 medium bowl • Soup (grilled/broiled chicken/lentil/meat), 4 oz • Cooked vegetables, 1 cup • Cooked rice (brown rice), 1 cup • Dessert: 1 small piece • Water/unsweetened drinks, 2 glasses (825 kcal CHO exchange =5)
2000 kcal/day Weight maintenance for women > 150 cm tall and for men		Healthy Snack 10-20% (1-2 CHO exchange)	150-300 kcal/meal • Fruit, 1 piece • Dessert - 1 small (milk-based such as kheer, rasmalai made with sweetener) • Water/unsweetened drinks, 2 glasses (285kcal CHO exchange =2)	180-300 kcal/meal • Walnuts 1 handful, cheese • 1 glass milk • Water/unsweetened drinks, 2 glasses (340 kcal, CHO exchange = 2)

*For a complete Ramadan Meal Plan and Ramadan Plates for other Muslim regions from around the globe Visit website for further details www.daralliance.org

CHO, carbohydrate; GI, glycaemic index; GL, glycaemic load; SFA, saturated fatty acids; tbs, tablespoon
1 CHO exchange = 15 g CHO

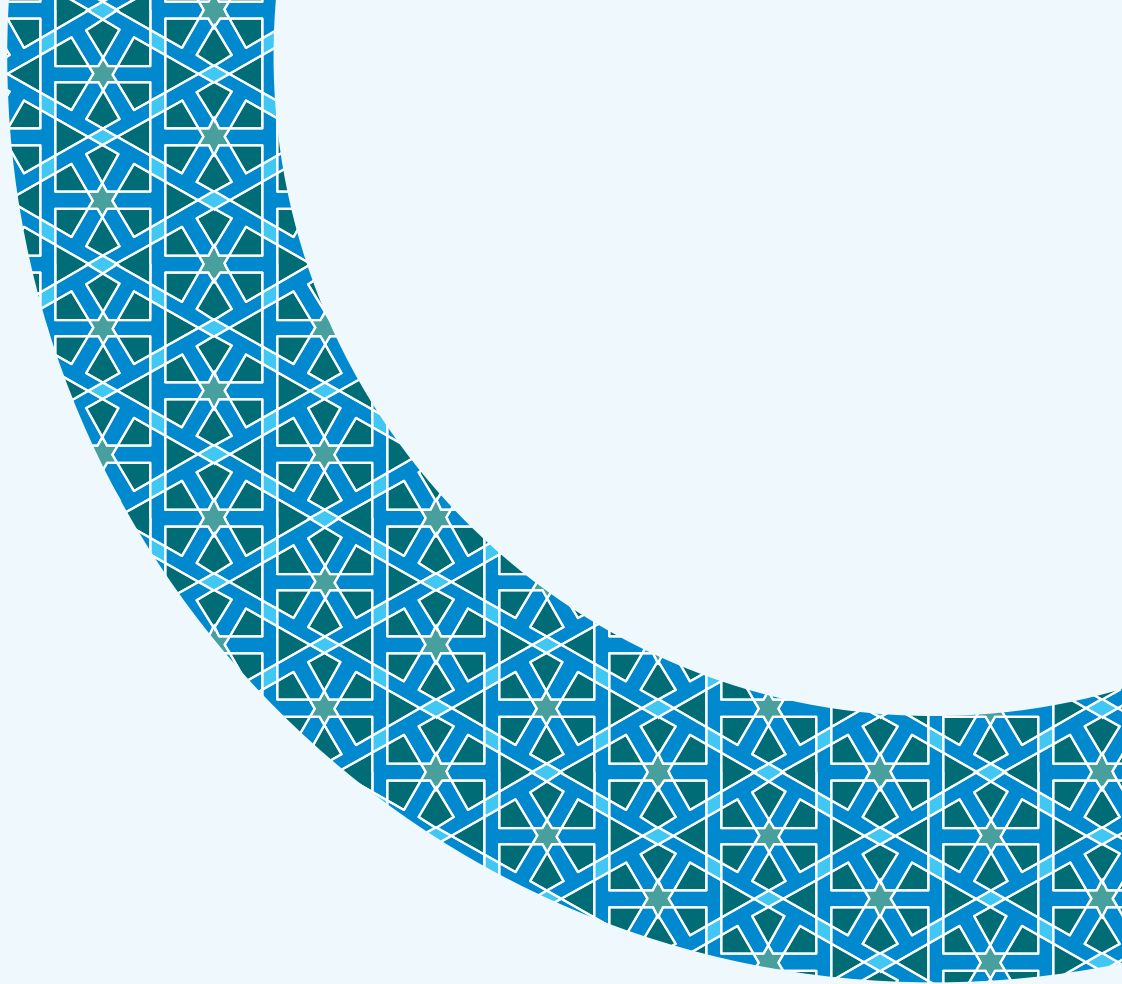
FIGURE 4

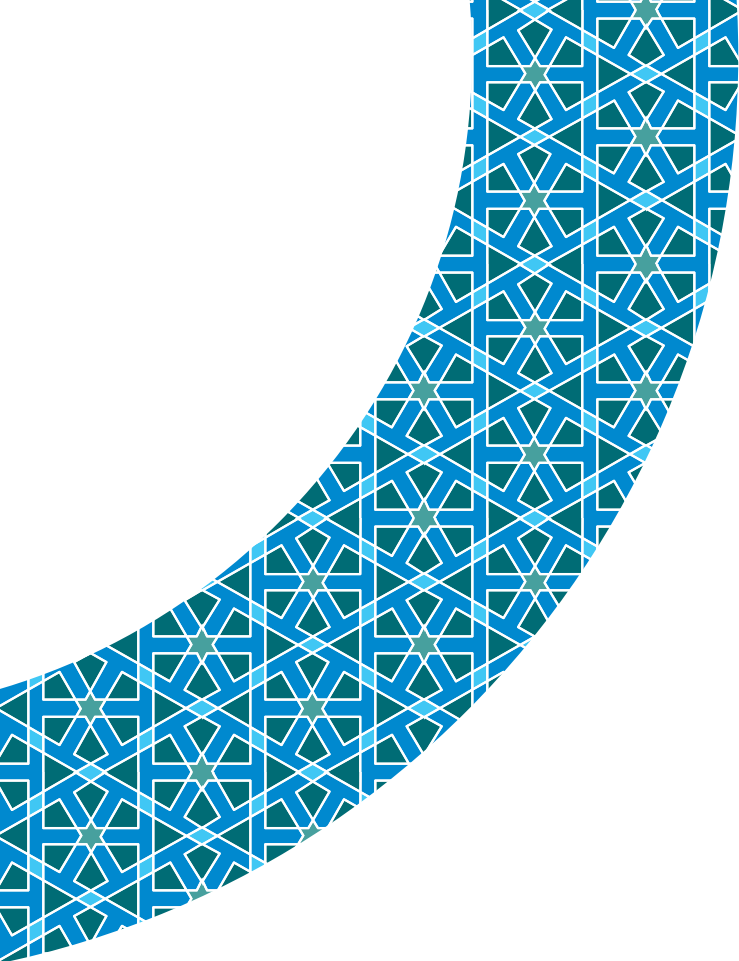
Examples of Ramadan Meal plans from different countries*

RAMADAN NUTRITION CARE PLAN ALGORITHM 2			TOOL KIT SAMPLE RAMADAN NUTRITION PLAN FOR ASIA & MIDDLE-EAST	
Target Daily Calories	Nutrients Composition and Lifestyle Recommendations	Calories and Carbohydrate Distributions	 1200 kcal/day Malaysia	 2000 kcal/day China
1200 kcal/day Weight reduction for woman < 150 cm height	Carbohydrates 40 - 50% <ul style="list-style-type: none"> Recommend low GI, GL, whole grains and high fibre Protein 20 - 30% <ul style="list-style-type: none"> Recommend lean meat, legumes, pulses and vegetable protein Fat < 35% <ul style="list-style-type: none"> Recommend SFA < 7% and choose less fat cooking methods (grilled, baked and steamed) Lifestyle Recommendations <ul style="list-style-type: none"> Begin Iftar with plenty of water to overcome dehydration from fasting Keep physically active Do not sleep for longer than usual 	Suhoor 30-40% (3-5.5 CHO exchanges)	300-480 kcal/meal <ul style="list-style-type: none"> Oats Porridge and chicken with vegetables (carrots/ broccoli), 1 cup Diabetes-specific formula (DSF) 7 scoops / milk 1 glass Water/unsweetened drink (434kcal; CHO exchange =3) 	600-800 kcal/meal <ul style="list-style-type: none"> Noodles, 1 ½ cup Beef (lean), 2 pieces Spring onion Boiled egg, 1 whole Soybean milk (unsweetened), 1 cup (678kcal; CHO exchange =5)
1500 kcal/day Weight maintenance for women < 150 cm tall and weight reduction for women > 150 cm tall		Iftar Snack 10-20% (1-2 CHO exchanges)	120-240 kcal/meal <ul style="list-style-type: none"> Steamed spring rolls with prawn, carrot and yam bean, 1 piece OR Savoury pancake Dates, 1 small piece Water/unsweetened drinks (168kcal; CHO exchange =2) 	180-360 kcal/meal <ul style="list-style-type: none"> Fruit, 1 piece @ dates, 1-3 small pieces Water/unsweetened drinks, 2 glasses (60kcal; CHO exchange =1)
1800 kcal/day Weight maintenance for women > 150 cm tall and weight reduction for men		Iftar Meal 40 – 50% (3-5.5 CHO exchange)	480-600 kcal/meal <ul style="list-style-type: none"> Grilled fish with tamarind sauce, 4 oz Tempeh with sambal, ½ block Spinach and mushroom (cooked in soup), 1 cup Cooked rice (brown rice), 1 cup Mango, ½ piece Water/unsweetened drinks (444 kcal CHO exchange =3) 	800-1000 kcal/meal <ul style="list-style-type: none"> Salad (Tomatoes, cucumber, greens peas with lemon/vinegar dressing) 1 medium bowl Soup (grilled/broiled chicken/lentil/meat), 4 oz Cooked vegetables, 1 cup Cooked rice (brown rice), 1½ cups Dessert: 1 small piece Water/unsweetened drinks, 2 glasses (905 kcal CHO exchange =5.5)
2000 kcal/day Weight maintenance for women > 150 cm tall and for men		Healthy Snack 10-20% (1-2 CHO exchange)	120-240 kcal/meal <ul style="list-style-type: none"> Diabetes-specific formula, 4 scoop blends with 1 date, 1 glass Water/unsweetened drinks (141kcal CHO exchange =2) 	200-400 kcal/meal <ul style="list-style-type: none"> Walnuts 1 handful, cheese 1 glass milk Water/unsweetened drinks, 2 glasses (340 kcal, CHO exchange = 2)

*For a complete Ramadan Meal Plan and Ramadan Plates for other Muslim regions from around the globe Visit website for further details www.daralliance.org

CHO, carbohydrate; GI, glycaemic index; GL, glycaemic load; SFA, saturated fatty acids; tbsp, tablespoon
1 CHO exchange = 15 g CHO





CHAPTER 9

Management of Type 1 diabetes when fasting during Ramadan

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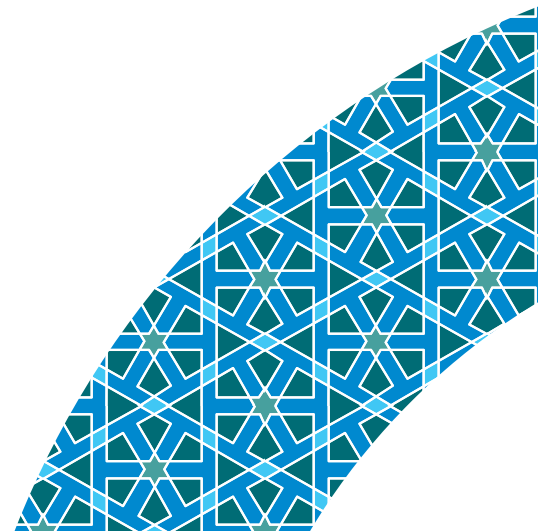
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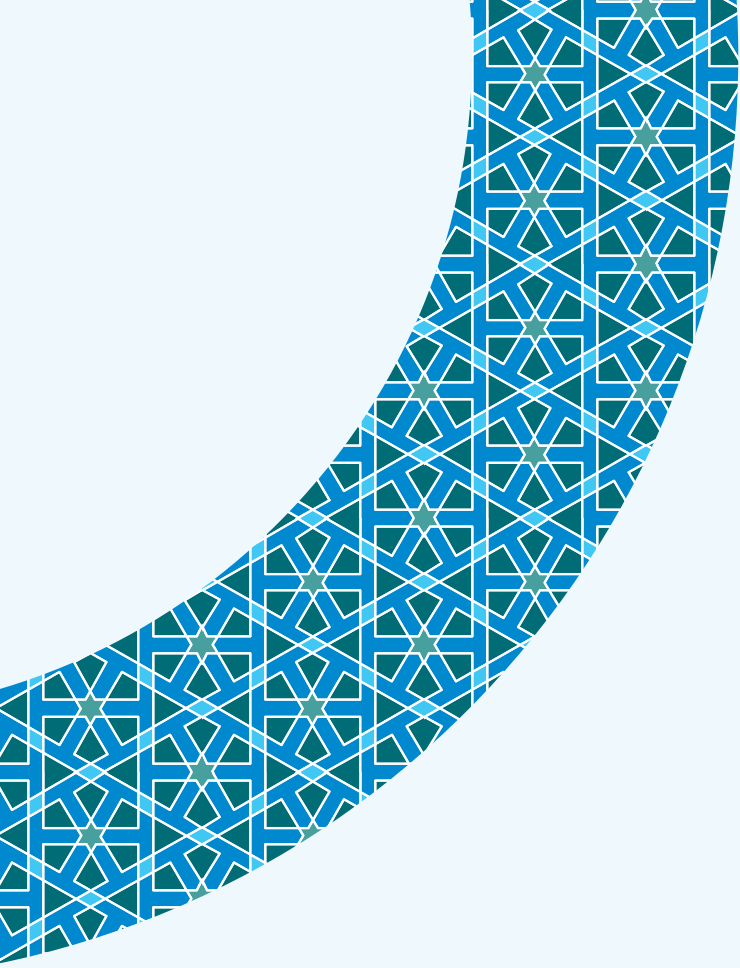
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CHAPTER 9

INDEX

1. INTRODUCTION	163
1.1 Safety, Risks, and complications of fasting	163
1.1.1 Adolescents and Young Individuals	163
1.1.2 Adults	167
1.1.3 Complications that can arise during fasting	171
1.2 Risk stratification of people living with T1DM during Ramadan	172
1.3 Criteria for Fasting during Ramadan in people with T1DM	173
1.4 Blood glucose monitoring for people with T1DM during Ramadan	174
1.5 Physical activity for people with T1DM during Ramadan	175
1.6 Nutritional care and meal planning for people with T1DM during Ramadan ...	176
1.7 Management of adolescent individuals with T1DM during Ramadan	177
1.7.1 Insulin regimens	177
1.7.2 Basal-bolus regimen (MDI)	178
1.7.3 Conventional insulin treatment	182
1.7.4 Continuous subcutaneous insulin infusion pump (CSII)	183
1.7.5 Sensor-augmented pumps: Low-glucose suspend (LGS) and Predictive low-glucose insulin-suspend (PLGS) pumps	185
1.8 Management of adults with T1DM during Ramadan	190
1.8.1 Basal-bolus regimen (MDI)	190
1.8.2 Premixed insulins	190
1.8.3 Continuous subcutaneous insulin infusion pump (CSII)	190
1.9 When to break the fast during Ramadan – all people with T1DM	191
SUMMARY	192
REFERENCES	193



WHAT IS KNOWN?

- Fasting in adolescents and adults with T1DM carries a high risk.
- Insulin analogues are better than conventional Natural Protamine Hagedorn insulin (NPH) or regular twice daily regimens.
- Insulin pumps are beneficial when fasting.
- Education is still not available to many people with T1DM – both adolescents and adults.

WHAT IS NEW?

- Risks associated with fasting is not the same for all people with T1DM — adolescents and adults.
- New studies have shown that some people with T1DM may have a lower risk and can safely fast during the month of Ramadan if certain needs are met.
- New research on the impact of daily life on glycaemic control shows that fasting attitudes and outcomes vary considerably among different countries.
- Evidence suggest that Continuous Glucose Monitoring (CGM) can aid safe fasting and sensor augmented pumps have allowed individuals to fast for most if not the whole month.

WHAT IS MISSING?

- Adequately powered randomised clinical trials comparing different treatment regimens and algorithms for dose adjustments for adolescents and adults with T1DM who seek to fast during Ramadan.
- Research on the impact of daily life on glycaemic control — this can vary considerably among different countries. Likewise, further research on fasting plans is needed with consideration of the type, duration, and intensity of physical exercise; demands of schooling; dietary habits; the season in which Ramadan falls; and the duration of fasting.
- A validated risk score stratification method for adolescents and adults to help conduct safe fasting.
- Research into quality of life, focusing on the psychological effects of facing peer pressure in those who choose not to fast and on the effects of acute complications during fasting.

1. INTRODUCTION

Fasting during Ramadan is an integral part of Islam and though there are exemptions made for people that suffer illness, it remains a personal choice. People living with diabetes generally have to take extra precautionary measures during Ramadan, particularly in the case of Type 1 diabetes mellitus (T1DM).

Fasting for extended periods of time can increase the risk of people with T1DM experiencing the effects of poor glycaemic control including hypoglycaemia, hyperglycaemia, diabetic ketoacidosis (DKA) and dehydration, among other challenges. However, it is also important to recognise that these additional risks are not evenly distributed, and different approaches for the management of T1DM during Ramadan may need to be taken among adolescent and young individuals and adults.

Much of the literature on fasting during Ramadan in people with T1DM has been based on adolescent and young individuals and, therefore, the guidance and recommendations have predominantly been targeted towards these age groups. Though, recently a few studies have been carried out on older populations and advice for adult individuals with T1DM who are seeking to fast during Ramadan can now be offered.

For the purposes of this chapter, we will have adolescents and young individuals together as one group and adults as a separate group. The terms adolescents and young individuals will be used interchangeably. The guidance offered to adults in this chapter do not necessarily apply to the elderly and specific guidance for the elderly will be offered in **chapter 12: Management of diabetes among the elderly when fasting during Ramadan**.

1.1 Safety, Risks, and complications of fasting

1.1.1 Adolescents and Young Individuals

According to Islam, fasting during the month of Ramadan becomes obligatory for children from the age of puberty, however, much like in adults, those with medical conditions that can be compromised by fasting are exempt from this obligation. Medical societies and experts have generally discouraged individuals with T1DM, in particular adolescents, from fasting [1] and T1DM continues to be listed as a high-risk factor for fasting [1, 2]. In spite of this, many adolescents, and even pre-pubertal children, with T1DM insist on fasting, against the advice of their healthcare providers [3, 4]. The recommendation to fast varies among different countries, reflecting different cultural perspectives and views held by treating physicians. Fasting intentions can also differ among specific age groups, as shown in a recent survey of the Middle East and North Africa region, with adolescents reporting a higher intention to fast than adults - 75.4% vs 69.6% ($p=0.034$) [5].

Over the past decade, several studies have evaluated fasting among adolescents with T1DM and its associated safety during the month of Ramadan. It has been shown that the majority of individuals can fast for longer than 15 days, and over 60% fasting for the whole month [6, 7]. Kaplan *et al.* compared continuous glucose monitoring (CGM) data during Ramadan fasting and in the month before and after Ramadan, and found no differences in the mean interstitial



glucose (IG), or in glucose fluctuation [8]. Additionally, El-Hawary *et al.* reported a statistically significant drop in fructosamine after the end of Ramadan in a cohort of 28 adolescents of who managed to fast the whole month of Ramadan [9]. On the other hand, studies have reported wide fluctuations in IG, and extended periods of unrecognised hypoglycaemia from CGM data [7]. This has raised some concerns about the implementation of safety instructions or the breaking of a fast at the onset of the hypoglycaemia when reliant solely on glucose readings from self-testing. These findings indicate the need for close monitoring and an increased education on appropriate decision-making.

Some studies have evaluated the use of specific insulin regimens to minimise the risk of hypoglycaemia during fasting; for example the use of rapid insulin analogues compared to regular human insulin [10]. Others have investigated the actual treatment regimens; for example, the use of continuous subcutaneous insulin infusion (CSII) compared to the conventional or multiple daily injection regimens [11-13]. Additionally, the use of advanced technological features has resulted in a significant reduction in the exposure to hypoglycaemia and enhanced the ability of individuals with T1DM to fast for the whole month of Ramadan, specifically the low-glucose suspend (LGS) feature of insulin pumps has proven to be particularly useful [14] (please see **Table 1**). A recent global study was able to show that the timing of hypoglycaemia during Ramadan was important. Almost 80% of participants reported that they experienced hypoglycaemia during the first week of Ramadan, higher than other weeks of Ramadan. The same was seen for hyperglycaemia. On the other hand, it was also found that 1 in 10 adolescents did not change their behaviours after discovering hypoglycaemia [5]. This highlights the important of pre-Ramadan education in helping to avoid these events altogether and in understanding appropriate responses when these events are discovered (see **chapter 7: Pre-Ramadan Assessment and Education**). Nevertheless, further research is still needed on patient reported outcomes such as a measure of quality of life to help understand the experiences of individuals with T1DM more closely.

The above factors, when available, may reduce risk of hypoglycaemia but they do not eliminate it and individuals still require close supervision and monitoring. The risks of hypoglycaemia in people living with T1DM that have reduced access to advanced medical care and medical supervision remain significantly high and fasting cannot be encouraged.

TABLE 1: A COMPARISON OF STUDIES EVALUATING THE SAFETY OF FASTING DURING RAMADAN IN CHILDREN AND ADOLESCENTS WITH T1DM

Insulin Regimen	Author(date)	Sample size and study details	Findings related to Hypoglycaemia	Findings related to Hyperglycaemia	Findings related to Glycaemic control	Key Findings
1. Insulin pump 2. MDI (glargine plus short-acting insulin)	Kaplan & Afandi (2015) [7]	N=21 Observational study Mean age was 15 ± 4 years Two groups based on regimen (18 on Insulin pump; 3 on MDI) Country: United Arab Emirates	Hypoglycaemia observed in 14.2% of the fasting hours and 2.5% of the eating hours p<0.05 No severe cases of hypoglycaemia were reported	Hyperglycaemia (>300 mg/dL or 16.7 mmol/L) was observed in 12% of the fasting hours and 17% of the eating hours p<0.05	Large fluctuations in blood glucose Consequently Symptomatic hypoglycaemia resulted in breaking the fast in 15% of the days	Though 76% of patients fasted ≥25 days, there were periods of wide blood glucose fluctuation during fasting and eating hours., with periods of unrecognised hypoglycaemia
1. MDI 2. Insulin pump (All used CGM)	Kaplan et al. (2017) [8]	N=40 Observational study Mean age 15 ± 4 years Country: United Arab Emirates	There were no notable differences in the duration of hypoglycaemia during Ramadan compared to times outside of Ramadan	There were no notable differences in the duration of hyperglycaemia during Ramadan compared to times outside of Ramadan	There was a subgroup effect found in subjects with a HbA1c ≤ 8% (64 mmol/mol) where the duration of hypoglycaemia during Ramadan was lower than times outside of Ramadan - 6.2% and 9.6% or 44 – 81.4 mmol/mol respectively; p<0.001	Adolescents with T1DM have the same scope of BG fluctuations during Ramadan than outside of Ramadan. Subgroup effects in this study support the emphasis placed on pre-Ramadan glycaemic control However, these associations may be spurious and need confirming

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TABLE 1: A COMPARISON OF STUDIES EVALUATING THE SAFETY OF FASTING DURING RAMADAN IN CHILDREN AND ADOLESCENTS WITH T1DM

Insulin Regimen	Author(date)	Sample size and study details	Findings related to Hypoglycaemia	Findings related to Hyperglycaemia	Findings related to Glycaemic control	Key Findings
1. MDI 2. insulin pump (All used CGM while fasting for a minimum of 3 days)	Afandi et al. (2017) [15]	N=21 Observational study Mean age 16 ±3 years Patients were categorised as well-controlled and poorly controlled if the pre-fasting HbA1C was ≤8% and >8%, respectively (well-controlled N=7; poorly controlled N=14) Country: United Arab Emirates	Hypoglycaemia was statistically significantly higher in the poorly controlled group than in the well-controlled group	Hyperglycaemia was statistically significantly higher in the poorly controlled group than in the well-controlled group	NA	The episodes of hypoglycaemia and hyperglycaemia were higher in the poorly controlled group than in the well-controlled group. Likewise, the overall durations of hypoglycaemia, hyperglycaemia and severe hyperglycaemia were longer in the poorly controlled group than those in the well-controlled group Good glycaemic control before Ramadan can reduce the potential risks of complications during Ramadan
1. MDI 2. Insulin pump	Kholoud Mohamed et al., (2019) [16]	N=50 children and adolescents with T1D Retrospective cohort study Mean age 12.7 ± 2.1 years Two groups based on regimen (27 MDI; 23 Insulin pump) Country: Kuwait	There were no statistically significant differences observed between the two insulin regimen groups in the frequency of hypoglycaemia Together, patients with HbA1c ≤ 8.5% had less-frequent hypoglycaemic attacks than those over 8.5% (p=0.01)	There were no statistically significant differences observed between the two insulin regimen groups in the frequency of hyperglycaemia	Patients with HbA1c ≤ 8.5% were able to fast more days during Ramadan than those over 8.5%	Fasting for children with T1DM is safe and feasible There was an indication supporting the need for good glycaemic control prior to Ramadan for favourable diabetes outcomes during Ramadan

1.1.2 Adults

As mentioned, fasting during Ramadan becomes obligatory from the age of puberty but those individuals that are unhealthy can be exempted. In circumstances where any missed days cannot be compensated for after Ramadan, *Fidya* can be paid. The general consensus has been that people living with T1DM are at risk of complications when fasting and can be exempted from undertaking it during Ramadan (see **chapter 5: Risk stratification of people with diabetes before Ramadan**). Though the risks of complications and the intentions to fast [5] are not exactly the same in adults when compared to adolescents the complications of T1DM that may arise are.

The body of research that has been conducted on safe fasting during Ramadan in adults is relatively small, but in recent times there have been a few studies that have studied older individuals. These studies can be relevant and help provide specific guidance for adults (see **Table 2**).

Al Awadi *et al.*, in an observational study conducted in the United Arab Emirates, was able to show that there were no statistically significant differences in the frequency of hypoglycaemia prior to and during Ramadan. Though data were not reported on hyperglycaemia, it was shown using laboratory tests that fasting could improve glycaemic control [17].

Further, Al-Ozairi *et al.*, showed, in a study investigating the use of MDI and insulin pump regimens, that participants were able to reduce rates of hypoglycaemia during Ramadan when compared to before Ramadan ($p=0.001$) without any reported severe hypoglycaemic events. They also found that glucose variability improved in insulin pump users. Much like in the studies conducted on adolescents with T1DM, an important emphasis was placed on education prior to Ramadan wherein all participants in this study had previously attended the Dose Adjustment for Normal Eating course in Kuwait [18]. (For further information on Pre-Ramadan Education, please see **chapter 7: Pre-Ramadan Assessment and Education**) Amoudi *et al.*, in a larger prospective study of 156 participants, again demonstrated improvements upon glycaemic variability in those that used insulin pumps compared to MDI. There were no significant differences in hypoglycaemia between both groups and no reported DKA events in the study [13].

Likewise, Al fadhil was able to observe similar results when investigating people that were on a basal bolus regimen and found that CGMS were important to successful and confident fasting during Ramadan [19]. These findings were wholly supported by Al Awadi *et al.*, who in another study, investigated individuals on several different insulin regimens [17].

On the other hand, Malek *et al.*, looked into people with T1DM in Algeria in a multicentre study; they showed that people that they classified as high or very high risk were most likely to experience hypoglycaemia and break their fast. Of concern was the finding that SMBG was reduced while fasting during Ramadan [20]. This highlights the need to provide support and help increase motivation among people that are high or very high risk that fast during Ramadan. As noted in **section 9.1.1**, a global survey study reported that a majority of participants experienced hypoglycaemia, where most of these occurrences took place in the first week of Ramadan [5].



TABLE 2: A COMPARISON OF STUDIES EVALUATING FASTING DURING RAMADAN IN ADULTS WITH T1DM

Insulin Regimen	Author(date)	Sample size and study details	Findings related to Hypoglycaemia	Findings related to Hyperglycaemia	Findings related to Glycaemic control	Key Findings
1. Basal bolus 2. Insulin pump	Al-awadi et al. (2020) [21]	N=24 Prospective observational study Mean age 23.3 ± 7.85 years Country: United Arab Emirates	There were no statistically significant differences in the number of hypoglycaemic events before and during Ramadan	Data not reported	The average laboratory HbA1c prior to Ramadan was 8.2% (66 mmol/mol) and it reduced to 7.9% (63 mmol/mol) post Ramadan p=0.01 Conversely, the average sensor estimated HbA1c was 7.9% (63 mmol/mol) prior to Ramadan and increased to 8.5% (69.4 mmol/mol) in Ramadan	Fasting may be safe in selective patients There were conflicting results on glycaemic control before and during Ramadan Larger randomised trials are needed to establish any recommendations
1. CSII 2. MDI and FGM	Al-Ozairi et al. (2020) [18]	N=43 Prospective observational study Mean age 31.7 years Two groups based on regimen (21 CSII; 22 MDI) Dose Adjustment for Normal Eating (DAFNE) course attendants Country: Kuwait	In total, the rate of hypoglycaemia was reduced during Ramadan when compared to before Ramadan (0.53 and 0.81 respectively; p=0.001) There were no severe hypoglycaemic events	No statistically significant differences to report	A measure called the coefficient of variation (CV) was calculated to measure glucose variability The CV was seen to reduce during Ramadan when compared to before Ramadan in the CSII group – this reduction was maintained after Ramadan	This study demonstrated the importance of education prior to Ramadan Providing a good level of education patients with T1DM on CSII or MDI can safely fast during Ramadan

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TABLE 2: A COMPARISON OF STUDIES EVALUATING FASTING DURING RAMADAN IN ADULTS WITH T1DM

Insulin Regimen	Author(date)	Sample size and study details	Findings related to Hypoglycaemia	Findings related to Hyperglycaemia	Findings related to Glycaemic control	Key Findings
Multiple regimens	Malek et al. (2019) [20]	N=65 (T1DM) Prospective multicentre observational study Mean age 45.8 ± 17.69 Country: Algeria	In this study there were relatively few cases of hypoglycaemia (12 cases) Patients that were categorised as high-very high risk were the most likely to experience hypoglycaemia	Hyperglycaemia was observed in 10 cases and was an important reason for stopping fasting	There were no real differences observed in HbA1c before and after Ramadan However, mean glycaemia (mg/dL) was lower after Ramadan when compared to before Ramadan; p=0.005	31% of patients stopped fasting due to reasons including complications due to T1DM SMBG was reduced when fasting It was deemed that there needs to a much greater emphasis on education
1. All patients except one were on basal bolus insulin (1 patient used an insulin pump) All used CGMS	Al fadhli (2018) [19]	N=24 Observational study Mean age 22 ± 6 Country: Kingdom of Saudi Arabia	Hypoglycaemia rates were lower during fasting and there were no reports of severe episodes The average time spent in hypoglycaemia was 0.60 ± 1.5 hours 4 patients broke their fast due to mild hypoglycaemia	The average time spent in hyperglycaemia, post-Suhoor, was 3.63 ± 4.3 hours Hyperglycaemia rates were higher than that of hypoglycaemia Approximately half of the time, patients were experiencing hyperglycaemia (≥ 180 mg/dL or 10 mmol/L) and 13% of the time experiencing severe hyperglycaemia (≥ 300 mg/dL or 16.7 mmol/L)	Sensor glucose levels were lower during fasting than when during the eating hours; 188.4 mg/dL (10.5 mmol/L) and 212.5 mg/dL (11.8 mmol/L) respectively p<0.001	Patients with T1DM that fasted during Ramadan experienced wide fluctuations in glucose levels There was a greater tendency towards hyperglycaemia CGMS was successfully used and can increase confidence in fasting during Ramadan

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TABLE 2: A COMPARISON OF STUDIES EVALUATING FASTING DURING RAMADAN IN ADULTS WITH T1DM

Insulin Regimen	Author(date)	Sample size and study details	Findings related to Hypoglycaemia	Findings related to Hyperglycaemia	Findings related to Glycaemic control	Key Findings
Multiple regimens: (rapid acting; intermediate-acting; basal bolus; premix; Insulin pump)	Al Awadi et al. (2020) [17]	N=136 Prospective observational study Mean age 32 years Countries: Middle East and North Africa	Incidence of hypoglycaemia did not change from before Ramadan to during Ramadan This was also the case for severe hypoglycaemia	Incidence of hyperglycaemia did not change from before Ramadan to during Ramadan This was also the case for severe hyperglycaemia	The mean HbA1c levels reduced during Ramadan when compared to before Ramadan (-0.6%; p<0.001) Likewise, Fasting plasma glucose decreased by 21.2 mg/dL or 1.2 mmol/L p<0.001 and post-prandial plasma glucose decreased by 22.8 mg/dL or 1.3 mmol/L p<0.001	Nearly half of patients in this study fasted for the whole duration of Ramadan During Ramadan mean glycaemic control improved with no increases in severe hypoglycaemic events These may be due to pre-Ramadan education and careful dose adjustments (80% had dose reductions)
1. MDI 2. Insulin pump	Al Amoudi et al. (2017) [13]	N=156 Prospective cohort study Mean Age (23.4±6.1 years) Two groups based on regimen (95 MDI; 61 Insulin pump) Country: Kingdom of Saudi Arabia	No statistically significant difference was observed in the rate of mild or severe hypoglycaemia between groups	The mean rate of hyperglycaemia was higher in the insulin pump group compared to the MDI group; p=0.03	No differences in glycaemic control were observed between both groups; measured using fructosamine and A1c levels	More patients on the insulin pump than in patients on the MDI regimen managed to fast the whole month of Ramadan without the need to break their fast 31.2% and 22.1% respectively; p=0.41 The use of an insulin pump regimen was associated with less glucose variability; p=0.02

Taken together, these findings suggest a similar outlook in adults to adolescent and young people when fasting during Ramadan. However, a stronger effort needs to be made to investigate adults with T1DM, this can be through actively studying adults in prospective studies or randomised controlled trials or generally including more adults into the cohort of participants when conducting studies. This will allow for a greater depth of understanding and for systematic reviews and meta analyses to highlight specific differences or similarities between adults and adolescent and young individuals with T1DM.

Various studies have demonstrated that both adolescents and adults can achieve safe fasting during Ramadan with no worse outcomes than prior to Ramadan.

1.1.3 Complications that can arise during fasting

Though there are differences that need to be acknowledged between adolescents and adults, the complications of T1DM that can arise during fasting are by and large the same [5]. Fasting during Ramadan for people with T1DM can be dangerous if not conducted properly and the complications of doing so must be considered.

The period of fasting, that can reach over 20 hours in some countries, imposes a high risk of dehydration to all people living with T1DM. Conceivably, this risk would be even higher in children and adolescents, due to their higher surface area to volume ratio [22] and their relatively greater rate of physical activity. To the best of our knowledge, no study has been conducted to assess the associated risk of dehydration during fasting in adolescents with T1DM, nonetheless, all precautions should be taken to minimise the risk of this complication.

Furthermore, based on a large population-based retrospective survey conducted across 13 countries, adult individuals with T1DM reported a higher incidence of severe hypoglycaemia and diabetic ketoacidosis (DKA) during Ramadan compared to other months of the year [2, 4]. However, several subsequent studies conducted in countries with advanced medical care have shown no difference in severe hypoglycaemia or DKA between Ramadan and non-Ramadan days in adolescent with T1DM [6, 7, 23-25]. Kaplan *et al.*, in a study of CGM data, reported no difference in the duration of hypoglycaemia during Ramadan and the month before or after Ramadan among adolescents with T1DM [8]. Similar findings were recently reported by Lessan *et al.* [26]. This was explored in further detail by Afandi *et al.*, where they reported an average daily duration of hypoglycaemia whilst fasting during Ramadan of 1.39 hours per individual, with almost 70% of hypoglycaemic episodes occurring in the final 6 hours of fasting [27]. Another study, highlighted the importance of glycaemic control prior to Ramadan, showed that hypoglycaemia, hyperglycaemia, and severe hyperglycaemia were significantly higher in individuals with poor glycaemic control [15]. In a recent global survey of individuals with T1DM that were intending to fast, it was shown that the majority of adolescents and adults that fasted experienced day-time hypoglycaemia, highlighting its importance as a complication in



certain individuals. Although fewer individuals reported hyperglycaemia (approximately 45% of adolescents and adults), it also was an important complication [5]. **Table 3** summarises the some of the key parameters in those with T1DM who fasted during Ramadan [5].

TABLE 3: KEY PARAMETERS OF THOSE WITH T1DM WHO FASTED RAMADAN (N=1054, 71% OF SURVEY POPULATION) highlights from the DaR global survey [5]			
Duration of Fast	26.8% fasted for full 30 days	45% fasted 22-29 days due to diabetes related illness	28.2% fasted 21 days or less due to diabetes related illness
Hypoglycaemia	39.3% reported no symptoms of hypoglycaemia	48% reported symptoms of hypoglycaemia over 1-7 days	12.8% reported symptoms of hypoglycaemia over 8-30 days
Hyperglycaemia	55.2% reported no episodes of hyperglycaemia (BG>300 mg/dl)	28% had hyperglycaemia over 1-7 days	16.8% had hyperglycaemia over 8-30 days
Severe events leading to hospital admission	93.2% did not require Emergency Room or hospital admission for hypoglycaemia/hyperglycaemia		6.8% required Emergency Room or hospital admission for hypoglycaemia/hyperglycaemia

Overall, it is important to carefully select those with T1DM who are prone to developing complications and advise them not to fast.

1.2 Risk stratification of people living with T1DM during Ramadan

People that have T1DM that wish to fast during Ramadan have generally been placed in a blanket, 'high' or 'very high' risk category and this has made it difficult for medical professionals to advise and support people that wish to fast during Ramadan. As mentioned, fasting during Ramadan is an important aspect of a Muslim's life and remains a personal choice and so - must be respected. Moreover, Hussain *et al*, argued that people with T1DM need a more flexible approach to risk stratification when planning to fast during Ramadan [28]. Though, it is important to note that this does not directly advise people with T1DM to fast and may not be accessible or applicable to everybody living with T1DM. (For further information on Risk stratification please see **chapter 5: Risk stratification of people with diabetes before Ramadan**).

That risk stratification for a person with type 1 diabetes wishing to fast should be individualised and dependent on a range of different factors including:

- Pre-Ramadan glucose control
- The duration of T1DM – for example those newly diagnosed may be within the 'honeymoon period'
- Hypoglycaemia risk
- Level of hypoglycaemia awareness
- The level of diabetes related education
- Motivation for self-monitoring of blood glucose (SMBG)
- The ability to take appropriate decision making

- The feasibility of, and access to, continuous glucose monitoring and advanced insulin delivery technology
- The presence of diabetes related complications and/or associated autoimmune disorders such as Coeliac disease and thyroid disorders

Where all of the above have been considered and satisfied, people with T1DM can be advised that they are able to fast, only if they are willing to be educated on decision making around breaking their fast and comply to strict glucose monitoring and, where applicable, dietary and medication adjustments. Where these conditions are not met, or not feasible, fasting would pose a high risk and should not be encouraged.

1.3 Criteria for Fasting during Ramadan in people with T1DM

The findings from research studies that have been discussed thus far apply to individuals with access to advanced medical care, good education programmes and appropriate support. We believe that people with T1DM who have these privileges and wish to fast during the month of Ramadan can be allowed to do so, after proper risk scoring (see **chapter 5: Risk stratification of people with diabetes before Ramadan**), alongside the fulfilment of the following conditions:

- **A pre-Ramadan clinical evaluation and a full review of an individual's glucose profile should be completed. If poor glycaemic control is found (HbA1c >9% or 75 mmol/mol and or wide glucose fluctuation), the insulin treatment regimen should be adjusted as necessary and re-evaluated once again before the start of fasting.**
- **Individuals with T1DM, regardless of their age, and their carers or guardians should be taught about the potential adverse effects of fasting, including hypoglycaemia, hyperglycaemia and dehydration, and appropriate preventative measures to minimise the risks of these occurring. Additionally, the rationale for the revised insulin regimen should be explained and emphasised.**
- **There should be a nutritional assessment reviewing carbohydrate (CHO) intake and recommendations about the proper food options for the two main meals of the day. Carbohydrate counting techniques should also be discussed. An emphasis needs to be placed on the importance of a scheduled time for meals rather than following a looser erratic and frequent eating pattern. Also, an adequate intake of sugar-free beverages, especially with the pre-dawn meal, should be stressed.**
- **While there is still a debate about the best insulin regimen for during fasting, a basal insulin dose reduction by 10-30% has been recommended by the majority of experts and medical societies. More importantly, an individualised regimen should be considered and based on a review of the individual's glucose profile within the first few days of fasting.**
- **Frequent glucose testing is fundamental to ensure early recognition of abnormal glucose readings and that the proper measures in controlling them are taken. The use of CGM or FGM is superior to the traditional BG monitoring and should be the method of choice if available.**



- **Fasting should be broken immediately with hypoglycaemia (< 70mg/dL; 3.9 mmol/L) in individuals using MDI, both symptomatic or asymptomatic. Those using CSII may try suspending the pump if glucose drops below 90mg/dL (5 mmol/L) but should also break the fast if glucose is < 70 mg/dL (3.9 mmol/L).**

The allowance to fast cannot be generalised across to all individuals with T1DM, especially those where the aforementioned criteria are not met. We acknowledge that data on the safety of fasting is incomplete and may be prone to selection-bias in that individuals that are not willing to fast or those that show poor glycaemic control are not represented in these studies. It is therefore not possible to quantify or be assured of the exact risk related to fasting, and an individualised risk assessment remains the most appropriate method.

1.4 Blood glucose monitoring for people with T1DM during Ramadan

People with T1DM who choose to fast must regularly check their blood glucose levels through SMBG or CGM. The benefits of real-time CGM was demonstrated in a study of adolescents with T1DM where it showed that it can be effective in lowering HbA1c; reaching a target level of HbA1c; reducing glucose variability; reducing mild to moderate hypoglycaemia; and increasing the Time in Range (TIR) [29]. However, it is worth noting that the effectiveness of CGM, in children and adolescents with T1DM, may depend on the duration of sensor use [30].

The use of these advanced methods to monitor blood glucose trends can be a valuable tool to detect hypoglycaemia and prevent glycaemic excursions during Ramadan fasting [7]. The use of CGM during Ramadan or in the month before or after the Ramadan, is also key for therapy adjustments [8, 31, 32]. Other systems such as flash glucose monitoring (FGM) have also been proved to be useful tools in studying T1DM [27].

Importantly, most CGM studies during Ramadan have been performed in countries with similar durations of fast. These findings have not been replicated in countries with longer daylight times fasting hours and intentions of fasting [5] and so guidance should not be generalised. When CGM is not feasible, frequent and regular SMBG is necessary for an appropriate adjustment of insulin dosing.

Telemedicine, necessitated by the Coronavirus disease 2019 (COVID-19) crisis, has thus far shown strong results and remains an important tool that health care providers rely on to treat 'high-needs' individuals such as adolescents or adults living with T1DM. Insulin pumps, CGMs, and most blood glucose meters have the ability to be downloaded onto either the manufacturer's platform or a uniform secondary service. The downloading of device data enables patients and

their caregivers to visualise the glucose profile, through seeing summary statistics and trends in glycaemic data. It also provides an opportunity for clinicians and diabetes educators to review such data remotely between visits and make more frequent dosing adjustments. However, technological barriers remain a concern in those living in remote or rural locations.

- **Frequent glucose testing is fundamental to ensure safe fasting.**
- **The use of CGM or FGM is superior to SMBG monitoring, and should be the method of choice if feasible.**
- **Fasting should be broken immediately with hypoglycaemia (glucose < 70mg/dL; 3.9 mmol/L).**

1.5 Physical activity for people with T1DM during Ramadan

It is recommended that a relatively moderate level of activity be maintained during Ramadan, with the consideration to avoid strenuous activity in the hours before the sunset meal, where hypoglycaemia is most likely [33].

Similar to meal routines, exercise patterns in Ramadan differ between countries, cultures, the need for school attendance, and the season that Ramadan comes in. Sleep patterns are also affected. In a study where Ramadan time coincided with the summer vacation, more than 90% of individuals with T1DM reported sleeping until 4.00 pm, and were only mildly active between 9.00 pm to 1.00 am [34].

Evidence on the impact of fasting during Ramadan on athletic performance and treatment guidance for athletes when fasting is scarce. In a review of the available literature [35], Shepard concluded that changes in training, fluid intake, diet, and sleep patterns can be managed but do not go far enough to attenuate the risk; he recommended that athletes with T1DM seek a medical exemption from fasting, but if they choose to fast then an individualised plan to optimise performance and ensure safety is needed. A consensus guiding nutritional management for athletic performance in people with T1DM has been outlined [36], however, it requires an adaptation for athletes choosing to observe Ramadan fasting in order to meet the different fluid, energy, and electrolytes requirements [33].

Research is limited on the exercise patterns of people with T1DM during Ramadan. Generally, their activity patterns tend to vary, particularly so in adolescents where sport can be planned or spontaneous. Pre-Ramadan diabetes education should discuss physical activity, with a plan for appropriate insulin adjustment, hydration and hypoglycaemia treatment in an individualised manner [33].



1.6 Nutritional care and meal planning for people with T1DM during Ramadan

Individualised nutritional assessments, education, and meal planning are all essential for safe fasting. Any proper assessment of people with T1DM should consider an individual's energy requirements, most commonly eaten foods, personal timing of the *Suhoor* (pre-dawn) and *Iftar* (after sunset) meals, insulin regimen type and time of administration in relation to meals, and exercise patterns [33].

An individual's mealtime routine and type of food that is consumed during Ramadan can vary tremendously due to cultural differences but also other reasons owing to the fact that variation can also be seen even within households of the same culture. Amoudi *et al.* studied the different habits of 156 T1DM patients (aged 14-50 years old) in a middle eastern country; it was found that while the majority of patients consumed a large meal at the sunset prayer call, many others only consumed a small meal or a snack of dates and yogurt or soup, and had their main meal later, within a time range of 30 minutes to 4 hours after sunset. The insulin timing in relation to *Iftar* also varied, with some splitting their doses and others taking it with the main meal [34]. This certainly has implications on post-prandial glucose levels and should prompt physicians and educators to include this when providing education.

Commonly eaten types of food during Ramadan tend to be high in fat and sugar. This was demonstrated by Eltoun *et al.* who subsequently recommended that people with T1DM lower their saturated fat and sugar intakes during this period [37].

A late evening meal (around 10-11 PM) is a common habit among people with T1DM; this could be a small snack or even the main meal for those who had a small *Iftar*. The timing of *Suhoor* was also been found to be quite variable [34]; ideally it should be eaten within in the last predawn hour, however many individuals tend to prefer eating it earlier allowing them a little bit of time to correct for hyperglycaemia before dawn and may even have another snack that is not covered with insulin. It is strongly recommended that the predawn meal is eaten as close to dawn as possible to minimise the fasting period. Lean protein and carbohydrates low on the glycaemic index (GI) are particularly important at the predawn meal to enhance satiety during the day. Caution with the insulin dose at predawn is essential to minimise any risk of hypoglycaemia and avoid any need for the disruption of fasting. Another important consideration is the proper distribution of fluid intake during the non-fasting hours to maintain adequate hydration [33], a common habit of bingeing large amounts just before dawn is discouraged.

An assessment of individual patient habits during Ramadan will help to tailor patient education programmes and in making timely and proper decisions regarding therapy [38]. For those using intensive insulin therapy, education on carbohydrate counting is recommended to allow for the adjustment of the prandial insulin dose to match carbohydrate intake at *Iftar*, *Suhoor* or the supper meal. Daily consistency in carbohydrate intake at *Iftar* and *Suhoor* is necessary for those on a twice daily injection regimen. Continual snacking overnight after *Iftar* should be discouraged [33]. Pre-prandial bolus insulin is preferable to insulin administered during or after the meal [39]. Frequent SMBG monitoring, or preferably CGM, is recommended to allow for appropriate insulin adjustments[1].

In younger individuals, an appropriate energy intake to maintain growth and development is necessary [40]. The IDF and Diabetes and Ramadan (DAR) International Alliance recommend that for adults the calorie load during fasting should be similar to the rest of the year to prevent weight gain (please see the **chapter 7: Pre-Ramadan Assessment and Education**). In children and adolescents with T1DM, both weight gain [41] and weight loss [42] have been reported. Weight loss can be explained by the reduced caloric intake with fasting, however it has also been associated with deterioration in glycaemic control [42]. Weight, as well as types of food and the appropriate insulin coverage of meals, need monitoring during Ramadan.

A moderation in traditional sweet intake and fried foods are strongly recommended, particularly at the sunset meal. This should be covered by prandial rapid-acting insulin to prevent postprandial glycaemic excursions. The use of an extended bolus delivered by an insulin pump, where some of the insulin is delivered promptly and the remainder over 2 to 6 hours, enables bolus insulin to match the glycaemic effect of the meal. This is particularly useful for high-fat meals such those consumed at *Iftar*. CGM is a useful tool to show the impact of meals consumed during Ramadan. It can guide changes in the timing of insulin administration and the insulin dose to match the profile of high fat foods [33].

Taken together, it is essential to design an individualised meal plan well before Ramadan. The plan should be to help individuals maintain an adequate caloric intake and help avoid excessive weight changes. Furthermore, this meal plan should take into account the insulin regimen, the type of food consumed, and meal timing. During Ramadan continuous glucose monitoring and daily adjustments are required to achieve good glucose control and avoid excursions.

1.7 Management of adolescent individuals with T1DM during Ramadan

1.7.1 Insulin regimens

Most studies investigating the efficacy and safety of different insulin regimens in adolescents are observational studies with small sample sizes making evidence-based guidance difficult. See **Table 1**. Therefore, an individualised approach is key, and the choice of treatment regimen largely depends on culture; access to specialist care; medication; and supportive diabetes technology, if these are available.

The most widely used insulin regimens in adolescents are:

- Basal-bolus regimens – meal adjusted Multiple Dose Injection therapy
- Continuous subcutaneous insulin infusion (CSII) with or without sensors
- Conventional, twice daily NPH/Regular short acting (human) insulin
- Premixed insulins (the least frequently used and generally not recommended for T1DM)



All of the above options are yet far from replicating physiological insulin secretion; MDI and CSII remain the closest options available [43].

1.7.2 Basal-bolus regimen (MDI)

This regimen, using a long-acting insulin analogue and a premeal rapid acting insulin analogue, is associated with a lower risk of hypoglycaemia when compared to conventional, twice-daily, insulin regimens [1], and is the preferred treatment option for paediatric and adolescent individuals with T1DM [44].

Basal insulin: Long-acting analogues

The safety and efficacy of **first-generation** basal insulin analogues (such as glargine U-100), in individuals with well controlled T1DM, who fasted with an average range of 17-19 h/day, have been demonstrated in a number of observational studies [41, 45-49]. However, some saw an observed significant decline in plasma glucose, with a tendency towards hypoglycaemia, that occurred mostly towards the end of the fasting period. To minimise the risk of hypoglycaemia, many studies suggested a reduction of the basal insulin during Ramadan [41, 44, 50-53]. In some studies, the pre-Ramadan basal dose was reduced by 20% and given earlier in the evening [11, 41, 48, 50] while in other studies a reduction of up to 40% was needed [2, 8, 51].

Basal insulin should, ideally, be administered earlier in the day. This is to reduce the exposure to active insulin during the last hours of fasting; this is supported by CGM studies showing that approximately 70% of the hypoglycaemic events occurred in the last 6 hours of fasting [15]. A general recommendation has come to the fore — Ramadan fasting should be started with a reduction of basal insulin and taken at *Iftar* or earlier in the evening in order to help prevent hypoglycaemia [54]. Though, this notion has been challenged with recent studies reporting no difference in the incidence of hypoglycaemia between T1DM individuals who reduced or did not reduce their dose of basal insulin in a retrospective study [6] and in a treatment timing randomised cross-over study, utilising FGM [55]. Interestingly, a less recent study even suggested an increase in insulin dose [56].

This clearly demonstrates that until greater clinical evidence accumulates, a greater emphasis must be placed on individualisation. A careful intensification of metabolic control prior to Ramadan must be achieved through close monitoring using frequent SMBG or CGM/FGM and this will help inform adjustments in basal insulin dosage.

The new, second generation, long-acting insulin analogues (glargine U-300 and degludec), have been reported as safe and effective, with no major risk of hypoglycaemia and good glycaemic control in two studies in type 2 diabetes [57, 58] among adult individuals observing Ramadan. However, further research is needed to replicate these findings in young individuals with T1DM.

Bolus insulin

The exact dose adjustment needed to achieve safe fasting while avoiding hyperglycaemia remains controversial. Alalwan *et al.* successfully used a pre-*Iftar* dose equal to that of a pre-Ramadan lunch dose and a pre-dawn dose equal to a pre-Ramadan evening dose of rapid acting insulin [48].

An evaluation of the contents of a meal and blood glucose readings are important for proper insulin dose estimation. In current practice, most paediatric endocrinologists base a bolus (rapid-acting) insulin dose on the meal carb-count. The insulin to carbohydrate ratio (ICR) measure is highly dependent on insulin sensitivity and may vary between different meals and the time of day and, therefore, should be well adjusted before Ramadan.

Moreover, taking the bolus of rapid-acting insulin 20 minutes before a meal results in a significantly better postprandial glucose control than when the meal insulin bolus is given just prior to the meal or after meal initiation. The timing of this dose is especially important for high-fat and high-protein meals, which are often associated with *Iftar* [59].

A premeal high blood glucose level in the evening may require an extra dose of insulin as a corrective measure [41]. This correction dose is calculated using the insulin sensitivity factor (ISF) and the target blood glucose level. It should not be given more frequently than every 3 hours so that insulin stacking, and consequent hypoglycaemia can be avoided.

TABLE 4: STUDIES EVALUATING THE USE OF BASAL-BOLUS INSULIN IN ADOLESCENTS DURING FASTING IN RAMADAN

Insulin Regimen	Author(date)	Sample size and study details	Findings related to Hypoglycaemia	Findings related to Hyperglycaemia	Findings related to Glycaemic control	Key Findings
1. Conventional BID pre-mixed insulin regimen	Al-Khawari <i>et al.</i> (2010) [41]	N=22 Observational study	Greater number of cases in patients on basal/bolus than in those on conventional insulin 61.5% and 44% respectively	Twice daily insulin had hyperglycaemia during the day whilst those on basal-bolus insulin showed a steady fall in blood glucose towards normal by the time of breaking their fast	The mean HbA1c of patients on conventional insulin was 8.8% or 73 mmol/mol and was 10.2% or 88 mmol/mol in patients on Basal/bolus prior to starting the fast Patients on conventional insulin continued to have hyperglycaemia during the fast but not in those on basal/bolus	The dose of basal insulin was recommended to be reduced by 10-20% in order to ensure safe fasting during Ramadan
2. Basal Bolus		Mean age was 13.9 years (range 9–18) Two groups based on regimen (conventional N=9; Basal Bolus N=13) Countries: UK, Kuwait				

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TABLE 4: STUDIES EVALUATING THE USE OF BASAL-BOLUS INSULIN IN ADOLESCENTS DURING FASTING IN RAMADAN

Insulin Regimen	Author(date)	Sample size and study details	Findings related to Hypoglycaemia	Findings related to Hyperglycaemia	Findings related to Glycaemic control	Key Findings
1. Insulin MDI in both the fasting and non-fasting groups	AlAlwan et al. (2010) [48]	N=20 Observational study Ages ranged from 8-14 years Patients divided into a fasting (N= 12, mean age 12.4 years) and a Non-fasting group (N=8, mean age 10.5 years) Country: KSA	1 child in the fasting group withdrew due to hypoglycaemia	-	No change in HbA1c before and after Ramadan in the Fasting group A slight change in HbA1c before and after Ramadan of -0.2%, which was not statistically significant	The Pre-Iftar dose given was equal to that of the pre-Ramadan lunch dose of rapid acting insulin The Pre-Suhoor dose given was equal to that of the pre-Ramadan evening dose of rapid acting insulin. The Pre-Ramadan Basal dose was reduced by 20% and given in the evening. Fasting during Ramadan can be conducted relatively safely
1. Glulisine, Lispro or Aspart 2. NPH – BID	Kadiri A et al. (2001) [10]	N=64 Open label randomised, crossover study in Young adults	Hypoglycaemia lower with lispro than regular insulin - 23.4% vs 48.4%; p=0.004	The 2-hr BG after Iftar was significantly lower in those treated with lispro p=0.026	No statistically significant changes in HbA1c	It was deemed Lispro is better than regular insulin in managing diabetes during Ramadan
1. MDI of Ultralente and Regular short acting insulin	Kassem et al. (2005) [50]	N=17 Observational study Mean age was 18.8 years Country: Lebanon	No episodes of severe hypoglycaemia	-	No statistically significant changes in HbA1c	Insulin regimens should be switched to long lasting insulins for patients with T1DM wishing to fast The dose was recommended to be 85% of their initial insulin dose and composed of 70% Ultralente and 30% rapid insulin, and divided equally between iftar and Suhoor

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TABLE 4: STUDIES EVALUATING THE USE OF BASAL-BOLUS INSULIN IN ADOLESCENTS DURING FASTING IN RAMADAN

Insulin Regimen	Author(date)	Sample size and study details	Findings related to Hypoglycaemia	Findings related to Hyperglycaemia	Findings related to Glycaemic control	Key Findings
1. Insulin (conventional BID regimen)	Zabeen et al. (2014) [42]	N=33 Observational study Ages ranged from 11-18 years Country: Bangladesh Split into groups of children that completed fasting and those that did not	2 (10.0%) patients developed hypoglycaemia in those completing their fasting compared with 3 (23.1%) in those that did not complete their fast No severe episodes were reported	-	No statistically significant changes were observed in either group	Children can safely fast during Ramadan given that there is adequate education in place prior to Ramadan and intensive monitoring during Ramadan

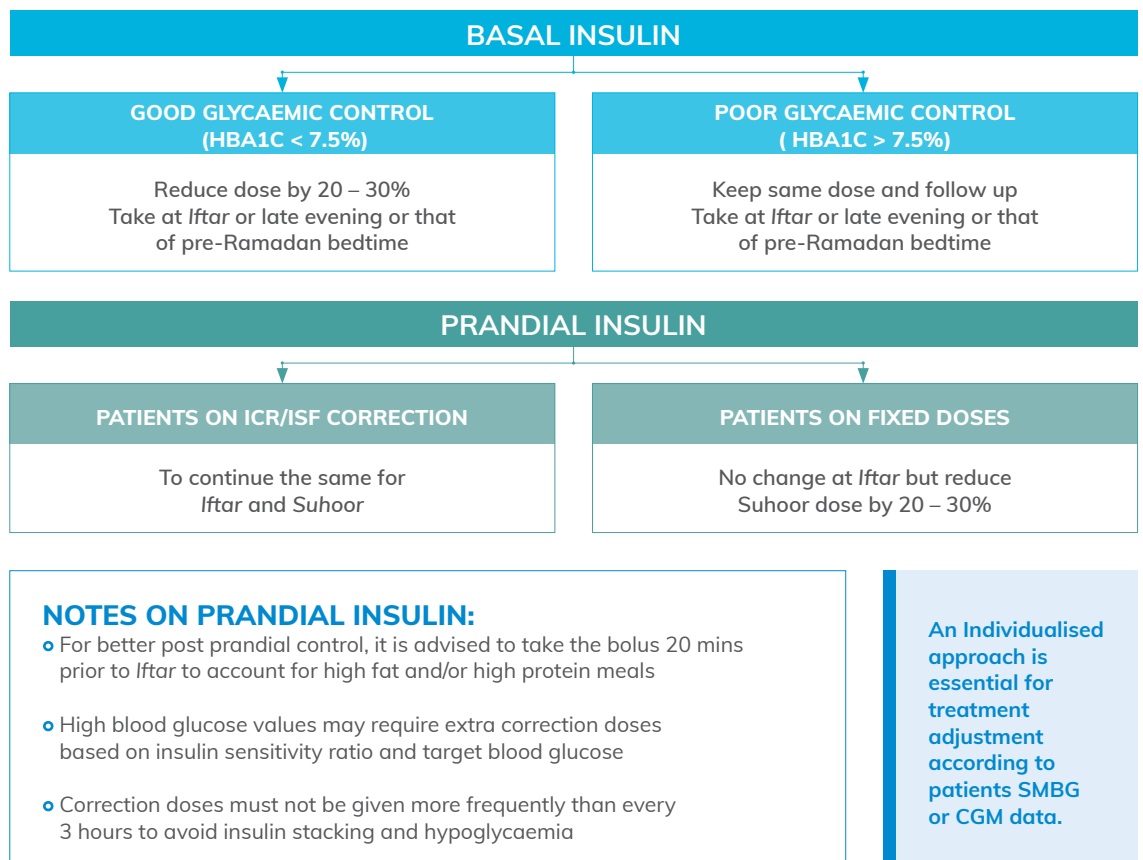


FIGURE 1

The recommended use of MDI therapy in adolescents with T1DM that are fasting during Ramadan



1.7.3 Conventional insulin treatment

It has been shown, in adolescents, that the use of **long acting insulin analogues** are preferred over intermediate acting insulin through providing a steady fall in blood glucose concentration towards normal levels by sunset time [60]. Al-khawari *et al.* reported children on a conventional twice daily regimen are more prone to hyperglycaemia, with or without ketones than those on a basal-bolus regimen. Further, children on twice daily regimens continued to show hyperglycaemic values during the daytime, while those on basal-bolus insulin showed a steady fall in their blood glucose concentration up until the time of breaking their fast [41], (see **Table 4**).

The duration of action and the timing of the peak effect of intermediate acting Neutral Protamine Hagedorn (NPH) and the regular (human) insulins should be considered when adjusting insulin doses alongside the content and portions of food and the hours of fast. The need for two to three daily injections allows less flexibility and freedom in lifestyle and nutritional choices. **The use of conventional regimens is discouraged in individuals with T1DM who fast during Ramadan. However, if this is the only conceivable option then adjustments should be carried out as shown in Figure 2.**

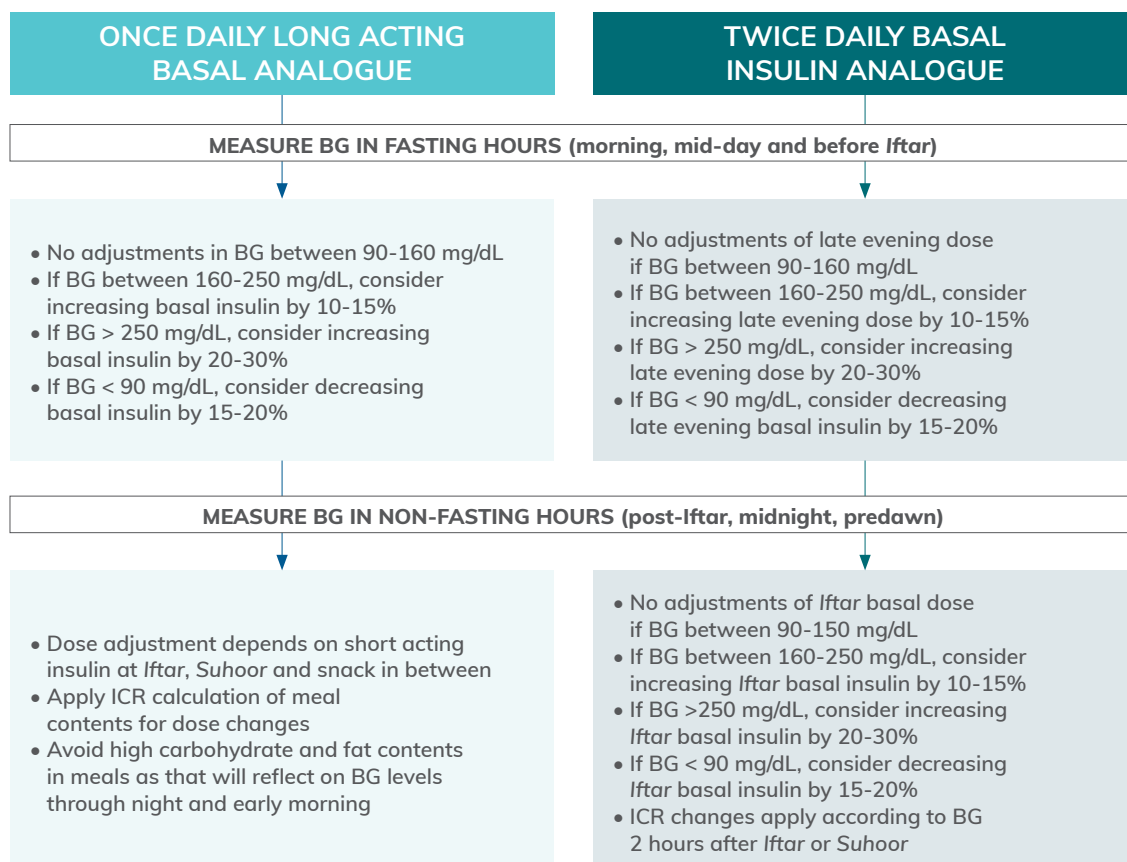


FIGURE 2
Schematic adjustments of insulin and/or food considerations during fasting and non-fasting hours

NOTES FIGURE 2

1. These adjustments depend on blood glucose trends and excursions (i.e. persistent increase of BG levels in all suggested timings for measurement without preceding hypoglycaemias)
2. An insulin regimen should be adopted and individualised according a patient's needs

Regimens that use **premixed insulin twice daily** require a fixed intake of carbohydrates, at set times, to counteract the two peaks of activity of the associated insulin profile. This may be difficult to use safely when fasting, especially with adolescents who tend towards having more erratic eating habits, and is therefore not advised [29].

- **Basal-bolus regimen is preferred over conventional twice daily regimens in adolescents with T1DM.**
- **Basal insulin should be adjusted according to fasting blood glucose levels, to reduce hypoglycaemia during fasting.**
- **Bolus insulin before *Iftar* and *Suhoor* using ICR and ISF-based corrections are recommended in order to control postprandial and evening hyperglycaemia.**
- **Premixed insulin regimens are incompatible with safe fasting and should be discouraged.**

1.7.4 Continuous subcutaneous insulin infusion pump (CSII)

Insulin pump therapy has proved to be beneficial in all paediatric groups with T1DM [61]. Achieving the targeted glycaemic control, reduction of severe hypoglycaemia with no significant increase in BMI, reverting hypoglycaemic unawareness, improved flexibility, quality of life, decreased total daily insulin doses, episodes of DKA and glycaemic variability have all been reported as advantages with the use of insulin pump [62, 63].

The use of technology can be a valuable asset in improving diabetes control without increasing the risk of hypoglycaemia and hyperglycaemia during Ramadan. The combined risks of hypoglycaemia from prolonged daytime fasting and hyperglycaemia from excessive night-time eating, can be more easily managed by adjustments of an insulin pump's settings than by multiple insulin dose-injection therapy. The ability to lower the basal insulin infusion rate or even suspending it, helped individuals with diabetes avoid major hypoglycaemic events during fasting [44]. Despite these benefits, its widespread use is limited in many countries primarily due to cost and access.



A number of studies [11, 13, 63] have shown the benefits of insulin pumps when fasting. In adolescents with T1DM, the use of subcutaneous insulin infusion was frequently associated with fewer hypoglycaemic episodes and an improvement in diabetes control [11]. Amoudi *et al.* reported significant better glycaemic variability, and an association with less hypoglycaemia (not statistically significant) in pump users [13]. In a retrospective study, Deeb *et al.* found no differences in hypoglycaemia events in adolescents between pump and multiple daily injection users [6]. A recent study showed that, fasting in children above the age of 10 years with T1DM is feasible and safe in both pump and non-pump users, and well-controlled individuals are less likely to develop complications. It was concluded that the education of families and their children before Ramadan, along with an intensive monitoring of fasting children during Ramadan are more crucial than the type of regimen used [16].

Most studies of CSII in young individuals and adolescents during Ramadan [8, 11, 14, 15] reduced the dose of **basal insulin by 10–25%** during fasting. Some studies propose an increase of the basal rate during eating hours and then reducing it throughout the fasting period, especially towards the final few hours of fasting; even up to a 40% reduction [8, 14, 15]. However, Deeb *et al.* found no difference in hypoglycaemia frequency when the basal rate was reduced [6].

A recent systematic review and meta-analysis of young individuals with T1DM showed that a CSII regimen had lower rates of severe hypoglycaemia, hyperglycaemia or ketosis, but a higher rate of non-severe hyperglycaemia than that of premixed or MDI regimens. These findings suggest that the appropriate selection of individuals is key. This paired with a regular, supervised fine-tuning of the basal insulin rate and intensive glucose monitoring might help mitigate the risk of hypoglycaemia during Ramadan [12].

In addition, a great benefit of new technology is the extra information provided through the use of integrated pump-sensor technology, allowing for a greater understanding of when to change basal settings during fasting and non-fasting hours. For more simpler pumps, temporary adjustments to basal insulin are made through algorithms that respond to fluctuations in blood glucose levels.

Boluses covering predawn and sunset meals should be based on the usual Insulin Carbohydrate Ratio (ICRs) and Insulin Sensitivity Factor (ISFs) [8, 14, 15]. A useful advantage of insulin pump therapy, is that the bolus dose can be delivered by three different mechanisms:

1. immediately, known as a standard or normal bolus
2. gradually over a certain duration of time, called an extended or square bolus
3. a combination of the previous two, known as a combo or dual wave bolus

Foods that are higher in fat, as observed in traditional *Iftar* meals, may need an extended or combination bolus to compensate for the delay in the rise of blood glucose due to the high levels of fat in the meal [64].

Bolus calculators, either on insulin pumps or through mobile phone applications, for MDI users can be a useful tool in determining any corrections to dosing. Their **use is associated with improved glycaemic control in individuals with T1D** and should be encouraged for all [65].

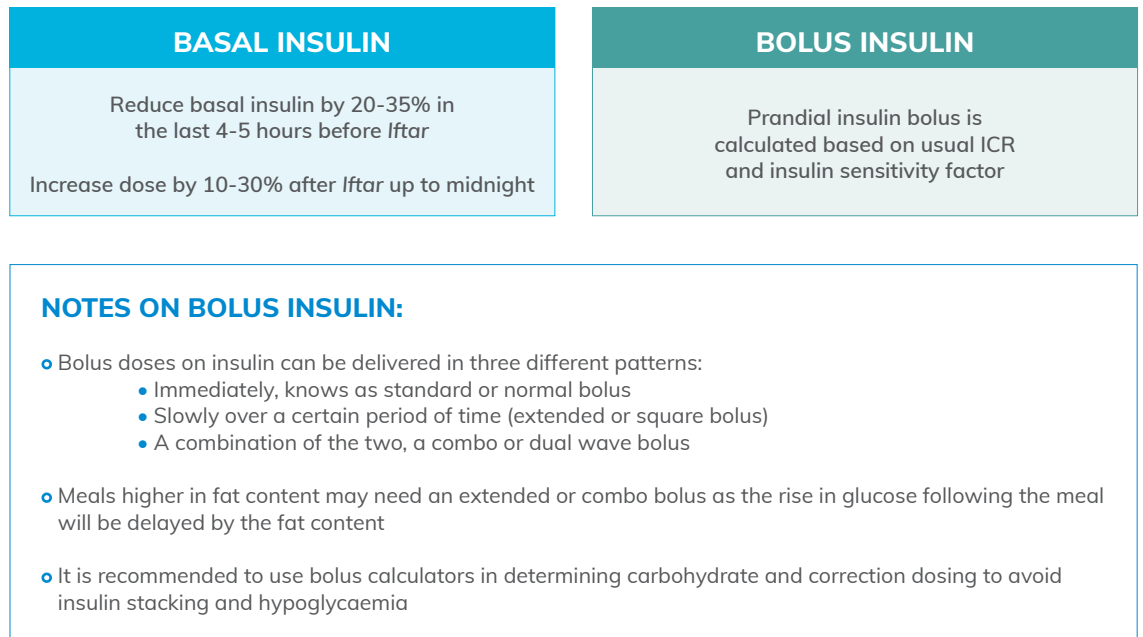


FIGURE 3

Highlights the different recommendations for adolescents with T1DM on insulin pump therapy

An individualised approach is essential for treatment adjustment according to a patient's SMBG or CGM data.

1.7.5 Sensor-augmented pumps: Low-glucose suspend (LGS) and Predictive low-glucose insulin-suspend (PLGS) pumps

Studies from Benbarka *et al.* and Khalil *et al.* both reported encouraging experiences with insulin pumps augmented by CGM during Ramadan [47, 66]. The advent of the Low Glucose Suspend (LGS) function, has allowed insulin to be automatically suspended for up to 2 hours when sensors detect a fall in glucose levels below a pre-set threshold [67]. Elbarbary investigated the LGS algorithm using insulin pumps in adolescents with T1DM during Ramadan and observed significant reductions in the exposure to hypoglycaemia which enabled individuals to fast through the whole month without interruption due to complications [14].

More recently, Predictive Low Glucose Suspend (PLGS) pumps have the ability to suspend insulin administration before blood glucose reaches hypoglycaemic values [68]. In two-cases, PLGS insulin suspension was associated with a significant reduction in the number of hypoglycaemic events with no serious adverse effects in adolescents with T1DM. In addition, other promising results include a significant reduction in the time spent below a glucose



level of 70 mg/dL (3.9 mmol/L), an increase in the time spent within target levels, no severe hypoglycaemic or DKA events, and everybody keeping their fast [69].

The results from these case reports are encouraging in that they point towards the ability to safely fast using advanced insulin delivering technology. Importantly similar studies using a larger sample size are needed to confirm these findings.

TABLE 5: A REVIEW OF STUDIES THAT HAVE EVALUATED THE USE OF INSULIN PUMP THERAPY IN ADOLESCENTS WITH T1DM WHEN FASTING DURING RAMADAN

Insulin Regimen	Author(date)	Sample size and study details	Findings related to Hypoglycaemia	Findings related to Hyperglycaemia	Findings related to Glycaemic control	Key Findings
1. Insulin pump	A Hawli (2009) [70]	N=5 Observational study Country: Lebanon	No cases of severe hypoglycaemia	Blood glucose concentrations did not change significantly when fasting	No statistically significant change of mean (HbA1c) before or at the end of Ramadan	Patients on an insulin pump regimen were able to fast during Ramadan without severe complications
1. Insulin pump With low glucose suspend (LGS)	Elbarbary (2016) [14]	N=60 Prospective observational study Mean age 15.6 ± 2.7 years Country: Egypt Split into two groups where some had the LGS function on (N=25) and the rest had the LGS function off (N= 35)	A total of 2716 LGS alerts occurred with 48.6% coming between 4pm and 7pm. The mean duration of LGS events was 26.5 min, 38% lasted for <5 min and 5.3% lasted for 120 min. LGS usage showed a meaningful reduction p<0.001	No episodes of severe hyperglycaemia occurred LGS usage showed a meaningful reduction p=0.006	No statistically significant changes in the mean HbA1c% 7.5±0.67 vs. in either group	LGS significantly reduced exposure to hypoglycaemia No patients in the LGS on group broke their fast whereas 15 did in the LGS off group Regimen proposal to adjust insulin pump during fasting

Automated insulin delivery (closed loop)

Automated insulin delivery (closed loop) not only suspends insulin delivery but can also increase insulin delivery based on its sensor glucose values. These systems improve the time in range (TIR), including minimising hypoglycaemia and hyperglycaemia [71, 72]. Though commercial availability remains limited, access to these systems is anticipated to improve and, therefore, increasing the ability to safely fast during Ramadan for adolescents with T1DM.

Hybrid closed-loop automated insulin delivery systems have also been of benefit to people with T1DM. Do-It-Yourself Artificial Pancreas Systems (DIY APS) are a form of hybrid closed-loop systems that use open-source algorithms, which determine the delivery of insulin in response to IG levels and other individually personalised variables. In a recent report, a T1DM patient shared her experience of using a Do-It-Yourself Artificial Pancreas System (DIY APS) during Ramadan fasting. There were reported benefits to her quality of life and her ability to self-manage diabetes [73].

On the whole, the need for flexibility and customisability for a fasting person with T1DM make Hybrid closed-loop automated insulin delivery systems a good option.

Insulin pump therapy or basal-bolus regimens?

There have been several studies conducted in the literature that have investigated the use of insulin pump therapy and basal-bolus treatment regimens during Ramadan (see **Table 6**). Some of these studies have found favourable outcomes in individuals using insulin pump therapy compared to those using basal-bolus regimens. Al-Agha *et al.* were able to show that pump therapy was associated with a lower likelihood of breaking the fast due to complications of hypoglycaemia during Ramadan ($p=0.03$). They also highlighted that the use of FMGS is important for safe fast in adolescents [24]. Likewise, in an earlier study Bin-Abbas found that the ability to use the LGS function in insulin pumps were very helpful towards achieving fewer hypoglycaemic events than compared to those on conventional insulin. It was also shown that conventional insulin users were more likely to break their and had poorer glycaemic control [11]. Interestingly, in contrast to these findings Deeb *et al.* found no difference between MDI and insulin pumps with regards to hypoglycaemia, hyperglycaemia or glycaemic control [6].

The general outlook in the literature is that insulin pump technology seems extremely promising but greater research is needed before direct recommendations can be made. More randomised trials powered to detect differences between insulin pump therapy and basal-bolus regimens are needed. In addition, there remains the issue of access with regards to technology; for many, insulin pump therapy may not be available or even appropriate. So as mentioned, the recommendations need to place an emphasis on individualisation.



TABLE 6: A REVIEW OF STUDIES THAT HAVE EVALUATED THE USE OF INSULIN PUMP THERAPY AND BASAL-BOLUS REGIMENS IN ADOLESCENTS WITH T1DM WHEN FASTING DURING RAMADAN

Insulin Regimen	Author(date)	Sample size and study details	Findings related to Hypoglycaemia	Findings related to Hyperglycaemia	Findings related to Glycaemic control	Key Findings
1. Insulin pump 2. MDI	Deeb et al. (2017) [6]	N=65 Observational study Median age 14.5 years (range 10.2-18.9) Two groups based on regimen (27 MDI; 38 Insulin pump) Country: UAE	No real difference was observed between both groups for the number of severe episodes of hypoglycaemia	No real difference was observed between both groups for the number of severe episodes of hyperglycaemia	There were not any notable changes to HbA1c levels	The use of an insulin pump does not appear to be different from MDI in the frequency of occurrence of complications The majority of adolescents with T1DM were able to fast during Ramadan with 57% fasting more than 14 days
1. Insulin pump 2. Conventional Insulin (CI) BID Regimen	Bin-Abbas (2008) [11]	N=9 Observational Ages ranged from (15-19 years) Country: KSA Two groups based on regimen (Insulin pump N=5; CI N=4)	Events counted per patient per Month: More events with BID than with insulin pump 29 and 16 respectively p<0.002 Three adolescents on CI therapy had to break their fast because of hypoglycaemia. None of the insulin pump group broke their fast	The mean blood glucose was lower in the insulin pump group compared to in the CI group (123 mg/dL or 6.8 mmol/L; 192 mg/dL or 10.7 mmol/L respectively) P<0.001	Mean HbA1c was lower in those using the insulin Pump compared to those on BID, 7.8% and 9.1% respectively p<0.001	A reduction of 10-15% of basal insulin in patients with an insulin pump was used A suspension of the insulin pump can be carried out to avoid hypoglycaemia Those on a CI regimen were more likely to break their fast, however it was noticed that adolescents may find it difficult to break their fast even if they do feel unwell

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TABLE 6: A REVIEW OF STUDIES THAT HAVE EVALUATED THE USE OF INSULIN PUMP THERAPY AND BASAL-BOLUS REGIMENS IN ADOLESCENTS WITH T1DM WHEN FASTING DURING RAMADAN

Insulin Regimen	Author(date)	Sample size and study details	Findings related to Hypoglycaemia	Findings related to Hyperglycaemia	Findings related to Glycaemic control	Key Findings
1. MDI 2. Insulin pump (All used FGMS)	Al-Agha et al. (2017) [24]	N=51 Prospective cohort study Mean age: 14.2 ±2.6 years Two groups based on regimen (33 MDI; 18 Insulin pump) Country: Kingdom of Saudi Arabia	In all: patients broke their fast on 33% of total fasting days – hypoglycaemia was the reason 15.4% of the time The mean number of hypoglycaemic episodes, during fasting hours, per day was 0.56 compared to 0.18 non-fasting hours p=0.0001 10% of these episodes were asymptomatic The percentage of patients that broke their fast due to hypoglycaemia were lower in those using an insulin pump compared to MDI; 41.9% and 60.9% respectively; p=0.03 No severe hypoglycaemia	The mean number of hyperglycaemic episodes during fasting hours was 1.24 per day, which was higher than that of during non-fasting hours 0.7; p=0.0001	There were not any notable changes to HbA1c levels	It was found that there was some evidence of an association between type of treatment and hypoglycaemia as the reason for breaking the fast. Pump users were less likely to break their fast than insulin users due to hypoglycaemia FGMS can be successfully used in adolescents with T1DM

- CSII therapy can be used safely and effectively in adolescents with T1DM during Ramadan to facilitate safe fasting.
- LGS and PLGS systems can reduce both the severity and duration of hypoglycaemia when fasting.
- Utilising bolus calculators with different types of bolus delivery can be useful for adjusting post-prandial insulin doses with different meal contents.



1.8 Management of adults with T1DM during Ramadan

Differences arise in the monitoring and adjustments in the dosing of insulin in adults with T1DM wishing to fast during Ramadan. The individual needs of individuals and the subsequent type of insulin regimens dictate the different recommendations for dose adjustments and blood glucose monitoring.

1.8.1 Basal-bolus regimen (MDI)

Those adults that are fasting during Ramadan and under a basal bolus or an MDI regimen with analogue or conventional insulin are advised to self-monitor using a 7-point glucose monitoring method – a check of blood glucose levels when fasting; post-breakfast; pre-lunch; post-lunch; pre-dinner; post dinner; and midnight. Doses of long acting insulins such as **glargine** or **Degludec** should be advised to reduce their dose by 30-40% and take the dose at *Iftar*. The dose of the rapid acting analogue should remain the same around *Iftar*, unless a reduction is warranted based on the 2-hour post-*Iftar* blood glucose levels, and the dose at *Suhoor* may be reduced by 30-50%. The use of short acting insulin analogues (glulisine, lispro, or aspart) were found to be associated with fewer hypoglycaemic events and an improvement in postprandial glycaemia when compared to regular insulin in a randomised control trial among adults with T1DM that were fasting during Ramadan [10].

1.8.2 Premixed insulins

As was the case in adolescents, the use of premixed insulin is not advised. Adults should be shifted onto a basal bolus regimen with either conventional or analogue insulins **a few months prior to Ramadan**. However, those that insist on continuing on with a premixed insulin regimen can be allowed to do so with proper adjustment and blood glucose monitoring (see **Table 7**). The pre-Ramadan dose of morning insulin may be shifted to the dose of the pre-*Iftar* and 50% of the pre-Ramadan evening dose can be shifted to the pre-*Suhoor* dose.

1.8.3 Continuous subcutaneous insulin infusion pump (CSII)

Those on insulin pump or CSII regimens should be advised to reduce the dose of basal insulin by 20-40% in the final 3-4 hours of their fast and increase their basal dose by 10-30% in the first few hours of *Iftar*. The dose of bolus insulin has to be adjusted on the same principles of carbohydrate counting as during the other times (see **1.6 Nutritional care and meal planning for people with T1DM during Ramadan**). The benefits of CSII have been summarised in **section 1.7.4 Continuous subcutaneous insulin infusion pump (CSII)**.

These findings are summarised in Table 7 (see **Table 7**).

TABLE 7: RECOMMENDATIONS FOR INSULIN DOSE ADJUSTMENTS BASED ON TYPE OF REGIMEN

Type of Insulin Regimen	Adjustment for fasting during Ramadan	Methods of monitoring during Ramadan
CSII / Insulin Pump	<p><u>Basal rate adjustment</u></p> <ul style="list-style-type: none"> 20-40% decrease for the last 3-4 hours of fast 10-30% increase for the first few hours after <i>Iftar</i> <p><u>Bolus doses</u></p> <ul style="list-style-type: none"> Same principles as prior to Ramadan 	CGM
MDI (basal bolus) with analogue insulin	<p><u>Basal insulin</u></p> <ul style="list-style-type: none"> 30-40% reduction in dose and to be taken at <i>Iftar</i> <p><u>Rapid Analogue Insulin</u></p> <ul style="list-style-type: none"> Dose at <i>Suhoor</i> to be reduced by 30-50% Pre-lunch dose to be skipped The dose around <i>Iftar</i> to be adjusted based on the 2-hour post-<i>Iftar</i> glucose reading 	7-point glucose monitoring
MDI (Basal bolus) with conventional insulin	<p><u>NPH insulin</u></p> <ul style="list-style-type: none"> The usual pre-Ramadan morning dose to be taken in the evening during Ramadan 50% of the pre-Ramadan dose to be taken at <i>Suhoor</i> <p><u>Regular insulin</u></p> <ul style="list-style-type: none"> Dose at evening meal remains unchanged <i>Suhoor</i> dose to be 50% of the pre-Ramadan evening dose Afternoon dose to be skipped 	7-point blood glucose monitoring or 2-3 staggered readings throughout the day
Premixed (analogue or conventional)	<ul style="list-style-type: none"> Shift the usual pre-Ramadan morning dose to <i>Iftar</i> 50% of the pre-Ramadan evening dose at <i>Suhoor</i> 	At least 2-3 daily readings and whenever any hypoglycaemic symptoms develop

1.9 When to break the fast during Ramadan – all people with T1DM

In general, it should be recommended that all people with T1DM fasting during Ramadan monitor their blood glucose levels closely and carefully.

ALL INDIVIDUALS SHOULD BREAK THEIR FAST IF:

- **Blood glucose <70 mg/dL (3.9 mmol/L)**
– re-check within 1 h if blood glucose 70-90 mg/dL (3.9 - 5.0 mmol/L)
- **Blood glucose >300 mg/dL (16.7 mmol/L)****
- **Symptoms of hypoglycaemia or acute illness occur**

** In people with previously well controlled diabetes, these targets can be adapted and individualised.



SUMMARY

- Fasting Ramadan for people with T1DM is generally associated with a high risk of hypoglycaemia and hyperglycaemia.
- With well-structured pre-Ramadan education programmes, the risks of fasting can be reduced, and suitable individuals can be allowed to fast under strict monitoring and after appropriate insulin dose adjustments.
- Approaches to treatment adjustments should be individualised. The following should be considered: pre-Ramadan diabetes control; previous Ramadan experience; availability of recourses; the level of education; and the motivation for self-care.
- Different demographic characteristics affecting duration of fast, access to insulin and glucose monitoring must be considered in any risk assessment for the safety fasting.
- Insulin analogues are preferred over conventional insulin regimens if fasting is considered.
- Frequent SMBG is essential and if feasible, through CGM or FGM.
- Advanced insulin technology seems very promising in allowing for safe fasting.
- There is a lack of research and guidance for adults with T1DM that are seeking to fast during Ramadan and further research needs to be conducted in this age group.
- Overall, further research, including randomised clinical trials, are needed to assess clinical outcomes during fasting in Ramadan to help produce the best treatment options for adolescents and adults with T1DM.

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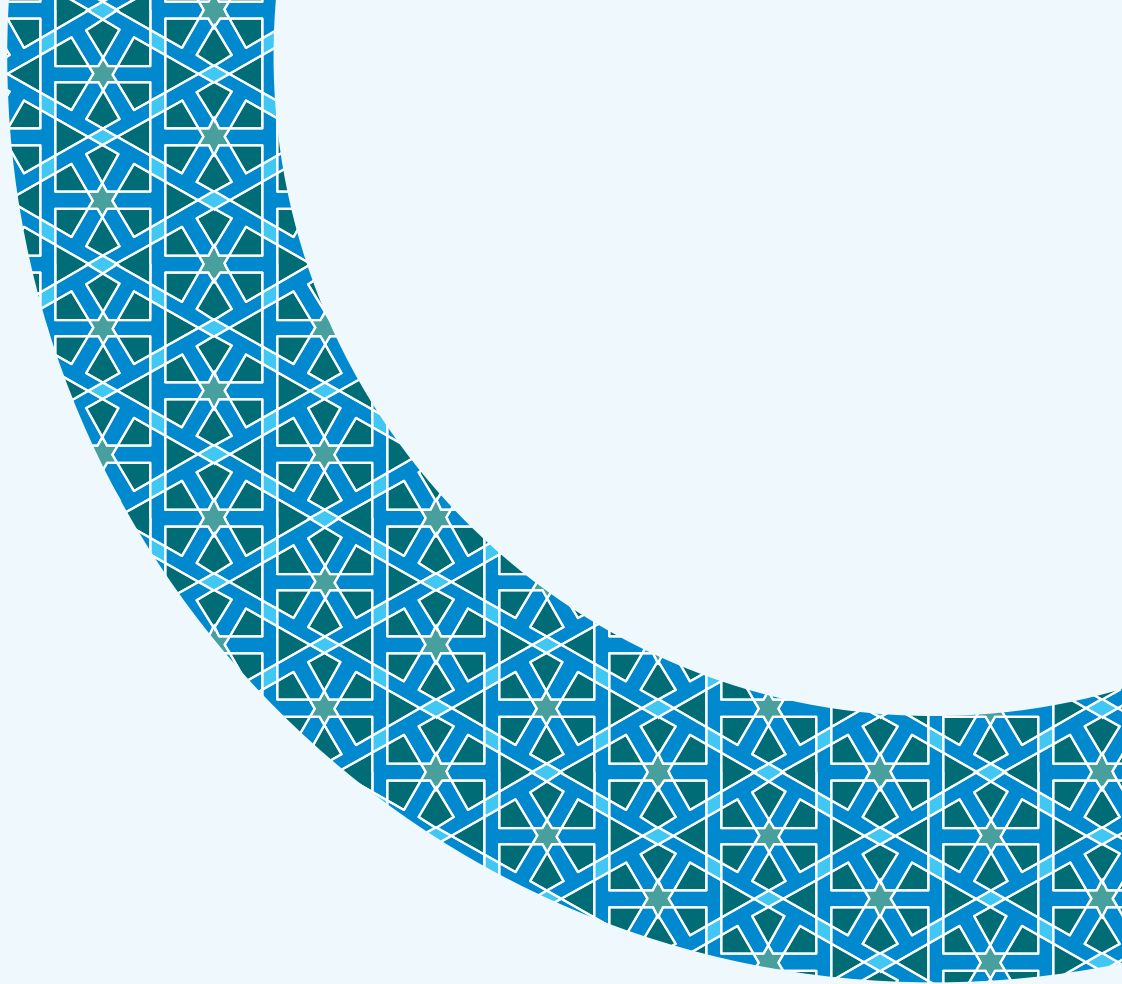
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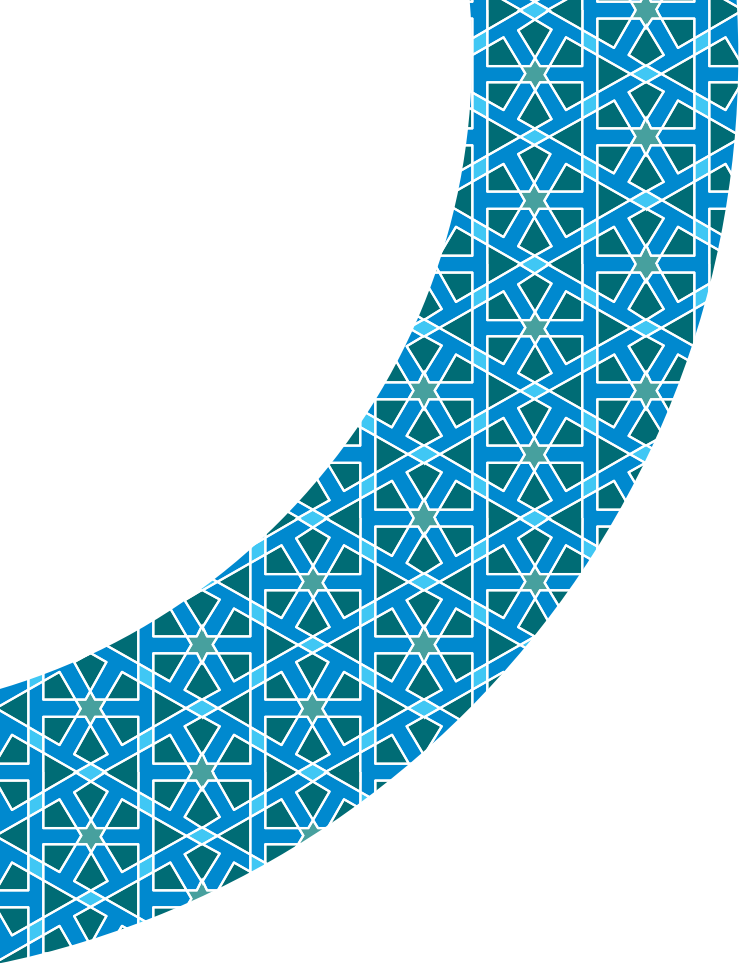
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CHAPTER 10

Management of Type 2 diabetes when fasting during Ramadan

Chapter lead:

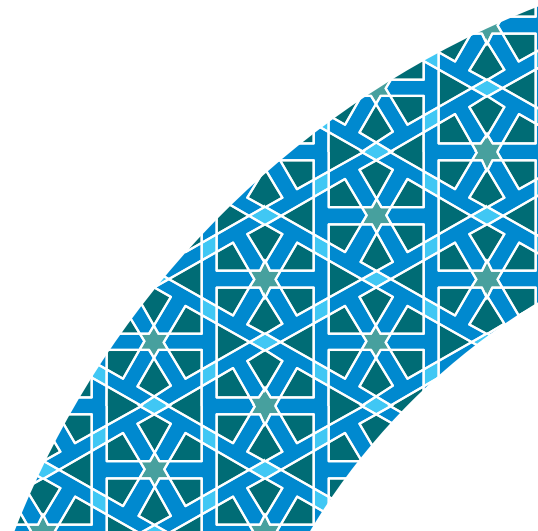
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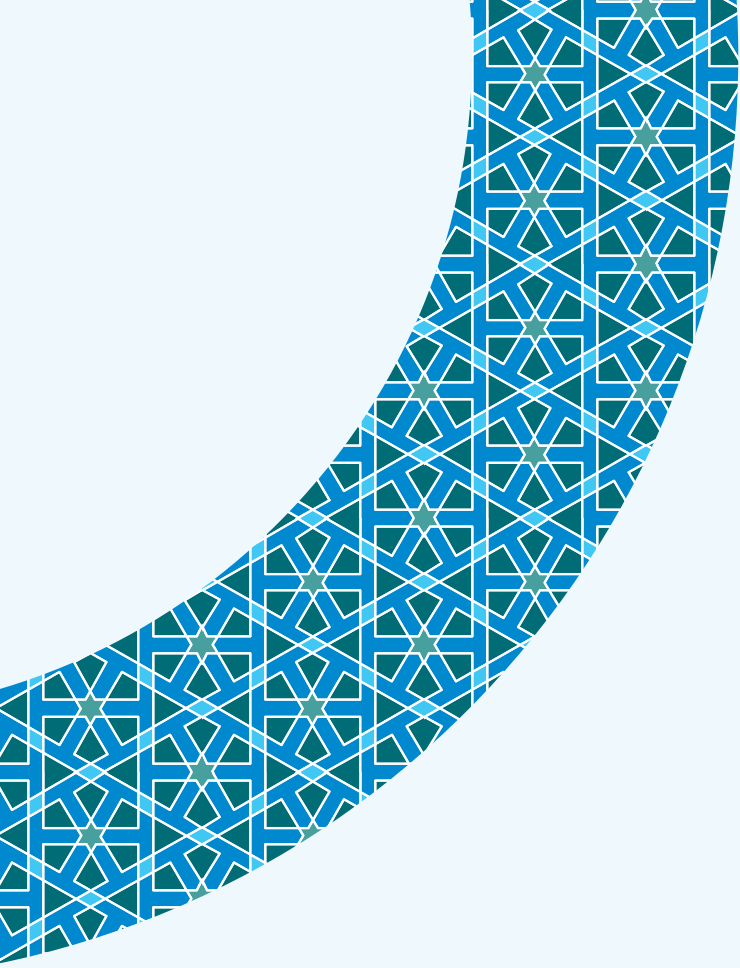
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CHAPTER 10

INDEX

1. INTRODUCTION	203
2. STEP 1: PRE-RAMADAN ASSESSMENT	203
3. STEP 2: MEDICATION ADJUSTMENTS	205
3.1 Metformin	205
3.2 Acarbose	205
3.3 Thiazolidinediones	206
3.4 Short-acting insulin secretagogues	207
3.5 Glucagon-like peptide-1 receptor agonists (GLP-1 RAs)	209
3.6 Dipeptidyl peptidase-4 (DPP-4) inhibitors	213
3.7 Sulphonylureas (SUs)	219
3.8 Sodium-glucose co-transporter-2 (SGLT2) inhibitors	224
3.9 Individuals on multiple antidiabetic therapy	226
3.9.1 Considerations and recommendations	228
3.10 Insulin treatment for T2DM	228
3.10.1 Evidence for insulin use in Ramadan	234
3.10.1.1 Basal insulin	234
3.10.1.2 Prandial insulin	234
3.10.1.3 Premix insulin	234
3.10.1.4 Insulin dose adjustments and monitoring	235
3.10.1.5 Insulin pump users	237
4. POST-RAMADAN FOLLOW-UP	238
SUMMARY	238
REFERENCES	239



WHAT IS KNOWN?

- A pre-Ramadan assessment is very important for all individuals seeking to fast during Ramadan.
- The majority of people with type 2 diabetes mellitus (T2DM) can safely fast during Ramadan.
- Individuals taking metformin, sulphonylureas (SUs), insulin secretagogues or insulin will need to make treatment adjustments to reduce the risk of hypoglycaemia.
- A post-Ramadan Assessment is recommended.

WHAT IS NEW?

- New studies on certain SUs highlight efficacy and ensure safe fasting for people with T2DM that wish to fast during Ramadan.
- New studies on Sodium-glucose co-transporter-2 (SGLT2) inhibitors provide more confidence on the use of specific drugs of this class during Ramadan fasting
- New studies have been published that provide stronger evidence regarding the use of different types of insulin and or Glucagon-like peptide-1 receptor agonists (GLP-1 RAs) in people with T2DM that fast during Ramadan
 - Dose modifications alongside stricter schedules of self-monitoring of blood glucose (SMBG) are important tools to ensure safe fasting with good glycaemic control during Ramadan.
- Individuals on multiple antidiabetic therapies need individualised dose reductions to avoid additional risks of hypoglycaemia or hyperglycaemia when fasting during Ramadan.

WHAT IS MISSING?

- Further randomised controlled trials for different antidiabetic therapies are required to provide more specific treatment recommendations.

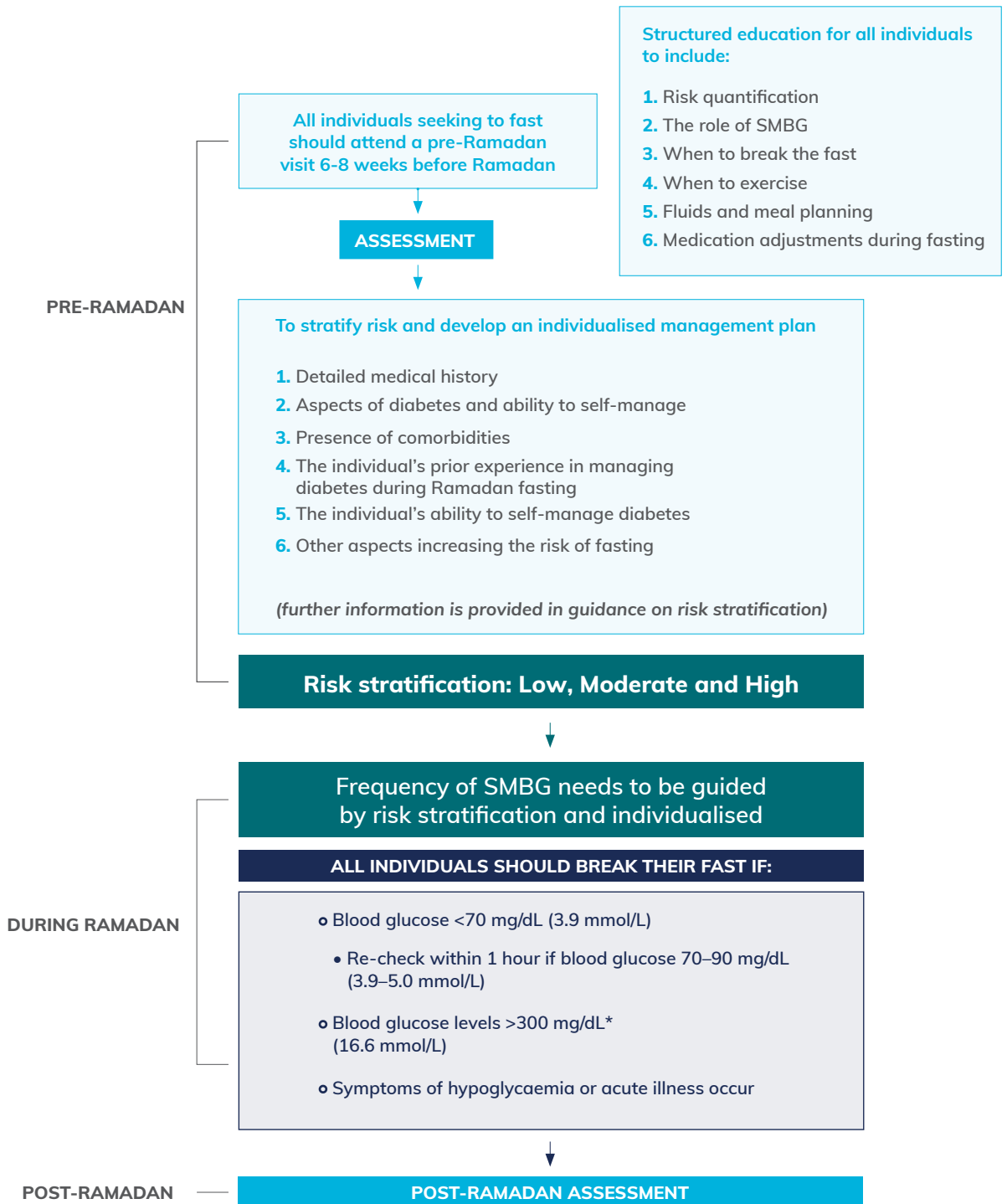
1. INTRODUCTION

Fasting during Ramadan can lead to metabolic changes during the fasting and eating hours and managing type 2 diabetes mellitus (T2DM) can present several challenges. One of the main risks is having uncontrolled blood glucose levels which can lead to hyperglycaemia and/or hypoglycaemia and measures need to be taken to minimise these risks. These measures include increasing self-monitoring of blood glucose (SMBG) and adjusting antidiabetic medications, which indirectly affect insulin effectivity [1], and insulin regimens. Many people with diabetes fast during Ramadan and the majority can do so safely if they follow expert advice and guidance. Existing guidelines and treatment algorithms recommend the individualisation of guidance as the best approach for the management of T2DM during Ramadan [2, 3]. This process can be broken down into a number of steps including a pre-Ramadan assessment, medication adjustments during Ramadan and a post-Ramadan follow-up.

2. STEP 1: PRE-RAMADAN ASSESSMENT

All people with diabetes seeking to fast during Ramadan should have a pre-Ramadan assessment with their healthcare provider, ideally, 6–8 weeks before the start of Ramadan. Healthcare professionals (HCP) can obtain a detailed medical history on individuals seeking to fast and review their glycaemic control and capability to self-manage their diabetes. Among other things, the HCP can apply the new risk scoring process to stratify the individual seeking to fast as “high”, “moderate” or “low” and provide advice on whether fasting is safe (see **Figure 1**). Information on risk stratification is described in detail, please see **chapter 5: Risk stratification of people with diabetes before Ramadan**.

If the individual decides to fast, which may be against the advice of the HCP, an individualised management plan must be provided. An integral part of management plan is Ramadan-focused education which should include information on diet, exercise, the frequency of SMBG and, critically, when to break the fast to avoid harm, (further information is provided in **chapter 7: Pre-Ramadan Assessment and Education**). Those individuals that wish to fast need to increase their frequency of SMBG to reduce risk of hypoglycaemia and/or hyperglycaemia. The use of continuous glucose monitoring (CGM) or flash glucose monitoring (FGM) systems can provide more detailed information especially for those treated with multiple insulin doses. Users of such devices are advised to increase the frequency of downloading and review of their glucose data. Moreover, dietary information must also be provided as Ramadan changes not only the timing of meals but often the types of food consumed. **Chapter 8: The Ramadan Nutrition Plan (RNP) for people with diabetes** describes the Ramadan Nutrition Plan as a way to educate individuals on the importance of diet during the holy month of Ramadan.



SMBG, self-monitoring blood glucose

*This applies for those with sudden rise in blood glucose level, individualisation of care is advisable

FIGURE 1
Assessment flowchart

3. STEP 2: MEDICATION ADJUSTMENTS

The type of medication the individual is taking for the management of their diabetes influences the potential risks that fasting during Ramadan may lead to and, therefore, needs careful attention when formulating the treatment plan. The following sections review the available evidence for the use of insulin and non-insulin antidiabetic therapies when fasting during Ramadan and provide medication dose adjustments where applicable.

3.1 Metformin

Metformin is the most commonly used, first-line, oral antidiabetic drug (OAD) and works by preventing the liver from producing new glucose. It comes in an immediate release preparation which may be taken up to three times per day, and a prolonged release formulation which is typically taken just once a day.

Severe hypoglycaemia in non-fasting individuals receiving metformin is rare, and while there are no randomised controlled trials (RCTs) on the use of metformin in people with T2DM that fast during Ramadan, it is considered safe for individuals on metformin monotherapy to fast. Dose adjustments are shown in **Figure 2**.

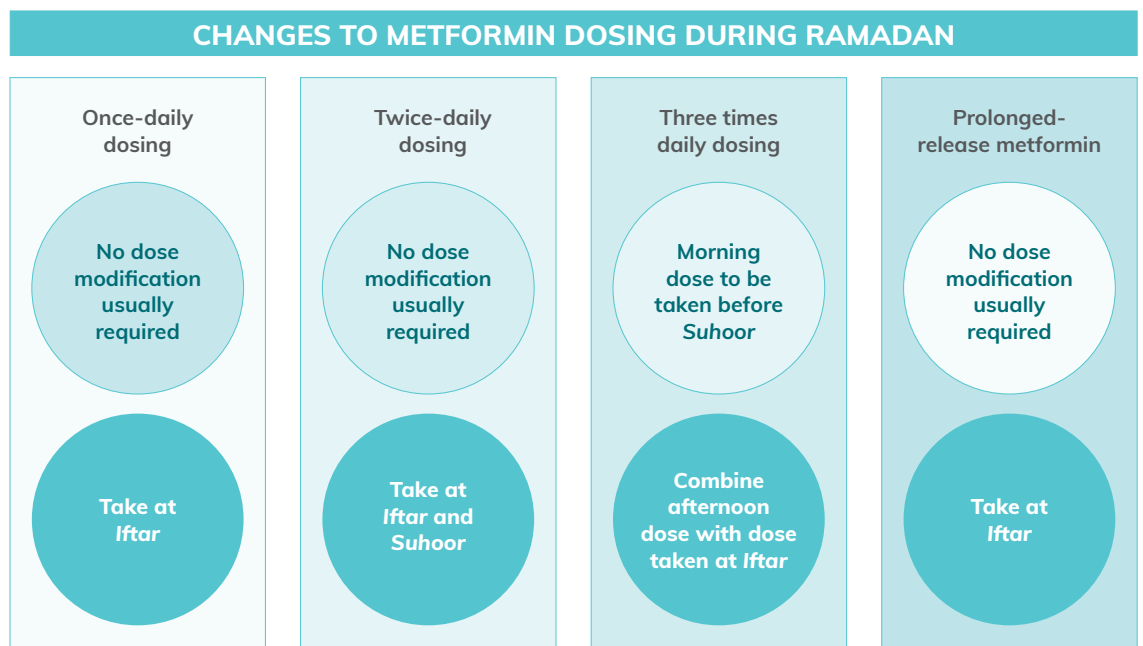


FIGURE 2
Dose adjustments for metformin

3.2 Acarbose

Acarbose is a drug that inhibits the actions of alpha-glucosidase, an enzyme that breaks down carbohydrates into glucose within the intestinal brush border, thereby, slowing down the absorption of glucose and modifying insulin secretion. Like metformin, acarbose is typically



introduced into treatment when healthy diet and exercise is not adequate for diabetes control. However, due to its lower efficacy when compared with metformin, and the occurrence of side effects such as flatulence, its clinical use has been limited.

While no RCTs have been conducted on acarbose in people with T2DM that fast during Ramadan, NO DOSE MODIFICATION is considered necessary as the risk of hypoglycaemia is low.

3.3 Thiazolidinediones

Thiazolidinediones (TZDs) improve the insulin sensitivity of fat, muscle, liver and peripheral tissue cells by specifically activating the peroxisome proliferator-activated receptor (PPAR)- γ . This receptor controls the level of proteins involved in glucose regulation and uptake; activation of PPAR γ via TZDs can increase glucose uptake and utilisation, particularly in adipose tissue. An increase in glucose uptake will subsequently lower glucose levels in the blood [4]. As TZDs function without increasing insulin secretion, the risk of hypoglycaemia in non-fasting people on TZD monotherapy is very low [5].

Pioglitazone is the only TZD widely approved for use in T2DM but there is limited clinical data on its use during Ramadan. One study evaluated the effects of pioglitazone in addition to background OADs in 86 fasting Muslims during Ramadan (Table 1). Compared with placebo, pioglitazone significantly improved glycaemic control during the early, mid- and post-Ramadan periods. There was no difference in the number of hypoglycaemic events between the two treatment groups but a significant increase in weight of 3.02 kg was associated with the pioglitazone group compared with a non-significant loss in weight (-0.46 kg) in the placebo group [6].

TABLE 1: STUDIES OF TZDS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Pioglitazone	Vasan et al., (2006) [6]	N=86 Study type: Double-blind, randomised, controlled trial Country: India Additional medication(s): Oral antihyperglycaemic agents Comparator: Placebo	A non-significant increase in the number of hypoglycaemic events was associated with Pioglitazone, when compared with placebo (39 vs 32, respectively; p=0.21)	Fructosamine levels were higher in the placebo group when compared with the Pioglitazone group: Early Ramadan: (p=0.003) Mid-Ramadan: (p=0.01) Post-Ramadan: (p=0.04)	The pioglitazone group saw an increase in weight 3.02kg (p=0.001) The placebo group saw a non-significant decrease in weight 0.46 kg (p=0.37)

N, total number of participants included in study

Due to the low risk of hypoglycaemia with pioglitazone, NO DOSE MODIFICATION is required during Ramadan, but dose should be taken with *Iftar*.

TZD medication should be taken with *iftar* rather than *Suhoor* and individuals should not be switched onto to this class of medications close to Ramadan as it can take up to three months for an optimal antihyperglycaemic effect of these drugs to be reached [3].

3.4 Short-acting insulin secretagogues

Short-acting insulin secretagogues such as repaglinide and nateglinide stimulate pancreatic β cells to secrete more insulin and are usually taken before meals. In two small observational studies, no hypoglycaemic events were reported among individuals treated with Repaglinide during Ramadan [7, 8], while a third demonstrated no difference in rates of hypoglycaemia when compared with insulin glargine or glimepiride — a sulfonylurea (SU) based therapy [9]. Similarly, in two randomised trials, a low incidence of hypoglycaemic events was associated with repaglinide use during Ramadan, occurring in similar proportions to individuals treated with glibenclamide and glimepiride [10, 11]. Details of all studies are in **Table 2**. Nateglinide use during Ramadan has not been reported, but as it has a faster onset and a shorter duration of action than repaglinide, the risk of hypoglycaemia occurring when fasting during Ramadan is expected to be low [2].

TABLE 2: STUDIES OF REPAGLINIDE IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Repaglinide	Anwar et al., (2006) [10]	N=41 Study type: Open-label, parallel-group, randomised trial Country: Malaysia Additional medication(s): NR Comparator: SU (glimepiride)	Events: No statistically significant differences observed between groups Symptomatic events during Ramadan: • Repaglinide: 2.9%, • Glimepiride: 3.5%	BG levels: Glimepiride was associated with lower BG levels than repaglinide	NR
	Bakiner et al., (2009) [7]	N=19 Study type: Observational Country: Turkey Additional medication(s): Insulin glargine Comparator: Non-fasting control group	Events: None reported in either group	No difference between the two groups	No significant weight changes in either group

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TABLE 2: STUDIES OF REPAGLINIDE IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Repaglinide	Cesur et al., (2007) [9]	N=65 Study type: Observational Country: Turkey Additional medication(s): NR Comparators: SU (glimepiride), insulin glargine	Individuals experiencing event: No significant difference between treatment groups of glimepiride, repaglinide or insulin glargine (14.3%, 11.1%, 10.0%, respectively) No severe episodes were noted	No significant difference between groups in terms of glycaemic control	No change in BMI in any group was identified
	Mafauzy, (2002) [11]	N=235 Study type: Open-label, parallel-group, randomised trial Countries: France, Malaysia, Morocco, Saudi Arabia, UK Additional medication(s): None Comparators: SU (glibenclamide)	Ramadan at midday with BG levels below 4.5 mmol/L (%): Repaglinide showed fewer cases when compared with glibenclamide (2.8% and 7.9%, respectively; p=0.001)	Fructosamine levels: Repaglinide led to a statistically significant decrease from baseline (p<0.05) Glibenclamide: did not lead to any statistically significant changes No statistically significant change in HbA1c in either group	NR
	Sari et al., (2004) [8]	N=52 Study type: Observational Country: Turkey Additional medication(s): NR Comparator: SU (glimepiride or gliclazide)	Events: No events reported in repaglinide group and 1 reported in glimepiride group	No statistically significant changes identified in either treatment group	No statistically significant changes in weight were identified in either treatment group

BG, blood glucose; BL, baseline; BMI, body mass index; HbA1c, glycated haemoglobin; N, number of patients included in study; NR, not reported; UK, United Kingdom; SU, sulphonylurea

The short duration of action of these agents make them appealing for use during Ramadan as they can be taken before *Iftar* and *Suhoor* and carry a low risk of hypoglycaemia.

The daily dose of short-acting insulin secretagogues (based on a three-meal dosing) may be REDUCED or REDISTRIBUTED to two doses during Ramadan according to meal sizes.

3.5 Glucagon-like peptide-1 receptor agonists (GLP-1 RAs)

GLP-1 RAs mimic the incretin hormone and decrease glucose levels in the blood by increasing insulin secretion in a glucose-dependent manner. Like endogenous GLP-1, drugs in this class reduce glucagon secretion, increase glucose uptake and storage in muscle, decrease glucose production by the liver, reduce appetite and retard gastric emptying [12, 13]. As they act in a glucose-dependent manner, the risk of severe hypoglycaemia is low when used as monotherapy, but this risk may be higher when given with sulphonylureas (SUs) or insulin [14].

A few studies on the use of GLP-1 RAs during Ramadan have been published and details can be found in **Table 3**.

TABLE 3: STUDIES OF GLP-1 RAS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Exenatide	Bravis et al., 2010 [15]	N=43 Study type: Observational Country: UK Additional medication(s): Metformin Comparator: SU (gliclazide)	Events: Exenatide led to a non-significant decrease (0.08%) in the number of events of hypoglycaemia (p=0.43) Gliclazide led to a statistically significant 53.0% increase in the number of events of hypoglycaemia (p=0.03)	NR	Weight change: Exenatide led to a non-significant increase of 0.12 kg (p=0.55) Gliclazide led to a statistically significant increase of 0.68 kg (p=0.01)
Liraglutide	Azar et al., (2015) [16]	N=343 Study type: Open-label, randomised controlled trial Countries: Algeria, India, Israel, Lebanon, Malaysia, South Africa, UAE Additional medication(s): Metformin Comparator: SU (gliclazide, glipizide or glibenclamide)	Symptomatic events during Ramadan: Liraglutide led to fewer events than SU (p=0.0009) Symptomatic events from baseline to end of Ramadan: Liraglutide led to fewer events than SU (p<0.0001)	Fructosamine levels during Ramadan were similar among Liraglutide and SU treated individuals (despite better glycaemic control in liraglutide group at start of Ramadan) Fructosamine levels decreased from baseline to end of Ramadan: Liraglutide led to a greater decrease than SU (p<0.05) HbA1c (%) levels decreased from baseline to end of Ramadan: Liraglutide led to a greater decrease than SU (p<0.0001)	Body weight decreased during Ramadan: Liraglutide led to a greater decrease than SU (p=0.0091) Body weight decreased from baseline to end of Ramadan: Liraglutide led to a greater decrease than SU (p<0.0001)

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TABLE 3: STUDIES OF GLP-1 RAS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Liraglutide	Brady et al., (2014) [17]	N=99 Study type: Open-label, randomised controlled trial Country: UK Additional medication(s): Metformin Comparator: SU	Self-recorded episodes of BG ≤ 3.9 mmol/l: Liraglutide led to fewer events than SU ($p < 0.0001$) No severe episodes were noted	Change in HbA1c (%): 3 weeks post-Ramadan Liraglutide led to a greater decrease than SU (0.54 and 0.27, respectively; $p = 0.03$) 12 weeks post-Ramadan Liraglutide showed some evidence of a greater decrease than SU (0.32 and 0.02, respectively; $p = 0.05$)	Body weight (kg): 3 weeks post-Ramadan Liraglutide led to a greater decrease than SU (2.23 and 0.42, respectively; $p = 0.02$) 12 weeks post-Ramadan Liraglutide led to a greater decrease than SU (2.57 and 0.25, respectively; $p = 0.002$)
	Khalifa et al., (2015) [18]	N=111 Study type: Observational Country: UAE Additional medication(s): Insulin, SU, none Comparator: None	No severe hypoglycaemia	HbA1c post-Ramadan compared with baseline: 8.0% and 7.4%, respectively ($p < 0.001$)	NR

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TABLE 3: STUDIES OF GLP-1 RAS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Lixisenatide	Hassanein et al., (2019) [19]	<p>N=184</p> <p>Study type: Open label randomised controlled trial</p> <p>Countries: Kuwait, India, Israel, Lebanon, Turkey</p> <p>Additional medication(s): Basal insulin (BI), Metformin</p> <p>Comparator: SU (glibenclamide, gliclazide, glimepiride, glipizide)</p>	<p>Individuals experiencing documented events:</p> <p>In the pre-Ramadan period Lixisenatide and BI was associated with fewer events than SU and BI (Odds Ratio 0.20; 95% CI 0.04-0.99)</p> <p>During the whole treatment period of pre-Ramadan, during Ramadan and after Ramadan</p> <p>Lixisenatide and BI was associated with fewer events than SU and BI (Odds Ratio 0.22; 95% CI 0.07-0.70)</p> <p>No hypoglycaemic events occurred during the Fasting hours for those on Lixisenatide and BI while 9 events occurred for those on BI and SUs.</p> <p>Only one episode of severe hypoglycaemia occurred during the whole study and within the BI + SU arm</p>	<p>There were reductions from baseline in HbA1c (%) seen in both treatment groups from baseline and the post-Ramadan period.</p> <p>However, there were no observed differences between treatment groups</p>	<p>There were reductions from baseline in body weight seen in both treatment groups from baseline and the post-Ramadan period.</p> <p>There were no observed differences between treatment groups</p>
	Sahay et al., (2020) [20]	<p>N=150</p> <p>Study type: Open label randomised controlled trial</p> <p>Countries: India</p> <p>Additional medication(s): Basal insulin (BI)</p> <p>Comparator: SU</p>	<p>Individuals experiencing documented events:</p> <p>During the Ramadan fasting period the number of events for those treated with Lixienatide and BI was 1 while for those treated with BI and SU were 5 (Odds Ratio 0.22; 95% CI 0.02-1.93)</p> <p>Any hypoglycaemic event:</p> <p>During the whole treatment period of pre-Ramadan, during Ramadan and after Ramadan, Lixienatide and BI was associated with fewer events than SU and BI (Odds Ratio 0.06; 95% CI 0.01-0.46)</p> <p>Only 1 severe event in the study among those with SU and BI</p>	<p>There were reductions from baseline in HbA1c (%) seen in both treatment groups from baseline and the post-Ramadan period.</p> <p>However, there were no observed differences between treatment groups</p>	<p>There were reductions from baseline in body weight seen in both treatment groups from baseline and the post-Ramadan period.</p>

BG, blood glucose; BL, baseline; GLP-1, glucagon-like peptide-1; HbA1c, glycated haemoglobin; N, number of patients included in study; NR, not reported; UAE, United Arab Emirates; UK, United Kingdom; SU, sulphonylurea; CI, confidence interval



The TREAT4 Ramadan trial examined the safety and efficacy of liraglutide compared to SU as add-on to metformin treatment among people with T2DM in the UK during Ramadan [17]. The primary outcome was the proportion of individuals who achieved a composite endpoint of HbA1c <7% (8.6 mmol/L), no weight gain and no severe events of hypoglycaemia noted by 12 weeks post-Ramadan. While more individuals achieved this primary outcome in the liraglutide group compared with the SU group (26.7% and 10.3%, respectively), this did not reach statistical significance. However, there was a statistically significant reduction in HbA1c levels and body weight at both 3 and 12 weeks post-Ramadan in the liraglutide group compared with the SU group (**Table 3**) [17]. The incidence rate of self-reported hypoglycaemic events was also significantly lower in the liraglutide group ($p<0.0001$) [17].

In the open-label LIRA-Ramadan study conducted in Africa and Asia, participants with T2DM were randomised to switch to once-daily liraglutide or continue on SU, both in combination with metformin [16]. The primary endpoint was a change in fructosamine from the beginning to the end of Ramadan. Similar fructosamine reductions were observed in both cohorts despite there being a better glycaemic control at the beginning of Ramadan in the liraglutide group. More individuals in the liraglutide group reached the composite endpoint (HbA1c <7% or 8.6 mmol/L, no weight gain, no hypoglycaemia) than in the SU group at the end of Ramadan (51.3% vs 17.7%; $p<0.0001$). Individuals in the liraglutide arm also demonstrated better weight control and fewer confirmed hypoglycaemic episodes compared with the SU group [16].

The effects of adding liraglutide to pre-existing antidiabetic regimens (including SU and insulin) during Ramadan was investigated in an observational trial in the UAE. No participants – 94.6% of whom were on SU, insulin or both – experienced a severe hypoglycaemic event during Ramadan, although 16.2% did develop symptoms of hypoglycaemia. A small but significant increase in HbA1c was observed following Ramadan [18].

The recent LixiRam study was a phase IV, randomised, open-label, 12–22 week study conducted in people with insufficiently controlled T2DM that intended to fast during Ramadan. Individuals were treated lixisenatide, as an add-on to basal insulin or with SUs together with basal insulin and one oral glucose-lowering agent. Those that took lixisenatide had fewer documented symptomatic hypoglycaemic events than those on SUs (3.3% and 8.9%; OR, 0.34; 95% CI, 0.09–1.35; proportion difference, -0.06; 95% CI, -0.13 – 0.01). The difference was statistically significant for ‘any hypoglycaemia’ (lixisenatide and basal insulin (4.3%) compared to SUs and basal insulin (17.4%); OR, 0.22; 95% CI, 0.07–0.68; proportion difference -0.13, 95% CI -0.22 to -0.04) [19].

A sub-group analyses [20] of the full study [19] was performed on 150 participants from India with T2DM who were randomised to receive either lixisenatide and basal insulin or SUs and basal insulin during Ramadan. The incidence of any hypoglycaemic event was lower among those treated with lixisenatide and basal insulin compared to those on SUs and basal insulin during Ramadan fasting (1.3% and 14.7%, respectively; OR: 0.09; 95% CI: 0.01–0.69). However, the differences in the documented events of hypoglycaemia between those treated with lixisenatide and basal insulin and those treated with SUs and basal insulin was not statistically significant (odds ratio (OR): 0.22; 95% CI, 0.02–1.93) [20].

A small observational study in people with T2DM that were treated with exenatide in addition to metformin reported no significant changes to weight or hypoglycaemic episodes during Ramadan [15]. There is yet more research needed into the use of newer GLP-1 Ras during Ramadan (such as dulaglutide and albiglutide).

These studies demonstrate that liraglutide and Lixisenatide are safe as an add-on treatment to pre-existing antidiabetic regimens including metformin and insulin. Data on exenatide is limited to one study but the short duration of action and dosing of exenatide suggest that, like liraglutide, the risk of hypoglycaemia during Ramadan is low.

As long as liraglutide, lixisenatide, exenatide have been appropriately DOSE-TITRATED prior to Ramadan (at least 2–4 weeks), NO FURTHER TREATMENT MODIFICATIONS are required.

3.6 Dipeptidyl peptidase-4 (DPP-4) inhibitors

DPP-4 is an enzyme that rapidly metabolises GLP-1, thereby regulating the activity of the hormone. By blocking this action, DPP-4 inhibitors effectively increase the circulating levels of GLP-1, which in turn stimulates insulin secretion in a glucose-dependent manner [13]. Currently available DPP-4 inhibitors include sitagliptin, vildagliptin, saxagliptin, alogliptin and linagliptin, which are administered orally once or twice a day and are considered one of the best tolerated antidiabetic drugs with low risk of hypoglycaemia in non-fasting patients [2]. Four RCTs [21–24] and five observational studies [25–29] have examined the efficacy and safety of DPP-4 inhibitor treatment during Ramadan and are detailed in **Table 4**.

TABLE 4: STUDIES OF DPP-4 INHIBITORS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Sitagliptin	Al Sifri et al., (2011) [21]	N=1,066 Study type: Open-label, randomised, controlled trial Countries: Egypt, Israel, Jordan, Lebanon, Saudi Arabia, UAE Additional medication(s): Metformin (not all patients) Comparator: SU (glimepiride, gliclazide or glibenclamide)	Risk of symptomatic events: Those treated with Sitagliptin had a lower risk of events than those treated with SU (p<0.001) Individuals experiencing symptomatic events: Sitagliptin was associated with fewer events than SU (6.7% and 13.2%) Breakdown of the events in the SU treated group: in ascending order the proportion of events in each group were Gliclazide 6.6%, glimepiride 12.4% and glibenclamide 19.7%	NR	NR

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TABLE 4: STUDIES OF DPP-4 INHIBITORS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Sitagliptin	Aravind et al., (2012) [22]	N=870 Study type: Open-label, randomised, controlled trial Countries: India, Malaysia Additional medication(s): Metformin (not all patients) Comparator: SU (glimepiride, gliclazide or glibenclamide)	Risk of symptomatic events: Sitagliptin was associated with a lower risk of events than SU (p=0.028) Individuals experiencing symptomatic events: Sitagliptin was associated with a lower risk of symptomatic events than SU (3.8% and 7.3%) Breakdown of the events in the SU group: in ascending order the proportion of events in each group were Gliclazide 1.8%, glimepiride 5.2% and glibenclamide 9.1%	NR	NR
Vildagliptin	Al-Arouj et al., (2013) [25]	N=1,315 Study type: Observational Countries: Bangladesh, Egypt, India, Indonesia, Kuwait, Lebanon, Oman, Pakistan, Saudi Arabia, UAE Additional medication(s): Metformin (not all patients) Comparator: SU (glimepiride, gliclazide, glibenclamide or glipizide)	Individuals experiencing ≥ 1 symptomatic event: Vildagliptin was associated with fewer events than SU (5.4% and 19.8%, respectively; p< 0.001) Among those treated with SU: Glipizide 12.5%, glimepiride 17.9%, gliclazide 19.2% glibenclamide 31.8% Events confirmed by BG level: Vildagliptin was associated with a lower risk than SU (2.7% and 12.9%, respectively) Individuals experiencing severe events: there was weak evidence that Vildagliptin was associated with a lower risk of severe events than SU (0 and 4, respectively; p=0.053)	HbA1c change from baseline: SU was associated with a small increase of 0.02% Vildagliptin was associated with a decrease of 0.24% (p<0.001)	Body weight decrease: Vildagliptin was associated with a greater decrease than SU (0.76 kg and 0.13 kg, respectively; p<0.001)
	Devendra et al., (2009) [26]	N=52 Study type: Observational Country: UK Additional medication(s): Metformin Comparator: SU (gliclazide)	Individuals experiencing ≥ 1 event: Vildagliptin was associated with a lower risk gliclazide (7.7% and 61.5%, respectively; p< 0.001) Change in the number of events during Ramadan: Vildagliptin caused a greater decrease in the number of events when compared to gliclazide (p=0.0168)	HbA1c change: similar between both treatment groups	Both treatment groups were associated with a decrease in weight during Ramadan

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TABLE 4: STUDIES OF DPP-4 INHIBITORS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Vildagliptin	Halimi et al., (2013) [27]	N=198 Study type: Observational Country: France Additional medication(s): Metformin Comparators: SU or glinide	Individuals experiencing ≥ 1 symptomatic event: the rates of symptomatic events were similar between all groups (34.2% Vildagliptin and 37.2% comparators; $p=0.665$) Confirmed by BG level: events among those treated with Vildagliptin was similar to those treated with comparators (23.5% and 30.8%, respectively; $p=0.260$) Individuals experiencing ≥ 1 severe event and/or medical visit: There was evidence that Vildagliptin treatment led to fewer severe events when compared to comparators (2.6 % and 10.4%, respectively; $p=0.029$)	Levels were stable and similar in both groups	Weight was stable in both treatment groups
	Hassanein et al., (2011) [28]	N=59 Study type: Observational Country: UK Additional medication(s): Metformin Comparator: SU (gliclazide)	Individuals experiencing events: Vildagliptin was associated with fewer events than SU (-41.7% decrease; $p=0.0002$)	HbA1c: Vildagliptin was associated with lower levels when compared to SU (-0.5%; $p=0.0262$)	No significant changes in weight in either group were observed No significant difference between groups were observed
	Hassanein et al., (2014) [23]	N=557 Study type: Double-blind, randomised, controlled trial Countries: Denmark, Egypt, Germany, Indonesia, Jordan, Kuwait, Lebanon, Malaysia, Russia, Saudi Arabia, Singapore, Spain, Tunisia, Turkey, UAE, UK Additional medication(s): Metformin Comparator: SU (gliclazide)	Symptomatic events: Vildagliptin and gliclazide showed no clear differences (6.0% and 8.7%, respectively; $p=0.173$) Confirmed events: Vildagliptin was associated with fewer events when compared to gliclazide (3.0% and 7.0%, respectively; $p=0.039$)	No significant changes were observed in either group	No significant difference between groups were observed

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TABLE 4: STUDIES OF DPP-4 INHIBITORS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Vildagliptin	Malha et al., (2014) [24]	N=69 Study type: Open-label, randomised, controlled trial Country: Lebanon Additional medication(s): Metformin Comparator: SU (glimepiride, gliclazide)	Events: the number of events in those treated with Vildagliptin was similar to those treated with SU (19 and 26, respectively; p=0.334)	HbA1c change: reductions were seen in both groups during Ramadan but no differences in this reduction were observed between treatments groups	Post-Ramadan BMI: Vildagliptin was associated with a decrease in weight at post-Ramadan from baseline (-0.7 kg/m ²) SU was associated with an increase in weight post-Ramadan from baseline (+0.9 kg/m ²)
	Shete et al., (2013) [29]	N=97 Study type: Observational Country: India Additional medication(s): Metformin (not all patients) Comparator: SU (glimepiride, gliclazide, glibenclamide or glipizide)	Individuals experiencing events: No clear differences were seen between Vildagliptin and SU (0% and 4.8%, respectively; p=0.104)	HbA1c change from baseline: SU was not associated with any changes in HbA1c levels from baseline (p=0.958) Vildagliptin was associated with a decrease in HbA1c levels from baseline -0.43% (p= 0.009) Individuals achieving HbA1c <7.0% (8.6 mmol/L): There was weak evidence that Vildagliptin leads to a greater number of individuals achieving target levels than those treated with SU (16.4% and 4.8%, respectively; p=0.055)	Between-group weight decrease in weight (kg): Vildagliptin was associated with a greater decrease in weight than those treated with SU (1.2 and 0.03, respectively; p<0.001)

BG, blood glucose; BL, baseline; BMI, body mass index; DPP-4, dipeptidyl peptidase-4; HbA1c, glycated haemoglobin; N, number of patients included in study; NR, not reported; UAE, United Arab Emirates; UK, United Kingdom; USA, United States of America; SU, sulphonylurea

Specifically, the four RCTs examined the effects of switching from SU therapy to either vildagliptin or sitagliptin prior to Ramadan compared with continuing on SU. The largest of these studies compared the incidence of self-reported hypoglycaemic events in 1,066 participants with T2DM treated with sitagliptin or SUs (with or without concomitant metformin) that fasted during Ramadan. Overall, the risk of hypoglycaemia significantly decreased on the sitagliptin-based regimen compared to continuing with SU treatment (relative risk ratio = 0.51 95% CI 0.34 to 0.75; p<0.001) [21].

A study in India and Malaysia reported similar results, when the risk of experiencing hypoglycaemic symptoms was almost halved on a sitagliptin regimen compared with SUs (risk ratio = 0.52 95% CI 0.29 to 0.94; $p=0.028$) [22]. In both studies the risk of hypoglycaemia with sitagliptin was equivalent to that of the SU gliclazide.

In the STEADFAST study, 557 individuals with T2DM in the Middle East, Europe and Asia, were randomised to receive either vildagliptin or gliclazide (plus metformin) while fasting during Ramadan. Participants in the study were switched to the study drug at least 8 weeks prior to fasting and continued treatment for up to four weeks after [23]. No statistically significant difference in the reporting of any hypoglycaemic event was observed between the two groups. However, the proportion of individuals experiencing at least one confirmed hypoglycaemic event during Ramadan was lower on vildagliptin when compared with gliclazide (3.0% and 7.0%, respectively $p=0.039$). Both glycaemic control and body weight remained stable throughout the study in both treatment arms.

A number of observational studies have demonstrated significantly lower incidences of hypoglycaemia with vildagliptin treatment when compared to SU during Ramadan (Table 4). One small study in the UK investigated the addition of vildagliptin or gliclazide to treatment regimens during the fasting period. Compared with the period before Ramadan, vildagliptin treatment was associated with a reduction in the number of hypoglycaemic events during Ramadan while gliclazide was associated with an increase. Two individuals (7.7%) in the vildagliptin group experienced hypoglycaemic events during Ramadan compared with 16 (61.5%) in the gliclazide group ($p<0.001$) [26]. Similar results were recorded in the VECTOR study where no self-reported hypoglycaemic events were reported in the vildagliptin group compared with 35 events in 15 (41.7%) individuals in the gliclazide arm (including one severe event). In addition, the change in HbA1c from baseline to post-Ramadan was statistically significantly better in the vildagliptin group compared with the gliclazide group ($p=0.0262$) while body weight remained unchanged in both groups [28].

The French VERDI study that compared the incidence of hypoglycaemic events during Ramadan in individuals who received vildagliptin or an insulin secretagogue in addition to metformin did not find a statistically significant difference in the number of individuals experiencing at least one hypoglycaemic event [27]. However, the proportion of individuals experiencing a severe hypoglycaemic event and/or an unscheduled medical visit due to hypoglycaemia was significantly lower in the vildagliptin group compared with the insulin secretagogue group ($p=0.029$) [27].

In India, a study found a significant reduction in HbA1c (-0.43%, $p=0.009$) and a higher proportion of individuals achieving HbA1c $<7.0\%$ (8.6 mmol/L) among individuals treated with vildagliptin while fasting during Ramadan compared with those treated with SU. No hypoglycaemic events occurred in the vildagliptin group [29].

The VIRTUE study, conducted in the Middle East and Asia, enrolled 1,315 individuals with T2DM. Similarly, it was found that DPP-4 inhibitor treatment (vildagliptin) led to significantly hypoglycaemic events during Ramadan compared with those on SUs (5.4% and 19.8%,



respectively; $p < 0.001$). Individuals on vildagliptin also demonstrated significant reductions in HbA1c and body weight from baseline compared with those on SUs [25].

A recent meta-analysis of 16 RCTs and 13 observational studies in people with T2DM who fasted during Ramadan suggested, in a pooled analysis, DPP-4 inhibitors were associated with the lowest incidence of hypoglycaemic events compared with SU [30]. Other more recently approved DPP-4 inhibitors (alogliptin, saxagliptin, and linagliptin) have not yet been studied during Ramadan and further research is needed.

Moreover, Loh HH *et al.* performed a systematic review and a meta-analysis on studies comparing the use of DPP4 inhibitors against SUs among Muslim individuals with T2DM who fast in Ramadan (N=4,276). DPP4 inhibitors showed similar efficacy to SUs in reducing HbA1c levels and weight change. Compared to insulin secretagogue, individuals on DPP4 inhibitors had a lower risk of hypoglycaemia; among those treated with DPP4 inhibitors the risk of symptomatic hypoglycaemia reduced by nearly 50%, and severe hypoglycaemia by almost 80%. The authors advocated DPP4 inhibitors to be more suitable to individuals deemed to be at high risk of hypoglycaemia (including the elderly, those with renal impairment, erratic food intake or those with history of hypoglycaemia while on SU treatments [31].

The results of the studies described above indicate that vildagliptin can be effective in improving glycaemic control and that both vildagliptin and sitagliptin are associated with lower rates of hypoglycaemia during fasting, making them suitable treatment options during Ramadan. These drugs do not require any treatment modifications during Ramadan.

DPP4-I do NOT REQUIRE TREATMENT MODIFICATIONS during Ramadan.

3.7 Sulphonylureas (SUs)

SUs are widely used as second-line treatment for T2DM after metformin and so there is a wealth of evidence and experience with this low cost efficacious drug class. SUs stimulate insulin secretion from pancreatic β cells in a glucose-independent process. Because of this, SUs are associated with a higher risk of hypoglycaemia compared with other OADs, which has raised some concerns about their use during Ramadan. However, this risk varies across medications within this class due to differing receptor interactions, binding affinities and durations of action. Studies that have evaluated SU treatment in individuals that fasted during Ramadan are outline in **Table 5**.

TABLE 5: STUDIES OF SULPHONYLUREAS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
≥ 1 SUs (glibenclamide, gliclazide, glimepiride and/or glipizide)	Aravind et al., (2011) [32]	N=1,378 Study type: Observational Countries: India, Israel, Malaysia, UAE, Saudi Arabia Additional medication(s): Metformin (not all patients) Comparators: NR	Symptomatic individuals: in ascending order the proportion of events in each group were Gliclazide 14.0%, glimepiride 16.8% and glibenclamide 25.6% Severe events: in ascending order the proportion of severe events were Gliclazide 2.6%, glimepiride 5.1% and glibenclamide 10.8%	NR	NR
	Aravind et al., (2012) [22]	N=870 Study type: Open-label, randomised, controlled trial Countries: India, Malaysia Additional medication(s): Metformin (not all patients) Comparator: DPP-4 inhibitor (sitagliptin)	Risk of symptomatic events: Sitagliptin was associated with a lower risk of symptomatic events than SU (p=0.028) Breakdown of SU group: In ascending order, the proportion of severe events were Gliclazide 1.8%, glimepiride 5.2% and glibenclamide 9.1%	NR	NR

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TABLE 5: STUDIES OF SULPHONYLUREAS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
≥1 SUs (glibenclamide, gliclazide, glimepiride and/or glipizide)	Al Sifri et al., (2011) [21]	N=1,066 Study type: Open-label, randomised, controlled trial Countries: Egypt, Israel, Jordan, Lebanon, Saudi Arabia, UAE Additional medication(s): Metformin (not all patients) Comparator: DPP-4 inhibitor (sitagliptin)	Risk of symptomatic events: Those treated with Sitagliptin had a lower risk of events than those treated with SU (p<0.001) Individuals experiencing symptomatic events: Sitagliptin was associated with fewer events than SU (6.7% and 13.2%) Breakdown of the events in the SU treated group: in ascending order the proportion of events in each group were Gliclazide 6.6%, glimepiride 12.4% and glibenclamide 19.7%	NR	NR
Glibenclamide	Belkhadir et al., (1993) [33]	N=591 Study type: Randomised, controlled trial Country: Morocco Additional medication(s): NR Comparators: Reduced dose of usual glibenclamide	Events: No significant differences were observed between groups	Fructosamine levels: No significant difference between groups were observed HbA1c levels: No significant difference between groups were observed	No significant difference in weight between groups were observed
	Mafauzy, (2002) [11]	N=235 Study type: Open-label, parallel-group, randomised trial Countries: France, Malaysia, Morocco, Saudi Arabia, UK Additional medication(s): None Comparators: SU (glibenclamide)	Ramadan at midday with BG levels below 4.5 mmol/L (%): Repaglinide showed fewer cases when compared with glibenclamide (2.8% and 7.9%, respectively; p=0.001)	Fructosamine levels: Repaglinide led to a statistically significant decrease from baseline (p<0.05) Glibenclamide: did not lead to any statistically significant changes No statistically significant change in HbA1c identified in either group	NR

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TABLE 5: STUDIES OF SULPHONYLUREAS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Glimepiride	Anwar et al., (2006) [10]	N=41 Study type: Open-label, parallel-group, randomised trial Country: Malaysia Additional medication(s): NR Comparator: Insulin secretagogue (repaglinide)	Events: No statistically significant differences observed between groups Symptomatic events during Ramadan: • Repaglinide: 2.9%, • Glimepiride: 3.5%	BG levels: Glimepiride was associated with lower BG levels than repaglinide	NR
	GLIRA Study Group (2005) [34]	N=332 Study type: Observational – newly diagnosed individuals and previously treated individuals Countries: Algeria, Egypt, Indonesia, Jordan, Lebanon, Malaysia Additional medication(s): NR Comparator: NR	Individuals experiencing events: Similar proportions of events were observed pre-Ramadan, during Ramadan and post-Ramadan Newly diagnosed: 3% Previously treated: 3.7%	HbA1c levels pre-Ramadan, during Ramadan and post-Ramadan were: 9.2%, 7.7%, 7.1%, respectively, among those newly diagnosed And 8.4%, 7.7%, 7.3%, respectively, among those previously treated	NR
	Cesur et al., (2007) [9]	N=65 Study type: Observational Country: Turkey Additional medication(s): NR Comparators: Insulin secretagogue (repaglinide), insulin glargine	Individuals experiencing event: No significant difference between treatment groups of glimepiride, repaglinide or insulin glargine (14.3%, 11.1%, 10.0%, respectively) No severe episodes were noted	No significant difference between groups in terms of glycaemic control	No change in BMI in any group was identified

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TABLE 5: STUDIES OF SULPHONYLUREAS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

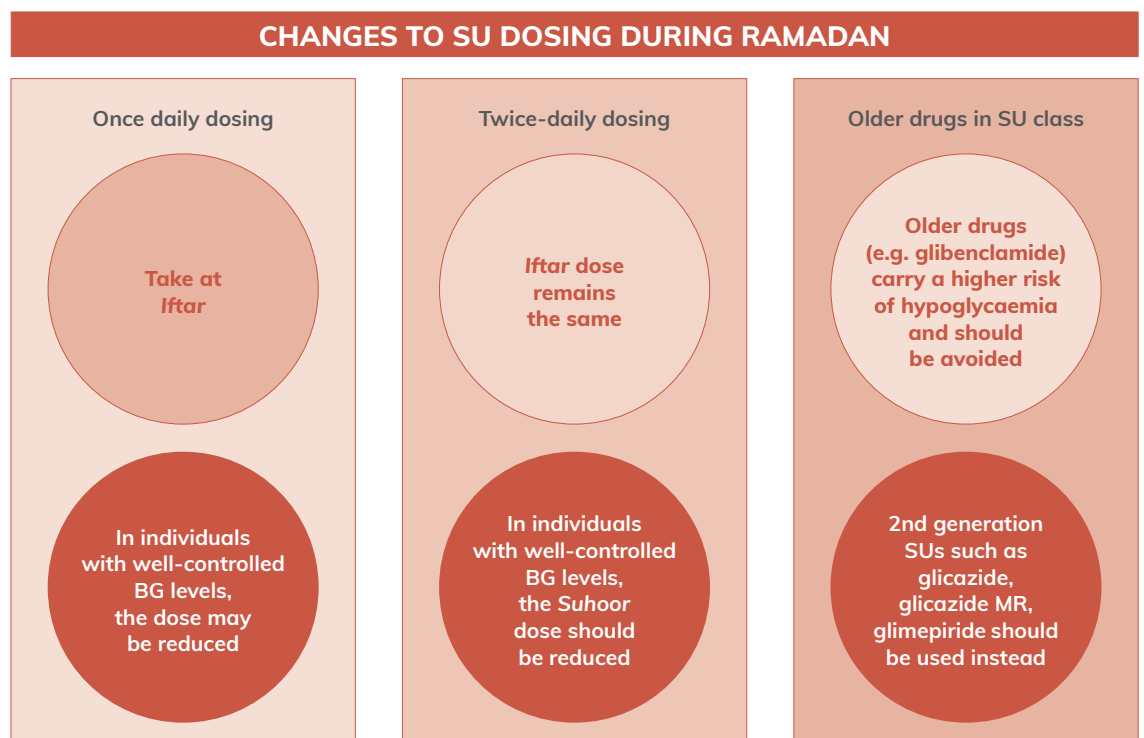
Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Gliclazide	Hassanein et al., (2014) [23]	N=557 Study type: Double-blind, randomised controlled trial Countries: Bangladesh, Egypt, India, Indonesia, Kuwait, Malaysia, Pakistan, Saudi Arabia and UAE. , UK Additional medication(s): Metformin, DPP-4 inhibitor	Symptomatic events: Vildagliptin and gliclazide showed no clear differences (6.0% and 8.7%, respectively; p=0.173) Confirmed events: Vildagliptin was associated with fewer events when compared to gliclazide (3.0% and 7.0%, respectively; p=0.039)	No significant changes were observed in either group	No significant difference between groups were observed
Gliclazide MR	Hassanein et al., (2020) [35]	N=1214 Study type: Real-world observational trial Countries: Bangladesh, Egypt, Indonesia, India, Kuwait, Malaysia, Saudi Arabia, UAE Additional medication(s): any other OAD or GLP1RA	The proportion of individuals with confirmed hypoglycaemia during Ramadan was 1.6% (total cases in all assessment periods before, during and after Ramadan 1.7%) There were no severe cases of hypoglycaemia during or after Ramadan	HbA1c levels were 7.5% (9.4 mmol/L) pre-Ramadan and 7.2% (8.9 mmol/L) post Ramadan; change of -0.3% p<0.001 Fasting Plasma Glucose reduced by 9.7 mg/dL at post-Ramadan compared to pre-Ramadan; p<0.001	Body weight was seen to decrease by 0.5 kg; p<0.001

BG, blood glucose; BL, baseline; BMI, body mass index; DPP-4, dipeptidyl peptidase-4 inhibitor; HbA1c, glycated haemoglobin; N, number of patients included in study; NR, not reported; UAE, United Arab Emirates; UK, United Kingdom; SU, sulphonylurea

In a multinational observational study of 1,378 people with T2DM treated with SUs that fasted during Ramadan, approximately one fifth experienced a symptomatic hypoglycaemic event. When this was broken down by the type of SU, the highest incidence was among those treated with glibenclamide (25.6%) followed by glimepiride (16.8%) and gliclazide (14.0%) [32]. A similar outcome was observed in a large observational study comparing vildagliptin with SU treatment during Ramadan. Symptomatic hypoglycaemic events occurred in 31.8% of individuals on glibenclamide but in fewer individuals treated with gliclazide (19.2%) or glimepiride (17.9%) [25]. In addition, glibenclamide demonstrated significantly more hypoglycaemic events with midday blood glucose <4.5 mmol/L when compared to repaglinide (7.9% and 2.8%, respectively, p=0.001) [11]. Lowering the dose of glibenclamide did not affect the incidence of hypoglycaemic events [33]. More modern SUs such as glimepiride, gliclazide and gliclazide modified release (MR) are therefore much more preferred over conventional SUs such as glibenclamide as the newer drugs have a more favourable safety profile in terms of hypoglycaemia.

No significant differences were observed in the proportions of individuals reporting hypoglycaemic events treated with vildagliptin or gliclazide in the STEADFAST trial (6.0% and 8.7%, respectively, $p=0.173$) [23]. The incidence of hypoglycaemia is also low during the Ramadan fasting period for glimepiride as shown in an open-label observational study where the incidence was just 3% in newly-diagnosed individuals and 3.7% in those previously-treated, and was also comparable to that observed before and after fasting [34]. Similarly, no statically significant differences in hypoglycaemic events were observed when glimepiride treatment was compared with either repaglinide or insulin glargine therapy [9, 10]. Recently, a new trial looking into the modified-release formulation of gliclazide during Ramadan was published. In this large real-world study of 1214 people with T2DM treated with gliclazide MR +/- other OADs, the rates of confirmed hypoglycaemia during Ramadan were 1.6% with no severe hypoglycaemia. Moreover, HbA1c, FPG and weight all improved compared to the baseline measurement [35].

These studies demonstrate that people with T2DM can continue to use modern SUs such as gliclazide MR, gliclazide and glimepiride and fast safely during Ramadan. The use of older drugs within this class, such as, glibenclamide should be avoided during Ramadan. The use of these drugs should be individualised following clinician guidance and medication adjustments are outlined in **Figure 3**.



BG, blood glucose; SU, sulphonylurea

FIGURE 3

Dose adjustments for sulphonylureas in people with T2DM fasting during Ramadan



3.8 Sodium-glucose co-transporter-2 (SGLT2) inhibitors

SGLT2 inhibitors including dapagliflozin, canagliflozin, empagliflozin and ertugliflozin are the newest class of OADs. SGLT2 inhibitors have a unique mode of action whereby they increase the excretion of glucose by the kidneys by reducing reabsorption in the proximal tubule, consequently decreasing blood glucose [36]. SGLT2 inhibitors have demonstrated effective improvements in glycaemic control and weight loss and are associated with a low risk of hypoglycaemia. Because of this, it has been proposed that they can be a safe treatment option for people with T2DM that fast during Ramadan. However, some safety concerns were raised, such as an increased risk of dehydration in vulnerable patients, which may be a particularly pertinent issue during Ramadan. The previous 2016 IDF-DAR guidelines were in favour of using SGLT2I, but there remains a need for caution during among those on loop diuretics, the elderly and those with renal impairment [37].

Over the last 5 years, a greater number of studies assessing the use of SGLT2I have been published. Cardiovascular outcome trials (CVOTs) including CANVAS, EMPA-REG OUTCOME, and DECLARE-TIMI 58 provided evidence of cardiovascular benefits in people with diabetes that took SGLT2I [38-42]. These information were used to important diabetes related guidance such as that of the ADAs, where SGLT2I and GLP1-RA showed cardiovascular benefit and were placed ahead of other classes of drugs in people with cardiovascular disease (CVD) or chronic kidney disease (CKD) or people at risk of these issues [40].

Meanwhile, the use of SGLT2I in people with T2DM that fast during Ramadan have also been studied recently and the outcomes of these are summarised in **Table 6**.

The results of these studies, alongside the importance of SGLT2I as a class for people with or at risk of CVD/CKD, prompted the authors of the Canadian diabetes and Ramadan guidelines to advise on withholding SGLT2I only in circumstances of significant volume depletion such as frequent vomiting or diarrhoea and in situations where medications such as ACE-I and diuretics are used [43].

TABLE 6: STUDIES OF SODIUM-GLUCOSE CO-TRANSPORTER-2 (SGLT2) INHIBITORS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia during Ramadan	Dehydration/Fluid homeostasis
Dapagliflozin	W. S. Wan et al., (2016) [41]	N=110 patients Study type: Randomised, open-label, two-arm parallel group study Country: Malaysia Additional medication(s): Metformin Comparators: SU	Individuals with any reported event of hypoglycaemia: 6.9% in SGLT2i against 28.8% in control; p=0.002	Postural hypotension was reported in 13.8% of those in the SGLT2I group and 3.8% in those control group, this difference was not statically significant; p=0.210 3.5% of individuals on Dapagliflozin reported feelings of thirst

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TABLE 6: STUDIES OF SODIUM-GLUCOSE CO-TRANSPORTER-2 (SGLT2) INHIBITORS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia during Ramadan	Dehydration/Fluid homeostasis
Canagliflozin	Mohamed Hassanein et al., (2017) [44]	N=379 Study type: Prospective, comparative, observational study Country: Lebanon, Kuwait, UAE Additional medication(s): Metformin with or without DPP-4 inhibitors Comparators: SU	Individuals with symptomatic events of hypoglycaemia: 3.7% had an event in the and SGLT2i group compared to 13.2% in the SU group, adjusted odds ratio 0.27 (95% CI 0.10 – 0.72) p=0.009	Hypovolemia was seen in 16.1% of SGLT2i group and 5% of the SU group The adjusted odds ratio for SGLT2i against SU was 3.5 (95% CI 1.3 – 9.2) p=0.011
Canagliflozin, Dapagliflozin	Alaaeldin Bashier et al., (2018) [45]	N=417 Study type: Retrospective, observational study Country: UAE Additional medication(s): other oral hypoglycaemic agents (OHA) not including SU, insulin Comparators: SGLT2i with insulin; SGLT2i with SU; SGLT2i with OHA	Symptomatic events of hypoglycaemia: 27% of all individuals experienced symptomatic hypoglycaemia Confirmed events of hypoglycaemia: 18.7% 37.8% of those treated with SGLT2i and insulin saw a confirmed case of hypoglycaemia compared to 18.0% among those treated with SGLT2i and OHAs; p<0.005	Feelings of thirst were seen among 13.1% of those treated with SGLT2i and insulin compared to 6.1% among those treated with SGLT2i and OHA; p 0.03
Canagliflozin, Dapagliflozin	Y. Shao et al., (2018) [46]	N=68 Study type: Prospective, observational controlled cohort study Country: Singapore Additional medication(s): SUs, other oral antidiabetic drugs (OAD), insulin Comparators: Individuals not using SGLT2is	Individuals experiencing events: There were no statistically significant differences seen among both groups No cases of severe hypoglycaemia were reported	There was a decrease seen in systolic blood pressure in both groups but no significant differences were seen between both groups
Dapagliflozin, Canagliflozin	Abdelgadir et al., (2019) [47]	N=95 Study type: Prospective, controlled study Country: UAE Additional medication(s): SUs, other oral hypoglycaemic agents (OHA) not including SU, insulin Comparators: Individuals not using SGLT2is	Hypoglycaemic events measured through flash glucose monitoring systems: 3.9% of those on SGLT2i had events compared to 3.3% of those not on SGLT2i, this difference was non-significant; p=0.97	No reported cases of any adverse events No statistically significant changes to systolic blood pressure reported in either group

N, number of patients included in study; UAE, United Arab Emirates; SU, sulphonylurea



The results of the studies in Table 6 have prompted several diabetes and Ramadan experts to reconsider the current recommendations for the use of SGLT2-I during Ramadan fasting [48]. However, these studies indicate the following recommendations:

- For stabilisation, SGLT2Is should be initiated at least two weeks to one month prior to Ramadan. SGLT2Is are recommended to be administered at the time of evening meal (*Iftar*). However, if the indication for SGLT2I initiation is cardiovascular or renal protection, then the pre-Ramadan initiation should be conducted with a lower dose.
- Increasing fluid intake during the non-fasting hours of Ramadan is recommended.
- Raising awareness among physicians about recent guideline changes and the benefits of new antihyperglycaemic agents is important.
- When choosing an antihyperglycaemic therapy, the impact on heart failure and renal function must be considered.
- SGLT2I do not require treatment modifications during Ramadan, however if an individual is on multiple medications a review of the doses should be made to avoid the risk of hypoglycaemia.
- SGLT2I use when fasting during Ramadan should be in accordance with the usual safety and prescribing measures as recommended by each drug SMP.

**SGLT2 inhibitors have a low risk of hypoglycaemia.
NO DOSE ADJUSTMENTS are required during Ramadan.**

3.9 Individuals on multiple antidiabetic therapy

The availability of several new glucose lowering therapies has made it increasingly common for individuals to be prescribed multiple drug regimens while fasting during Ramadan. The risk of hypoglycaemia may be amplified, especially since individuals on multiple glucose lowering therapies are likely to be older and with multiple comorbidities. Indeed, in the large multi-country, retrospective observational CREED study the group on multiple therapies was found to be at a higher risk of developing hypoglycaemia [49].

In a prospective study investigating dose adjustments of multiple antidiabetic agents for individuals with T2DM that fasted during the month of Ramadan (PROFAST Ramadan Study), Elhadd *et al.* assessed the incidence of hypoglycaemia. The methodology included the implementation of the DAR-IDF guidelines with pre-Ramadan education and adjustments of oral (50% reduction in sulphonylurea, a maximum of 1 g metformin, no changes in DPP4I or SGLT2I) and injectable (50% reduction in insulin, no change in GLP-1) glucose-lowering therapies. The overall incidence of hypoglycaemia (symptomatic and confirmed with blood glucose reading) during Ramadan was 16.3%, with the highest incidence in the group on insulin, SU and other agents (31.3%). The risk of hypoglycaemia was greatest among individuals on a combination of basal insulin, DPP4I and metformin and those on four or more glucose lowering therapies [50].

Furthermore, in a subgroup of individuals who underwent flash continuous glucose monitoring (FGM), it was found that individuals that were more physically active were shown to be more prone to asymptomatic hypoglycaemia [51]. The mitigation of hypoglycaemia in individuals that fasted during Ramadan was achieved by reducing the dose of basal insulin or SU according to the PROFAST-Ramadan protocol, confirming earlier findings from Elhadd *et al.* [52].

Recently, data from a Fitbit-2 pedometer and Freestyle Libre flash continuous glucose monitoring system and applied artificial intelligence (AI) and machine learning models have been developed to predict hyperglycaemic and hypoglycaemic excursions in individuals who fast during Ramadan [53]. These prognostic models can be very useful in the future in risk stratifications and medication recommendations. Further studies are needed in this area where individuals that fast during Ramadan can have their glycaemic profile data collected, this may be best conducted using continuous glucose or flash glucose monitoring systems.

Several other studies comparing individuals on multiple glucose lowering therapies have been published recently. The canagliflozin in Ramadan Tolerance Observational Study (CRATOS) study, assessed individuals with T2DM who fasted during Ramadan. This study showed that those on canagliflozin and metformin with or without a DPP4I had a lower risk of hypoglycaemia when compared to those on an SU with metformin, with or without a DPP4I. However, only 57% of the canagliflozin group and 50% of the SU group were on 3 agents [44].

In another study of individuals with T2DM who did not undergo adjustments to their oral agents, it was found that a lower rate of overall hypoglycaemia (rate ratio of 0.26, 95% CI 0.16-0.44; $p < 0.001$) and nocturnal hypoglycaemia (rate ratio of 0.17, 95% CI 0.08-0.38; $p < 0.001$) was associated with the use of insulin degludec/insulin aspart compared to biphasic insulin aspart 30 [44].

More recently in the ORION study, individuals with T2DM who fasted during Ramadan and did not undergo any adjustments to their oral agents (where 74% were on metformin, 47% on DPP4I, 45% on SU and 24% on SGLT2I) or basal insulin reported a very low incidence of overall hypoglycaemia [54].

One can conclude that the risk of hypoglycaemia among individuals on multiple antidiabetic agents is determined by multiple factors, of which include their medication, duration of their diabetes, renal function, pre-Ramadan glycaemic control and presence of other comorbidities. Risk stratification and dose adjustment of therapies using AI based algorithms utilising continuous glucose and activity monitoring may allow optimal outcomes tailored to the individual patient.



3.9.1 CONSIDERATIONS AND RECOMMENDATIONS:

1. Many individuals on multiple antidiabetic agents have a long duration of diabetes, multiple comorbidities and renal impairment. Hence, they are at higher risk of hypoglycaemia when fasting during Ramadan.
2. Individuals with T2DM on 3 or more antidiabetic agents who fast during Ramadan, should receive counselling and comprehensive advice on diet, lifestyle and drug dose modifications prior to Ramadan.
3. Individuals on 3 or more drug combinations, especially those on both insulin and SU should be considered at an increased risk of hypoglycaemia. An approximate 25-50% reduction in the dose of insulin is advised, depending on the subsequent risk score after risk stratification. A reduction in the dose of SUs is also advocated in these individuals.
4. Newer technologies including continuous glucose monitoring and activity monitoring need to be harnessed through AI to reduce the risk of hypoglycaemia in people with diabetes that are on multiple antidiabetic agents and fast during Ramadan.

3.10 Insulin treatment for T2DM

Many individuals with T2DM are on insulin therapy to control their diabetes and a variety of insulin regimens are used. These include long/intermediate basal insulins (insulin glargine, insulin detemir, insulin degludec or neutral protamine Hagedorn insulin) that are often combined with oral agents; basal insulin with bolus prandial rapid or short-acting insulins (lispro, glulisine, aspart or regular human insulin); and premixed insulins (fixed ratio combinations of short and intermediate acting insulins) [55].

Insulin use during fasting carries a risk of hypoglycaemia, especially when more complex insulin regimens are used. Although a small number of randomised trials and observational studies (**Table 7**) have been conducted to assess some insulin regimens during Ramadan, however information from large RCTs in this area are lacking.

TABLE 7: STUDIES EVALUATING INSULIN TREATMENTS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Basal insulin: glargine	Bakiner et al., (2009) [7]	N=19 Study type: Observational Country: Turkey Additional medication(s): insulin secretagogue (repaglinide) Comparator: Non-fasting control group	Events: None reported in either group	No difference between the two groups	No significant weight changes in either group

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TABLE 7: STUDIES EVALUATING INSULIN TREATMENTS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Basal insulin: glargine	Cesur et al., (2007) [9]	N=65 Study type: Observational Country: Turkey Additional medication(s): NR Comparators: SU (glimepiride), insulin secretagogue (repaglinide)	Individuals experiencing event: No significant difference between treatment groups of glimepiride, repaglinide or insulin glargine (14.3%, 11.1%, 10.0%, respectively) No severe episodes were noted	No significant difference between groups in terms of glycaemic control	No change in BMI in any group was identified
	Salti et al., (2009) [56]	N=412 Study type: Observational Countries: Bangladesh, China, Egypt, India, Indonesia, Kuwait, Jordan, Lebanon, Malaysia, Morocco, Oman, Saudi Arabia, Tunisia, UAE Additional medication(s): SU (glimepiride), metformin/TZD (not all individuals) Comparator: None	Events before, during and after Ramadan: (156, 346, 153, respectively) the increase from pre-Ramadan to during Ramadan was statistically significant, $p<0.001$ The subsequent decrease from during Ramadan to post-Ramadan was also statistically significant, $p<0.001$	No major changes observed during Ramadan	NR
Glargine 300	Hassanein et al., (2020) [35]	N=1214 Study type: Real-world observational trial Countries: Bangladesh, Egypt, Indonesia, India, Kuwait, Malaysia, Saudi Arabia, UAE Additional medication(s): any other OAD or GLP1RA	The proportion of individuals with confirmed hypoglycaemia during Ramadan was 1.6% (total cases in all assessment periods before, during and after Ramadan 1.7%) There were no severe cases of hypoglycaemia during or after Ramadan	HbA1c levels were 7.5% (9.4 mmol/L) pre-Ramadan and 7.2% (8.9 mmol/L) post Ramadan; change of -0.3% $p<0.001$ Fasting Plasma Glucose reduced by 9.7 mg/dL at post-Ramadan compared to pre-Ramadan; $p<0.001$	Body weight was seen to decrease by 0.5 kg; $p<0.001$

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TABLE 7: STUDIES EVALUATING INSULIN TREATMENTS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Prandial insulin: lispro	Akram et al., (1999) [57]	N=68 Study type: Open-label, crossover, randomised trial Countries: Egypt, Kuwait, Pakistan, Saudi Arabia, UAE Additional medication(s): Humulin NPH (basal) Comparator: Soluble insulin (Humulin R)	Individuals experiencing event: The proportions of individuals experiencing the number of events were similar for both treatment groups Events per individual per 14 days: Individuals on Insulin lispro had fewer events (1.3%) than people on soluble insulin (2.6%); p<0.002 No severe episodes	Increases in postprandial BG (mmol/L): Insulin lispro was associated with smaller increases when compared to soluble insulin (1 hour after meal: 3.0 and 4.3, respectively; p<0.01 2 hours after meal: 2.6 and 4.0, respectively; p=0.008)	NR
Premixed insulin regimens					
Insulin lispro Mix 50 (evening) and human insulin Mix 30 (morning)	Hui et al., (2009) [58]	N=52 Study type: Observational Countries: UK Additional medication(s): NR Comparator: Human insulin Mix 30 (twice daily)	Hypoglycaemic events during compared to before Ramadan: Group 1 - insulin lispro Mix 50 and human insulin Mix 30 led to a non-significant decrease of 0.04; p=0.81 Group 2 - Human insulin Mix 30 led to a non-significant increase of 0.15; p=0.43 The between group difference was not significant; p=0.36	HbA1c change: both groups were associated with decreases in HbA1c levels during Ramadan Group 1 - insulin lispro Mix 50 and human insulin Mix 30 led to a decrease of 0.48% (p = 0.0001) Group 2 - Human insulin Mix 30 led to a decrease of 0.28% (p = 0.007) Between-group difference, p<0.001	No significant differences in weight changes were observed between groups However, the reduction in weight pre-Ramadan and after Ramadan in group 1 (individuals on insulin lispro Mix 50 and human insulin Mix 30) was statistically significant; p<0.001

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TABLE 7: STUDIES EVALUATING INSULIN TREATMENTS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Premixed insulin regimens					
Insulin lispro Mix 25	Mattoo et al., (2003) [59]	<p>N=151</p> <p>Study type: Open-label, crossover, randomised trial</p> <p>Countries: Egypt, India, Malaysia, Morocco, Pakistan, Singapore, South Africa</p> <p>Additional medication(s): NR</p> <p>Comparator: Soluble insulin 30/70</p>	<p>Events per individuals per 14 days:</p> <p>Proportions of events were similar for both treatment groups</p>	<p>Daily glycaemia (mmol/L)</p> <p>Overall glycaemia: Glycaemia among those on Insulin lispro (9.5 mmol/L) was significantly lower than soluble insulin (10.1 mmol/L); p=0.004</p> <p>Pre-evening meal glycaemia: Glycaemia among those on Insulin lispro (7.1 mmol/L) was significantly lower than soluble insulin (7.5 mmol/L); p=0.034</p> <p>2 hours post-evening meal glycaemia: Glycaemia among those on Insulin lispro (10.5 mmol/L) was significantly lower than soluble insulin (11.6 mmol/L); p<0.001</p>	No significant changes in body weight were observed
	Hajjaji et al., (2019) [60]	<p>N=40</p> <p>Study type: Prospective observational study</p> <p>Countries: Libya</p> <p>Additional medication(s): Oral antidiabetic medications</p> <p>Comparator: Human insulin Mix30 twice daily</p>	<p>Hypoglycaemia: Minor episodes were experienced in 6 individuals in total (3 in each treatment group)</p>	<p>Blood glucose levels: During Ramadan, individuals on insulin 50% insulin lispro, 50% insulin lispro protamine suspension mix (experimental group) saw a decrease in the blood glucose levels by 21.1 mg% (1.2 mmol/L) more than the decrease in the Mixtard 30 group (control). This difference was statically significant (p<0.001)</p>	NR

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TABLE 7: STUDIES EVALUATING INSULIN TREATMENTS IN PEOPLE WITH T2DM THAT FASTED DURING RAMADAN

Study drug	Authors (Date)	Study details	Hypoglycaemia	Glycaemic control	Body weight changes
Premixed insulin regimens					
Insulin detemir and biphasic insulin aspart	Shehadeh et al., (2015) [61]	N=245 Study type: Open-label, prospective, randomised controlled trial Countries: Israel Additional medication(s): Metformin, SU (not all patients) Comparator: Standard care – ADA recommended insulin regimen	Individuals experiencing an event: This in the intervention group (aspart and detemir) had lower risk of hypoglycaemia (4.8%) when compared to standard care (ADA recommended regimen) (21.4%), p<0.001	Intervention was non-inferior to standard care in terms of blood glucose levels	NR
IDegAsp-70% insulin degludec and 30% insulin aspart	Hassanein et al., (2018) [62]	N= 263 Study type: Phase III open label randomised trial, Countries: Algeria, India, Lebanon, Malaysia and South Africa Additional medication(s): Oral antidiabetic drugs Comparator: Biphasic insulin Aspart 30, twice daily	The rate of overall hypoglycaemia throughout the treatment period was statistically significantly lower in the IDegAsp arm compared with in the BIAsp 30 arm, estimated rate ratio (ERR) 0.26, 95%CI: 0.16-0.44; p < .0001 This corresponded to a 74% reduction in the rate of overall hypoglycaemia.	Glycaemic control: Glycaemic control was maintained in both treatment arms throughout the study period. No statistically significant differences between the arms were reported	NR
Biphasic insulin aspart	Soewondo et al., (2009) [63]	N=152 Study type: Observational Countries: Indonesia Additional medication(s): Oral hypoglycaemic agents (not all patients) Comparator: None	Hypoglycaemic events: At the end of the study there were no clear differences found in the number of events compared to baseline	Biphasic aspart reduced all glycaemic indices - fasting plasma glucose (FPG), 2-hour postprandial plasma glucose (2-hr PPG), and glycosylated hemoglobin (HbA1c)	No significant changes in body weight or BMI were observed

BG, blood glucose; BL, baseline; BMI, body mass index; HbA1c, glycated haemoglobin; N, number of patients included in study; NPH, Neutral Protamine Hagedorn; NR, not reported; TZD, thiazolidinediones, UAE, United Arab Emirates; UK, United Kingdom; SU, sulphonylurea

Many individuals on insulin therapy elect to fast irrespective of their risk level and the advice of their physicians. It is, therefore, important that the physician gathers information about the individual's intention to fast and then assist the individual to fast safely. While the primary focus of concern is often placed on the risk of hypoglycaemic, care should also be given to glycaemic control during the Ramadan period.

As with all diabetic therapies, the insulin regimen must be individualised according to the individual's needs by taking into account their education, preferences, diet and lifestyle. Some authors recommend switching twice daily premixed or intermediate-acting insulin to long-acting or intermediate-acting insulin in the evening and rapid-acting insulin with meals [64]. Asking people with diabetes to change their regimen only for the Ramadan period may lead to errors, non-adherence and require additional education that is not readily available due to time and resource constraints. The physician/HCP should therefore assess whether a new treatment regimen is needed or whether modification of the dosing regimen of the insulins used prior to Ramadan is required. The individual's pre-Ramadan glycaemic control will determine whether insulin dose reductions are required. People who have controlled their diabetes well prior to Ramadan will usually require a dose reduction to minimise the risk of hypoglycaemia. This dose reduction is often not applicable in individuals with a history of poor control as insulin doses would likely be insufficient.

There is some evidence that insulin analogues, when used in place of human insulin, can reduce the risk of hypoglycaemia in people with diabetes [65] and also people with T2DM that fast during Ramadan [57]. Additionally, Akram *et al.* showed that insulin analogues could be associated with a lower risk of post-prandial hyperglycaemia when compared to human insulin [57]. There are also practical advantages associated with insulin analogues. Insulin analogues are injected just before a meal or even after a meal, meaning individuals that are fasting can administer the injection at the time of breaking the fast or at the time of *Suhoor* instead of 30 minutes prior to the meal.

It is therefore recommended that individuals wishing to fast be switched to insulin analogues for the month of Ramadan if hypoglycaemia, convenience and postprandial hyperglycaemia are areas of concern. The starting dose of insulin analogues should be 20-30% lower than the dose of regular insulin [66].

It must be emphasised that the administration of insulin via the subcutaneous, intramuscular or intravenous routes do not cause a breaking of the Ramadan fast. Individuals are still able to take their morning insulin or correction insulin doses after the fast has commenced.

In addition, modifications of insulin regimens, monitoring of blood glucose levels and self-titration of insulin doses while fasting all need implementation to enable safe fasting during Ramadan for individuals with diabetes.



3.10.1 Evidence for insulin use in Ramadan

3.10.1.1 Basal insulin

There is an increasing body of evidence supporting the safety of basal insulin for use in individuals with T2DM fasting during Ramadan.

In many studies, basal insulin was used in combination to oral hypoglycaemic agents. An observational study conducted on people with T2DM that fasted during Ramadan and were treated with insulin glargine and glimepiride saw a significant increase in mild hypoglycaemic events compared with the pre-Ramadan period; it was also found that a lower weight and smaller waist circumference was associated with this increased risk [56]. Two smaller observational studies found insulin glargine as safe for use during Ramadan, finding no evidence of increases to the risk of hypoglycaemia when compared with non-fasting individuals or when compared with individuals taking other OADs [7, 9]. A larger prospective observational study across 11 countries (the ORION trial) demonstrated that the second-generation basal insulin analogue, glargine 300u/ml, could be used safely in combination with oral agents in a real-world clinical setting. In this study, the majority of participants fasted for the full month of Ramadan and there was a low incidence of symptomatic hypoglycaemia and no episodes of severe hypoglycaemia. This study also demonstrated that glycaemic control can be successfully intensified in the Ramadan period without an added risk of hypoglycaemia [54].

3.10.1.2 Prandial insulin

Pre-meal administration of rapid or short-acting insulins may be required, in addition to long-acting basal insulin, to help control postprandial blood glucose. Akram *et al.* demonstrated this by compared the effects of two such insulins taken before *Iftar* during Ramadan — rapid-acting analogue insulin lispro and short-acting soluble human insulin. The postprandial rise in blood glucose levels after *Iftar* and the rate of hypoglycaemia were both significantly lower in the lispro group [57].

3.10.1.3 Premix insulin

Premixed insulins that combine short- and intermediate-acting insulins can be more convenient for individuals with diabetes, as they require fewer injections than basal-bolus regimens. However, they may be associated with a higher risk of hypoglycaemia in non-fasting individuals [67, 68].

Moreover, an open-label randomised trial compared the effects of two premixed insulin formulations on glycaemic control during Ramadan (analogue insulin lispro Mix25 – 25% short-acting lispro or 75% intermediate-acting lispro protamine; and human insulin 30/70 – 30% short-acting soluble human insulin or 70% intermediate-acting natural protamine hagedorn). Overall glycaemia was significantly lower among individuals on insulin lispro Mix25 compared with those on human insulin 30/70. Treatment effects were greatest when glycaemia levels were compared before and after *Iftar*. There was no difference observed in the number of hypoglycaemic episodes between treatments [59].

A prospective observational study in Indonesia found that biphasic insulin aspart reduced all glycaemic indices following Ramadan when compared to the period before Ramadan, without an increase in body weight or an additional risk of hypoglycaemia [63]. A multinational, randomised treat-to-target trial, comparing IDegAsp (co-formulated with 70% ultralong-acting analogue insulin degludec and 30% rapid-acting analogue insulin aspart) twice daily (BID) to twice daily BAsp 30 (70% intermediate-acting aspart and 30% rapid-acting aspart) demonstrated that IDegAsp achieved similar levels of control to blood glucose levels but with the added benefit of a lower risk of overall and nocturnal hypoglycaemia [62].

The commonest premix insulin formulations are low-ratio premix insulins with 25-30% short/rapid-acting insulin and 70-75% intermediate-acting insulin. This poses a challenge during Ramadan as the lower ratio of short/rapid acting insulin may provide inadequate prandial cover in the evening for the resultant post-prandial hyperglycaemia. Since the dose of prandial insulin cannot be independently adjusted there is also a risk of both post-prandial hyperglycaemia and hypoglycaemia after the morning meal.

A regimen of premixed insulin lispro Mix50 (50% lispro and 50% lispro protamine) in the evening and regular human insulin with natural protamine hagedorn (NPH) (30:70) in the morning was compared with regular human insulin with NPH (30:70) given twice daily during Ramadan in a small observational study. Switching the evening meal dose to insulin lispro Mix50 significantly improved glycaemic control without increasing the incidence of hypoglycaemic events [58]. A similar study from Libya also demonstrated improved post-prandial glucose control without an increase in hypoglycaemia [60]. A new regimen in which 40% of the daily insulin dose was given as insulin detemir at *Suhoor* and 60% was given as NovoMix70, a biphasic insulin aspart, before *Iftar* was assessed in a randomised study. The new regimen was found to be non-inferior to standard care with a significantly lower hypoglycaemic event rate [61]. These studies demonstrate that in appropriately selected individuals, pre-mix insulin can be safely used when fasting during Ramadan.

3.10.1.4 Insulin dose adjustments and monitoring

Specific recommendations on the optimal dosing and regimen strategies are difficult to make as there is limited evidence in the area of fasting during Ramadan. The results from the studies described in **Table 7** indicate that it may be safe to fast while on insulin. However, treatment must be appropriately individualised.

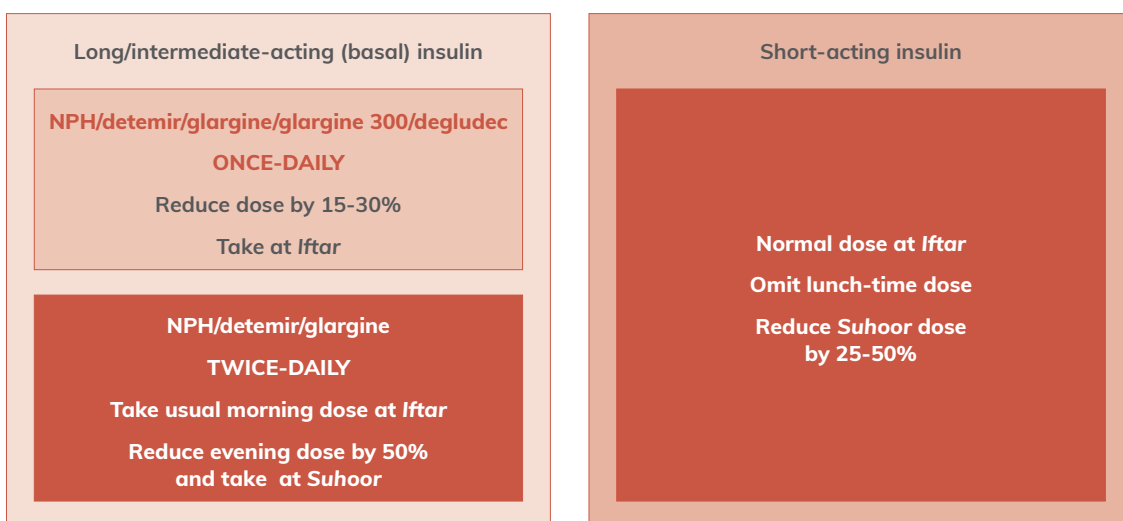
Recommended medication adjustments and SMBG-guided dose titrations for long/intermediate or short-acting insulin and premixed insulin can be found in **Figures 4** and **5**, respectively.

It must be emphasised that individuals need to be educated on SMBG and self-titration of insulin doses to ensure safe fasting. The times for monitoring are dependent on the insulin regimen used. Those individuals that are high risk or very high risk should check their blood glucose levels several times throughout the day when fasting. Similarly, those that are at the highest risk of hypoglycaemia (i.e. individuals on treatment regimens that are not glucose dependent such as insulin or SUs) should increase their levels of SMBG so that there are



several checks throughout the fasting period each day — those on premixed insulins should aim for at least 2-3 daily readings and whenever hypoglycaemic symptoms appear, individuals on other insulin regimens should aim to use the 7-point blood glucose monitoring method (a check of blood glucose levels when fasting; post-breakfast; pre-lunch; post-lunch; pre-dinner; post dinner; and midnight).

CHANGES TO LONG AND SHORT-ACTING INSULIN DOSING DURING RAMADAN



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

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

FIGURE 4
Dose adjustments for long or short-acting insulins

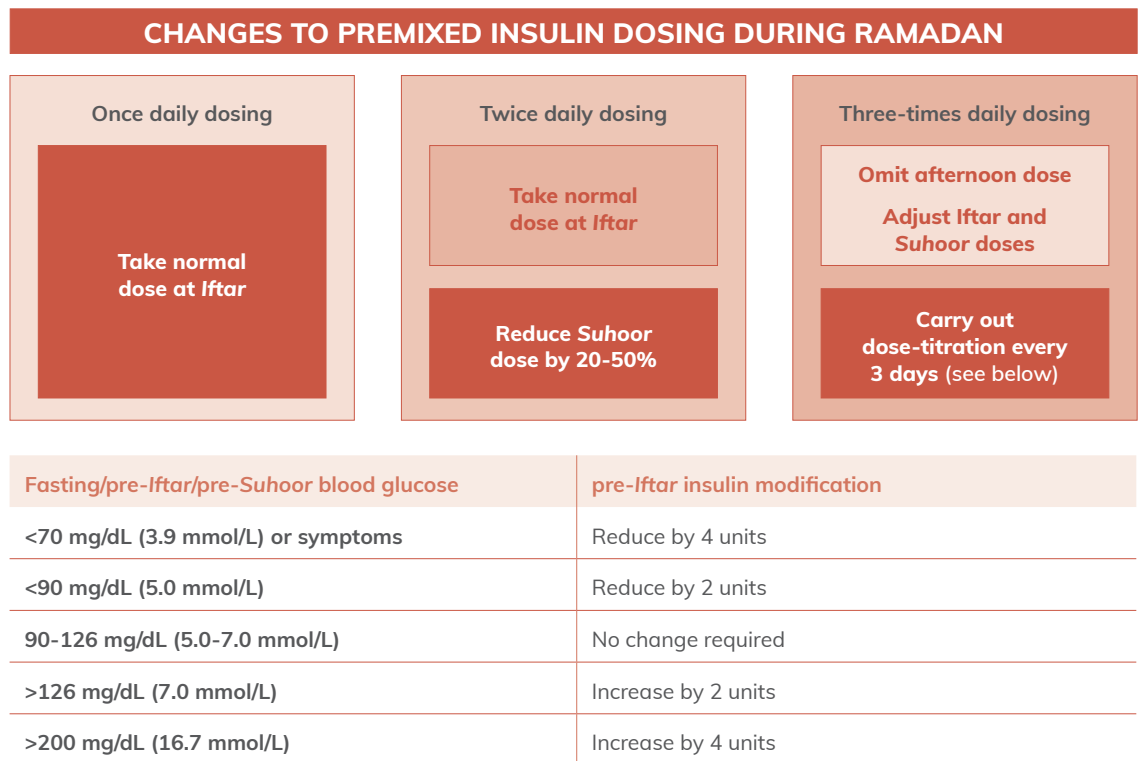


Table adapted from Hassanein et al. (2014) [66].

FIGURE 5

Dose adjustments for premixed insulin

3.10.1.5 Insulin pump users

Recommendations for dose adjustments in people with T2DM that are on insulin pump therapy are presented in **Figure 6**. Other information that may be useful for insulin pump users are presented in the **chapter 9: Management of Type 1 diabetes when fasting during Ramadan**.

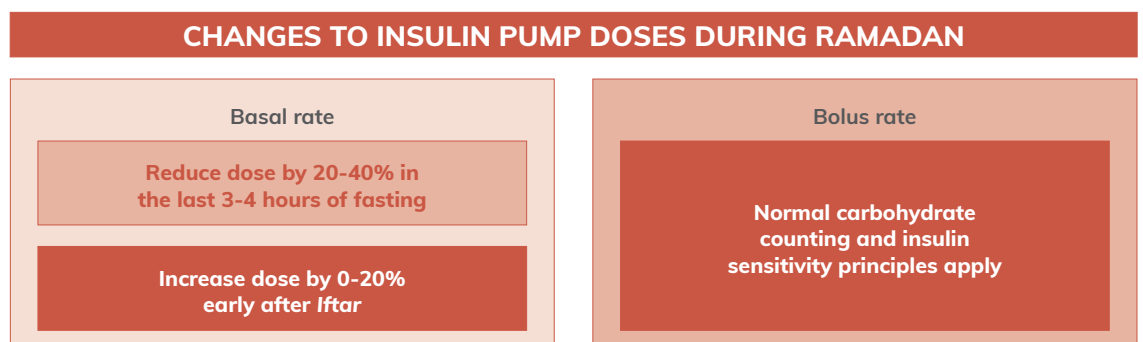


FIGURE 6

Dose adjustments for insulin pump therapy



4. POST-RAMADAN FOLLOW-UP

Eid ul-Fitr, a 3-day festival, marks the end of Ramadan and individuals with T2DM should be made aware of the risks of overindulgence during this time. A post-Ramadan follow-up meeting with HCPs is advisable in order to discuss medication and regimen readjustments and assess how the patient handled fasting during Ramadan. It should be stressed to the patient that fasting safely one year does not guarantee that they can fast safely the next nor make them a low risk for the Ramadan due to the progressive nature of diabetes.

SUMMARY

- A pre-Ramadan assessment is vital for any Individual with T2DM that intends to fast in order to evaluate the risks, educate the patient in self-management of the condition during Ramadan and to produce a patient-specific treatment plan.
- There are advantages and disadvantages associated with the different treatment options for people with T2DM that seek to fast during Ramadan.
 - Individuals taking metformin, SUs, insulin secretagogues or insulin will need to make dose adjustments to reduce the risk of hypoglycaemia.
- Individuals on multiple antidiabetic therapies will find themselves at a greater risk of hypoglycaemia
 - Counselling is recommended to individuals on 3 or more antidiabetic agents
 - Dose reductions need to be made to accommodate for the increased risk of hypoglycaemia.
- Artificial intelligence in the form of machine learning prognostic modelling can be a useful tool for future use in risk stratification and planning strategies for dose modifications.
- A post-Ramadan follow-up consultation is recommended to reassess treatment regimens and discuss fasting experiences during Ramadan.
- With the correct advice and support from HCPs most people with T2DM can fast safely during Ramadan.

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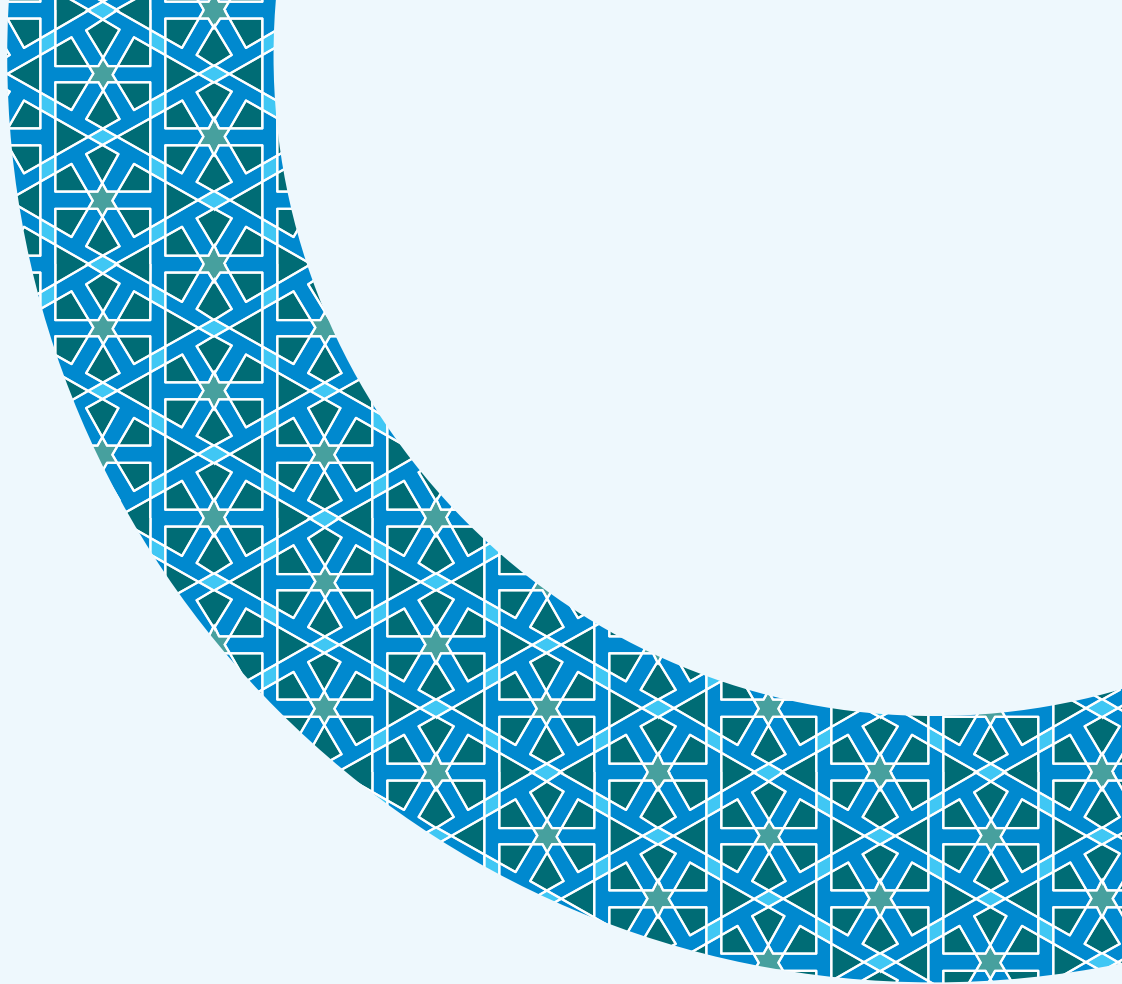


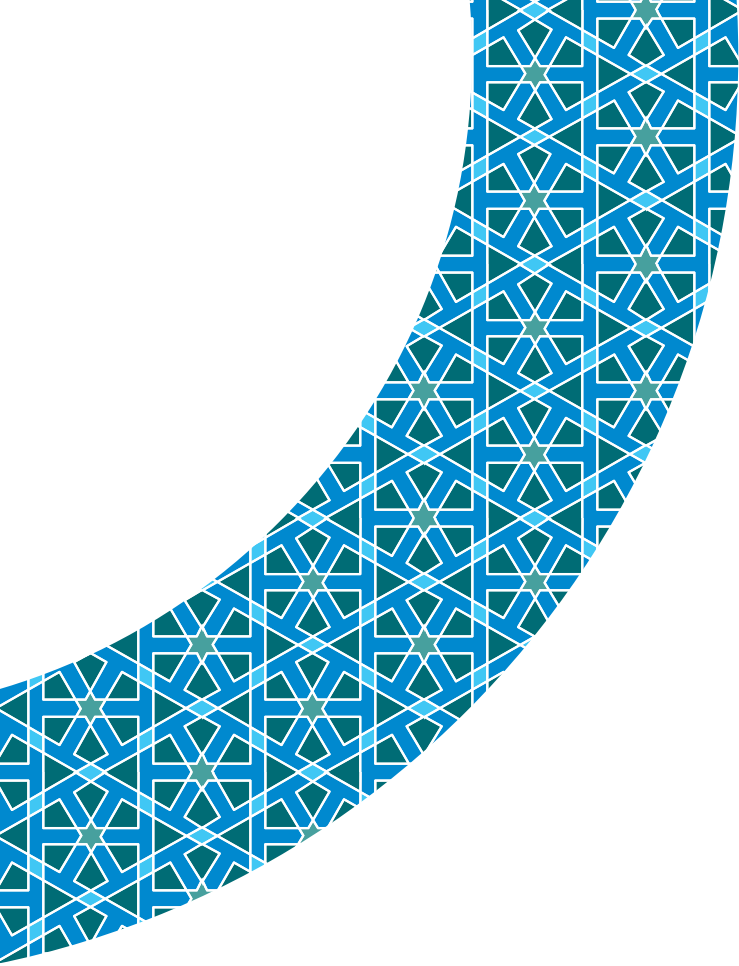
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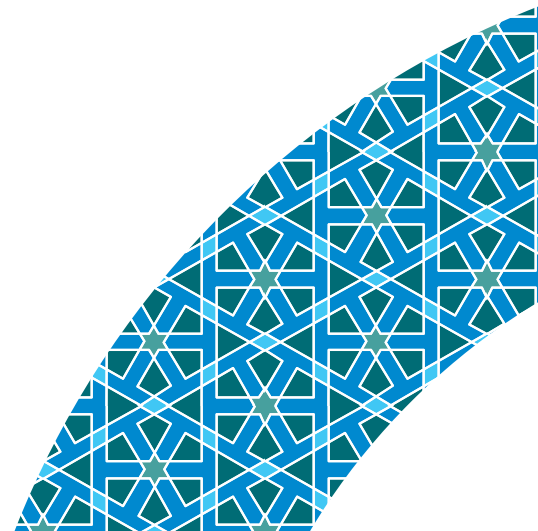


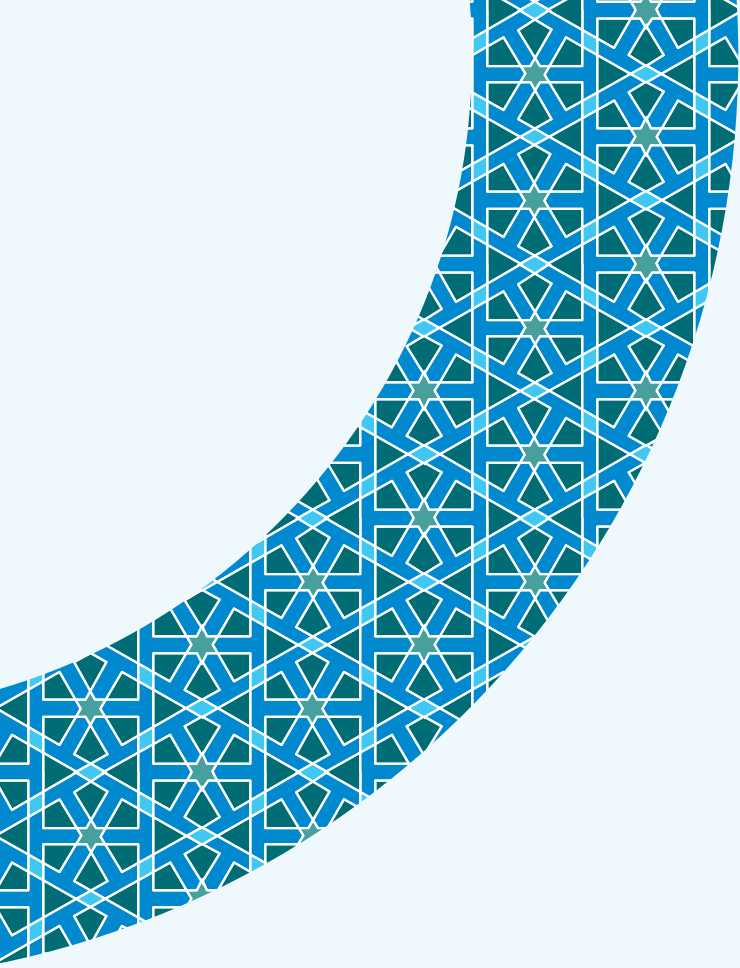
CHAPTER 11

Management of hyperglycaemia in pregnancy when fasting during Ramadan

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CHAPTER 11

1. INTRODUCTION	249
2. PREGNANCY AND FASTING	249
3. DIABETES IN PREGNANCY AND FASTING	249
4. MANAGEMENT OF HIP	250
4.1 Pre-Ramadan Assessment	250
4.2 Education and Blood Glucose Monitoring	250
4.3 Physical Activity	250
4.4 Nutritional care and meal planning	250
4.5 Recommendations for the management of hyperglycaemia in pregnancy during Ramadan fasting	251
4.6 T2DM or GDM controlled by diet alone or with Metformin	251
4.7 Insulin treated pregnant women	252
SUMMARY	253
REFERENCES	254



WHAT IS KNOWN?

- Ramadan fasting in healthy pregnant women is associated with biochemical changes somewhat similar to the effects of prolonged fasting with an increase in triglycerides (TG), free fatty acids (FFA) and Ketones and a decrease in glucose and insulin.
- Healthy pregnant women that fast during Ramadan can safely do so with no significant effects to the mother or the fetus.
- Pregnant women with hyperglycaemia need to achieve tight glycaemic targets, for both fasting and postprandial blood glucose levels, to avoid adverse pregnancy outcomes.
- There is a lack of comprehensive data demonstrating physiological changes, as well as mother and fetal outcomes in pregnant women who fasted Ramadan with different types of hyperglycaemia.

WHAT IS NEW?

- Several recent studies in the management of Gestational Diabetes Mellitus (GDM) during Ramadan were conducted over the last 5 years.
- Some of these studies used continuous glucose monitoring (CGM) or flash glucose monitoring (FGM) which can provide comprehensive information about glucose changes when fasting during Ramadan.
- Overall targets for blood glucose (BG) levels during Ramadan show improvements, however, postprandial blood glucose levels were frequently high.
- Episodes of hypoglycaemia were remarkably longer in duration during fasting hours. Most of these episodes were asymptomatic and many of them occurred during the last few hours of fasting.

WHAT IS MISSING?

- Large, multi-country, epidemiological studies on hyperglycaemia in pregnancy (HIP) during Ramadan need to be conducted.

1. INTRODUCTION

Islamic regulations provide all pregnant women with the option to not fast if they feel worried about their own health, fetal wellbeing, or if they feel burdened with fasting and pregnancy. Nevertheless, many pregnant Muslim women partake in the daily fast during the daylight hours in the month of Ramadan [1, 2]. Indeed, it was previously estimated that 70–90% of healthy pregnant women observe the fast [3], although other survey studies have suggested that they may not manage the full month [4, 5]. In some communities, the social urge to fast during the Holy month is so strong that many will not listen to medical advice. In the absence of robust evidence, both for or against fasting, the general advice has been to err on the side of caution and advise pregnant women against fasting. However, for those who insist, adequate support is offered to make this journey safe for both the mother and fetus.

2. PREGNANCY AND FASTING

The literature on the impact of fasting on healthy pregnant women is conflicting. Some studies in healthy pregnant women, with no diabetes, have shown no harmful effects of fasting on the baby or to the mother [6-8]. In contrast, one study found that low birth weight was 1.5-times more likely in women who fasted in the first trimester compared with non-fasting mothers [9]. Decreased placental weight was observed in women who fasted in the second and third trimesters, however, birth weight was unaffected [10]. This might have an effect on fetal programming with potential long-term health implications [11].

3. DIABETES IN PREGNANCY AND FASTING

Diabetes in pregnancy is associated with an increased risk of both hyperglycaemia and hypoglycaemia, with an increased risk for both the mother and the baby [12]. In recent times, a small number of studies have been conducted on women with Gestational Diabetes Mellitus (GDM), where the majority of women were treated through diet alone or diet with metformin and some those treated with insulin. These studies showed, that while there was an overall improvement in hyperglycaemia, there was an associated increase in the risk of asymptomatic hypoglycaemia [13-15]. In a consensus the authors concluded that, despite some encouraging results, there was not enough evidence to change the high-risk status of fasting during Ramadan for women with GDM. Importantly, these studies were conducted on motivated volunteers in centres with a high level of skill and support, including the use of CGM and FGM alongside good patient education.

Consequently, fasting for women with pre-existing T1DM or T2DM would be even more challenging and accordingly experts consider these individuals as a high-risk group for fasting. Women with T1DM or T2DM should be advised not to fast until further research is available to support any changes in their risk categorisation [15].

Nevertheless, fasting during pregnancy is an important personal decision and a practical approach is needed to clearly explain the potential risks of fasting to the mother and the fetus. Moreover, a structured education is needed to empower pregnant women with hyperglycaemia



with the knowledge and self-management skills for good pregnancy outcomes regardless of their fasting decision.

4. MANAGEMENT OF HIP

4.1 Pre-Ramadan Assessment

Many pregnant women are not clear on what to do during Ramadan fasting. Indeed, some studies indicate that many women get advice from family members or the Imam instead of healthcare professionals [16]. Hence, it is prudent that routine pre-pregnancy counselling, for Muslim women, include a discussion on fasting during Ramadan.

Pregnant women with pre-existing diabetes who intend to fast during Ramadan should be identified several months prior to Ramadan. A complete assessment should be conducted, and a proper fasting risk evaluation should be performed.

4.2 Education and Blood Glucose Monitoring

All pregnant Muslim women with hyperglycaemia should receive formal training on target blood glucose levels and their impacts to the mother and baby; actions of insulin; injection techniques; the management of acute complications; and the behind the breaking of a fast. This need is evident when considering the literature, wherein a recent study showed that a sizeable proportion of women with GDM who initially opted to fast had changed their mind once they developed hypoglycaemia or hyperglycaemia [17].

All pregnant women with diabetes should also be made aware that testing blood glucose levels with a fingerpick test DOES NOT break their fast. Pregnant women with diabetes should check blood glucose levels as indicated. Self-Monitoring of Blood Glucose (SMBG) has been the gold standard of care for evaluating blood glucose levels in pregnant women with hyperglycaemia. However, relying on SMBG during Ramadan fasting might be misleading as it is dependent on the timing and the frequency of the test and data suggest that many episodes of hypoglycaemia and hyperglycaemia could be missed [14]. CGM or FGM provide a more comprehensive glucose profile and a better opportunity for intervention [18-21], yet the accuracy of such devices during hypoglycaemia need to be established.

4.3 Physical Activity

Women are advised to maintain normal physical activity while fasting. The *Taraweeh* prayer is considered as exercise and should be taken into consideration when insulin dosage adjustments are made.

4.4 Nutritional care and meal planning

Pregnant women with diabetes should seek dietary advice before Ramadan wherever possible. The importance of healthy eating during Ramadan is emphasised regardless of fasting status. Abstaining from high calorie meals is essential. Fruit juices and sugary drinks should be avoided. Salty foods should also be avoided, and caffeine intake should be limited. Pregnant women should also be encouraged to eat foods rich in fiber and to drink 2-3 litres of water a day. Pregnant women with diabetes must take *Suhoor* as late as possible.

4.5 Recommendations for the management of hyperglycaemia in pregnancy during Ramadan fasting

During pregnancy, the vast majority of women with hyperglycaemia would be treated with insulin, metformin, or glibenclamide. While the last two agents are not approved by the US Food and Drug Administration, many authorities do not oppose their fair use in pregnancy. However, use of glibenclamide during Ramadan fasting should be discouraged [22, 23].

Pregnant women must understand that regardless of their fasting status, they need to sustain the standard blood glucose targets during pregnancy of:

- **Fasting between 70-95 mg/dL (3.9 – 5.3 mmol/L).**
- **Post-prandial < 120 mg/dL (6.7 mmol/L).**

Pregnant women must also understand that during pregnancy they should break their fast if any of the following occur:

- **BG levels < 70 mg/dL (3.9 mmol/L) during fasting hours.**
- **Feeling unwell.**
- **Reduced fetal movement.**

4.6 T2DM or GDM controlled by diet alone or with Metformin

It is recommended that pregnant women with T2DM or GDM take precautionary measures, these include:

1. Regular SMBG to ensure that they are within the recommended targets. At the very least they should test:
 - Before the sunset meal.
 - 1-2 hours after meals (depending on the individual patient's routine of 2 or 3 meals during Ramadan).
 - Once during the day while fasting, particularly in the afternoon.
 - Anytime they feel unwell.



2. There is also the additional risk of post-prandial hyperglycaemia if the meal portions are too large or too rich in carbohydrates. Indeed, a review from a dietitian would be advisable.
3. Exercise should still be encouraged but the schedule may need altering in its intensity and timing, for example 2h after the sunset meal. As mentioned previously, if patients are in the habit of performing the Taraweeh prayer, it can be taken as part of an exercise routine. Otherwise, it is suggested all other exercise continue as usual.

4.7 Insulin treated pregnant women

Pregnant women that are treated with insulin should adhere to the following:

1. Glucose monitoring - this should be performed as already mentioned, with an emphasis on testing at any time during the day where the patient may be feeling unwell or displaying signs of hypoglycaemia or hyperglycaemia.
2. For recommendations on insulin dose adjustments please see **Table 1**.

TABLE 1: INSULIN DOSE ADJUSTMENT RECOMMENDATIONS

Type of Insulin Regimen	Adjustment during Ramadan fasting	Monitoring during Ramadan fasting
CSII / Insulin Pump	<p><u>Basal rate adjustment</u></p> <ul style="list-style-type: none"> 20-40% decrease for the final 3-4 hours of fast 10-30% increase for the initial few hours of <i>iftar</i> <p><u>Bolus doses</u></p> <ul style="list-style-type: none"> Same principles as prior to Ramadan, and reducing the dose post-Suhoor by 20% 	CGM
MDI (basal bolus) with analogue insulins	<p><u>Basal insulin</u></p> <ul style="list-style-type: none"> 30-40% reduction in dose and to be taken at <i>Iftar</i> <p><u>RAI</u></p> <ul style="list-style-type: none"> Dose at <i>Suhoor</i> to be reduced 30-50% Pre-lunch dose to be skipped Dose at <i>Iftar</i> to be adjusted based on the 2hr post <i>iftar</i> glucose reading 	5-7 point glucose monitoring
MDI (basal bolus) with conventional insulins	<p><u>NPH insulin</u></p> <ul style="list-style-type: none"> Morning pre-Ramadan dose to be taken at <i>iftar</i> 50% of the pre-Ramadan dose to be taken at <i>Suhoor</i> <p><u>Regular insulin</u></p> <ul style="list-style-type: none"> Dose at <i>Iftar</i> to be adjusted based on the 2hr post <i>iftar</i> glucose reading <i>Suhoor</i> dose 50% of the pre-Ramadan evening dose Afternoon dose to be skipped 	5-7 point blood glucose monitoring
Premixed (analogue or conventional)	<ul style="list-style-type: none"> Shift the morning pre-Ramadan dose to the <i>Iftar</i> Inject 50% of the pre-Ramadan evening dose at <i>Suhoor</i> 	5-7 point blood glucose monitoring

SUMMARY

- Many pregnant women with pre-existing diabetes or GDM are considered as high-risk group for fasting during Ramadan.
- Multiple factors influence the risk assessment of a pregnant women with hyperglycaemia and these should be carefully reviewed prior to Ramadan.
- Patient education prior to Ramadan is essential to ensure mother and fetus safety regardless of fasting decision.
- Regular SMBG should be conducted and at the very least once before the sunset meal; 1-2 hours after meals; once while fasting; anytime feeling unwell.
- Pregnant women must break their fast if they feel unwell; BG levels drop below 70 mg/dL (3.9 mmol/L); or identify a reduction in fetal movement.
- Patients treated with insulin should have doses adjusted according to their insulin regimen.

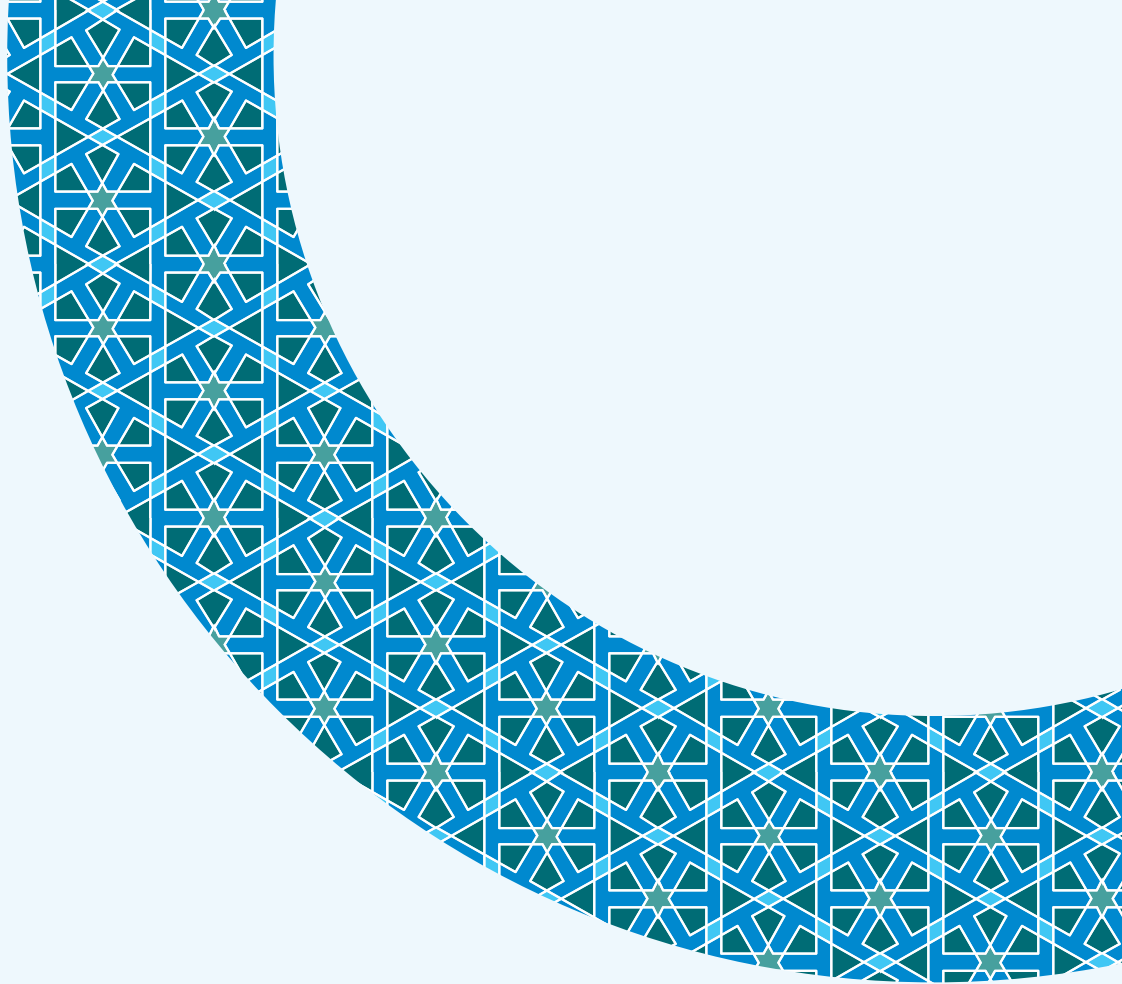


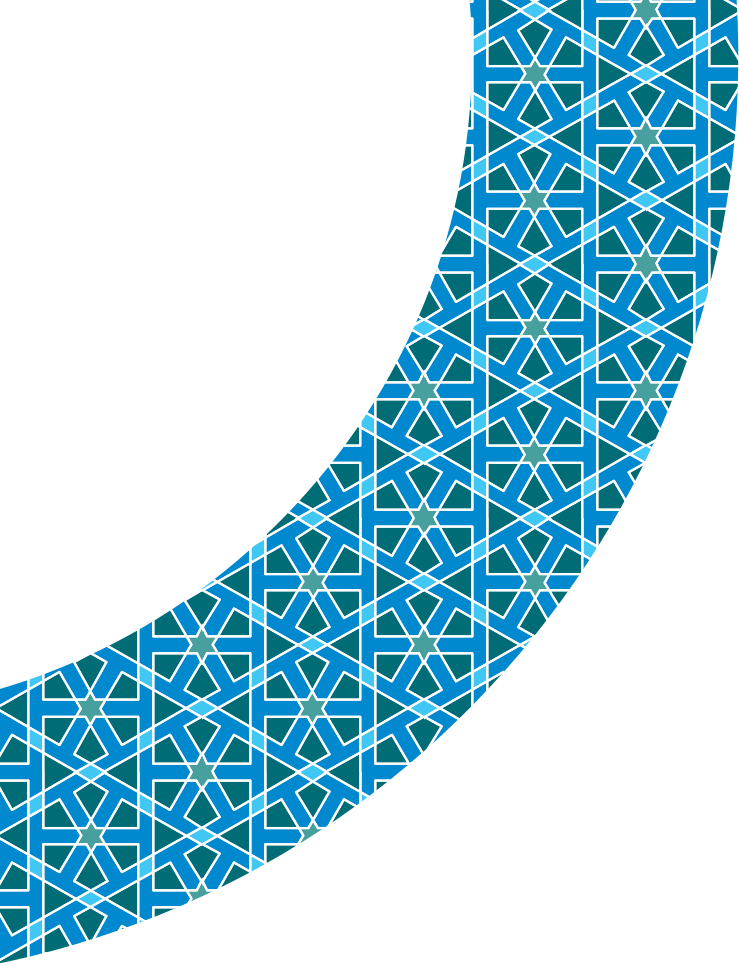
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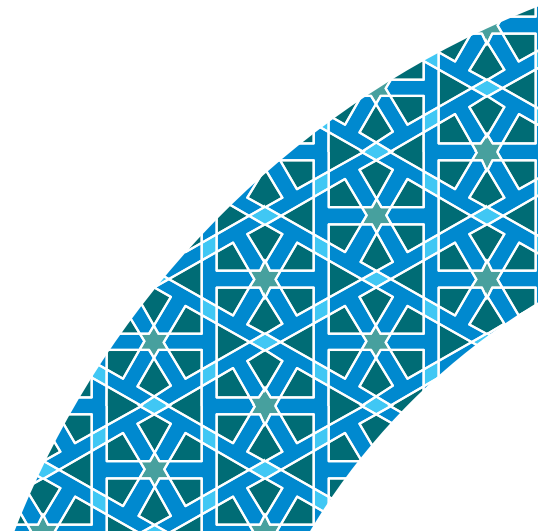


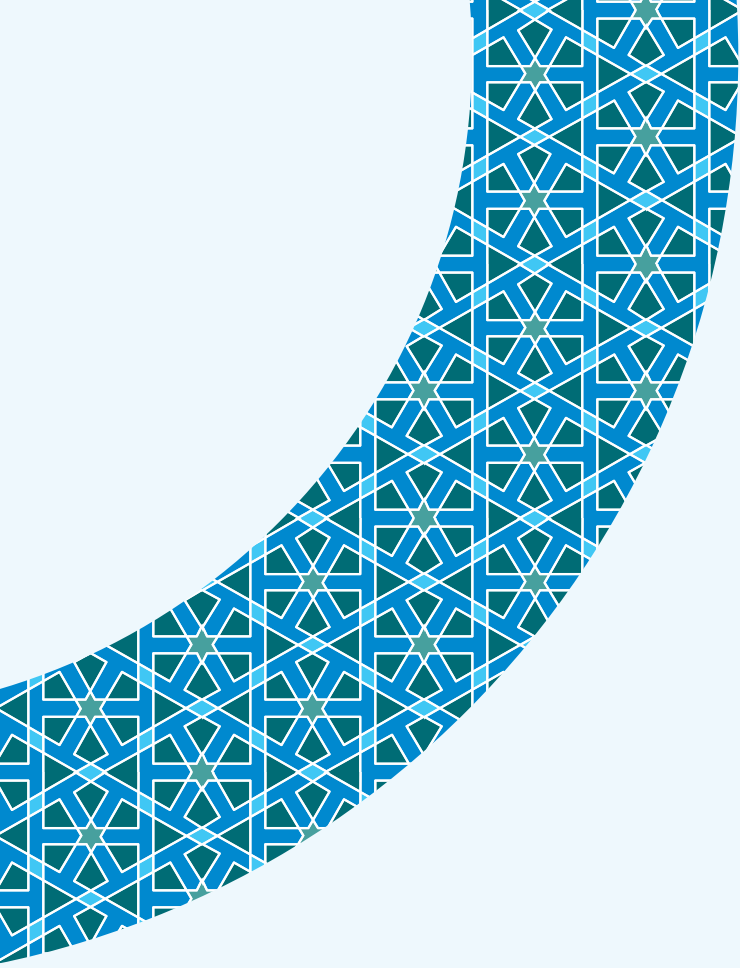
CHAPTER 12

Management of diabetes
among the elderly when
fasting during Ramadan

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CHAPTER 12

INDEX

1. INTRODUCTION	261
2. COMPLICATIONS OF DIABETES IN THE ELDERLY	262
2.1 Hypoglycaemia	263
2.2 Hyperglycaemia	264
3. MANAGEMENT OF ELDERLY INDIVIDUALS WITH DIABETES THAT FAST DURING RAMADAN	264
3.1 Pre-Ramadan education of elderly individuals with diabetes	265
3.2 Self-monitoring of Blood Glucose (SMBG)	265
3.3 Recommendations for treatment medications in the elderly	266
3.4 Top tips for elderly individuals seeking to fast during Ramadan	267
SUMMARY	268
REFERENCES	269



WHAT IS KNOWN?

- Age alone is often used as a risk factor for fasting during Ramadan.
- In elderly people with diabetes a particular consideration needs to be given to any accompanying comorbidities.
- Many elderly individuals will still fast during Ramadan and guidance is needed to help these individuals fast safely.

WHAT IS NEW?

- The prevalence of fasting in elderly individuals is lower than in younger individuals.
- Comorbidities such as impaired renal functions, cardiovascular disease (CVD), dementia, frailty and a risk of falls need to be considered alongside age in risk stratification.
- The risk of diabetes related complications is higher in elderly populations.
- Modifications to medications are essential for elderly people wishing to fast.

WHAT IS MISSING?

- There is a significant need for greater research in elderly individuals with diabetes that seek to fast during Ramadan, including people with associated comorbidities and diabetes related conditions.
- Greater research is needed into the use of antidiabetic medications in elderly individuals with differing comorbidities and circumstances.

1. INTRODUCTION

Previously, elderly people with diabetes have been placed in the higher risk categories for fasting during Ramadan based on their age alone. Many elderly people have enjoyed fasting during Ramadan for many years and should be allowed to continue doing so if their health is stable [1].

The risk stratification of elderly people with diabetes should not be based on age alone but rather on their health status and social circumstances.

Many elderly people, especially those who have lived with diabetes for a prolonged period, will have comorbidities that impact on the safety of fasting and present additional challenges to the healthcare professionals (HCPs) managing them. These comorbidities can often include impaired renal function and deterioration in cardiovascular health, the different risks and management of individuals in these contexts have been described in other chapters (see **chapter 5: Risk stratification of people with diabetes before Ramadan** and **chapter 13: Risks of fasting during Ramadan Cardiovascular, Cerebrovascular and Renal complications**). Assessments of functional capacity and cognition need to be performed and the care provided should be adapted accordingly [2]. The use of medications including anti-diabetic agents, which carry varying risks for hypoglycaemia, should also be reviewed. Throughout this chapter, elderly will be defined as people that are 65 years or older.

Challenges of fasting in the elderly subjects with diabetes mellitus

A major issue when it comes to providing guidance to elderly people with diabetes is that there is a significant lack of research in this population. Most of the current guidance on the management of diabetes that can be applicable to elderly people with diabetes are based on expert opinion rather than medical evidence. A prime example is the landmark, multi-country, EPIDIAR study which has been used to formulate guidance for people with diabetes that seek to fast during Ramadan, however this study did not include information specific to the elderly [3]. As such, the findings from this study will not necessarily be representative of elderly populations.

Future research on Ramadan fasting needs to include more elderly individuals with diabetes to make more specific recommendations.

It is clear that with gains made in life expectancy and advances in medical care, more people will live to the later ages in life. According to the International Diabetes Federation (IDF) 9th Atlas, 1 in 5 people with diabetes are above the age of 65 years old (163 million) [4]. Despite there being some elderly individuals that may not be able to fast, there is a high proportion of elderly individuals with diabetes that remain determined to fast during Ramadan. In recent cross-sectional study, the DAR 2020 Global survey studied the fasting practices and



characteristics of elderly individuals with T2DM during Ramadan of 2020. The intentions to fast was 71.2% among those ≥ 65 compared to 87.3% in those < 65 years [5].

Together these highlight the need for producing clear guidance and this remains an important challenge for healthcare providers to tackle.

2. COMPLICATIONS OF DIABETES IN THE ELDERLY

It is important to recognise that age in and of itself is not a good reason to categorise individuals as high risk for fasting during Ramadan, but rather it is the associated implications of old age that need consideration. Indeed, the elderly that do manage to fast can be more motivated than their younger counterparts — the DAR Global Survey found that 69% of those aged ≥ 65 years fasted for 30 days compared to 60% in those < 65 years [5].

However, people in the elderly ages can often have other comorbidities alongside diabetes. Indeed, people with diabetes have a heightened risk of complications such as diabetic kidney disease, cardiovascular disease (CVD) [6], retinopathy among others, see **Figure 1**. Indeed, old age can be a risk factor for diseases such as dementia or recurrent falls, hip fractures, amputation and visual impairment. In a study of elderly participants with diabetes and an added risk of CVD during Ramadan, it was found that there was an increased risk of impaired renal function [7]. Fasting during Ramadan was also found to have an effect on postural balance and attention in the elderly and may increase the risk of falls or fall-related injuries [8]. Volume depletion is also an important issue, especially among those aged over 75. This increase in the risk of complications occurring in elderly people with diabetes can have a direct impact on the number of days fasted during Ramadan. In a recent study there was a greater number of individuals that had to break their fast due to diabetes related complications of ages ≥ 65 compared to < 65 — 17% compared to 11.5% respectively ($p < 0.001$) [5]. Hence, it is important that all individuals that are fasting during Ramadan and recognise any acute complications or feelings of being unwell break their fast.

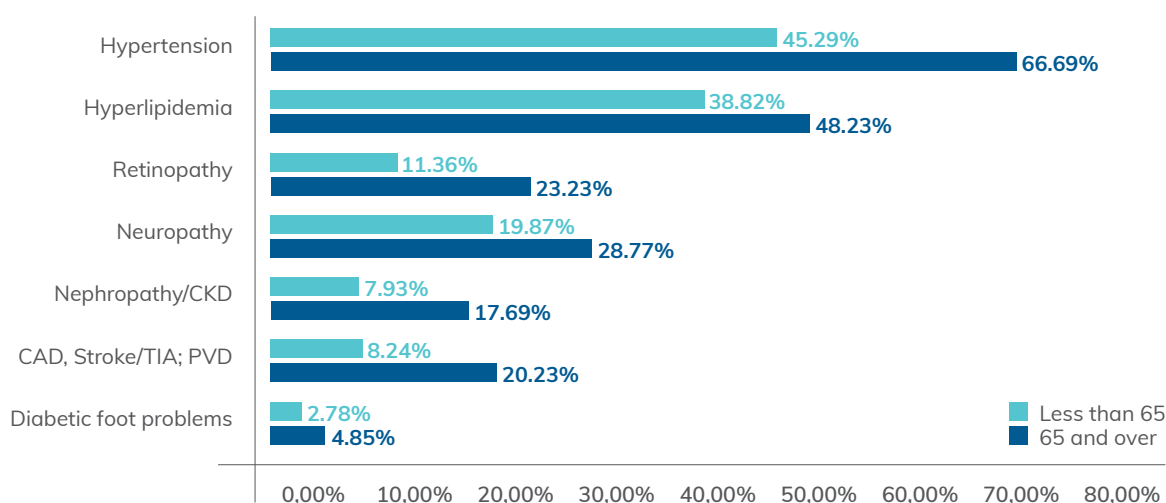


FIGURE 1

Reported complications among individuals with T2DM aged ≥ 65 and < 65 ; data adapted from the DAR 2020 Global survey [5]

It is also very important to assess an elderly individual's degree of independence and include this information in any risk assessment prior to fasting during Ramadan. An example would be (in ascending order of severity) those that are functionally independent; those that are functionally dependent — such as being frail or having dementia; those on End-of-Life Care. Likewise, any additional comorbidities to diabetes must be considered in risk stratification (see the **chapter 5: Risk stratification of people with diabetes before Ramadan**).

In elderly individuals with such comorbidities, there will inevitably be changes to their:

- Physical activity patterns
- Ability to self-manage blood glucose (SMBG)
- Ability to take medications
- Feeding patterns
- General independence

Therefore, pre-Ramadan education to elderly individuals with diabetes and their surrounding support network need to be clear and individualised covering all circumstances to prevent any unexpected outcomes from arising during the Ramadan fast.

2.1 Hypoglycaemia

The risk of hypoglycaemia is particularly increased [9] and may present with neuroglycopenic manifestations in the form of dizziness, delirium and confusion. Therefore, every measure must be taken to mitigate the risk of this occurring. This may include an increase in SMBG, or changes to treatment regimens that can cause hypoglycaemia such as beta blockers, salicylates, warfarin and tricyclic antidepressants. A particularly important concern among the elderly is hypoglycaemia unawareness and these individuals should be discouraged from fasting. **However, any changes made to these medications must be conducted in accordance with guidance from the relevant physicians as any changes could have significant consequences.**

The DAR 2020 Global Survey showed that people with T2DM aged ≥ 65 reported episodes of hypoglycaemia in statistically significantly higher proportions than those aged < 65 , 17.4% and 15.2% respectively ($p < 0.001$). Furthermore of those that experienced hypoglycaemia, 9.9% of those aged ≥ 65 had to go to the emergency department compared to 4.3% of individuals aged < 65 and similarly there was a suggestion that a greater proportion of those aged ≥ 65 required hospital admission [5].

It was also shown that in response to hypoglycaemia, many elderly individuals with T2DM reduced the dosing or frequency of their medications (31.5%) however a large proportion continued as normal with no changes (approximately 17%) [5]. Breaking the fast due to hypoglycaemia was also higher among individuals with T2DM aged ≥ 65 (67.7%) than those < 65 (55.4%), ($p = 0.02$).



2.2 Hyperglycaemia

Hyperglycaemia was defined as blood glucose levels > 16.6 mmol/L, 300 mg/dL)

The DAR 2020 Global Survey also showed that hyperglycaemia remains a large issue among the elderly. It was reported that there was a significantly higher proportion of elderly individuals with T2DM reporting hyperglycaemia during Ramadan 2020, with 19.3% among those aged ≥ 65 compared to 15.6% among those aged < 60, $p=0.006$. Among all, the mean number of days with hyperglycaemia was 8.1 which was similar in both age groups. The severity of hyperglycaemia meant that 8.4% of those aged ≥ 65 with T2DM had to attend the emergency department or required hospital admission. This was similar to those aged <65 years (7%) [5]. Of concern, the majority of all participants in the study did not break their fast (almost 80%) after experiencing hyperglycaemia; of those that acted on their symptoms, approximately 25% reduced their food intake or increased the dose of their medications (around 21%) and almost 20% did not change their behaviour at all.

3. MANAGEMENT OF ELDERLY INDIVIDUALS WITH DIABETES THAT FAST DURING RAMADAN

People that are in older age groups fast during Ramadan for many reasons (see **chapter 6: Diabetes and Ramadan A Medico-religious Perspective**) and it is important that their wishes to do so must be respected. As mentioned, many elderly individuals that fast do so with a heightened risk of complications. It is important that these are considered and taken into account when any individuals guidance or advice are offered. **Table 1** shows that there are similarities between the elderly and younger age groups in terms of fasting practices but there is also an increase in the risk of diabetes related complications.

TABLE 1: AN AGE COMPARISON OF THE KEY PARAMETERS OF INDIVIDUALS WITH TYPE 2 DIABETES WHO FASTED DURING RAMADAN; FIGURE ADAPTED FROM THE DAR 2020 GLOBAL SURVEY [5]

Individuals < 65 years old (N=4906)		
<ul style="list-style-type: none"> • 87.3% had an intention to fast during Ramadan • 61.9% of those that could fast did so for the whole duration of Ramadan • 84.4% reported no episodes of hyperglycaemia (BG>300 mg/dl) 	<ul style="list-style-type: none"> • Mean number of days fasting in Ramadan was 27 days • 84.3% with hypoglycaemia had events over 1-7 days • 62.5% with hyperglycaemia had episodes over 1-7 days 	<ul style="list-style-type: none"> • 94.8% fasted at least 15 days during Ramadan • 6.6% with hypoglycaemia required ER or hospital admission • 7.4% with hyperglycaemia required ER or hospital admission
Individuals ≥ 65 years old (N=935)		
<ul style="list-style-type: none"> • 71.2% had an intention to fast during Ramadan • 69% of those that could fast did so for the whole duration of Ramadan • 84.4% reported no episodes of hyperglycaemia (BG>300 mg/dl) 	<ul style="list-style-type: none"> • Mean number of days fasting in Ramadan was 27 days • 79.0% with hypoglycaemia had events over 1-7 days • 64.9% with hyperglycaemia had episodes over 1-7 days 	<ul style="list-style-type: none"> • 94.2% fasted at least 15 days during Ramadan • 12.4% with hypoglycaemia required ER or hospital admission • 8.4% with hyperglycaemia required ER or hospital admission

Statements in bold font were greater in that age group

Elderly individuals that do seek to fast during Ramadan must be given greater support than their younger counterparts. This can be through friends, relatives or carers, but it is imperative that elderly individuals that do plan on fasting have these support networks in place before conducting the fast. The heightened risk of complications arising during the Ramadan fast and the increased likelihood that individuals have accompanying comorbidities increases the need for extra care. Appropriate risk stratification must still be taken and further information on this is available in the **chapter 5: Risk stratification of people with diabetes before Ramadan**.

3.1 Pre-Ramadan education of elderly individuals with diabetes

Pre-Ramadan education for people seeking to fast during Ramadan has been described in greater detail in these guidelines (see **chapter 7: Pre-Ramadan Assessment and Education**). These measures remain an important consideration for all people seeking to fast during Ramadan and more so among the elderly. All measures must be implemented into individualised pre-Ramadan education and it is, therefore, crucial that HCPs work together in producing the most effective programmes.

It was shown that the need for pre-Ramadan education among the elderly was similar to those of younger age groups. In those that did receive education, the majority received it at their routine consultations [5]. It is important to make information widely available to ensure that dissemination is effective and methods such as online websites and mobile phone applications can be extremely useful, this need is well documented in several studies [10-13].

3.2 Self-monitoring of Blood Glucose (SMBG)

It is extremely important that elderly individuals that choose to fast pay careful attention to their blood glucose levels during Ramadan. Fluctuations in blood glucose levels can have serious detrimental effects on the health of the individuals if not appropriately treated. As mentioned, people that are of older ages carry additional risks and this makes the need to SMBG even more important.

There are many different means of monitoring blood glucose levels and these must be discussed and adopted well in advance of Ramadan. If continuous means of glucose monitoring or other specific monitoring regimens are not used, then elderly individuals must take at least 2-3 readings during fasting hours, 1-2 times during eating hours and whenever they are symptomatic with hypoglycaemia or hyperglycaemia. Indeed, it is also important that elderly individuals understand the symptoms of hypoglycaemia as awareness can often be impaired, primarily caused by a long duration of diabetes. Maintaining strict monitoring schedules will enable elderly individuals to keep track of their blood glucose levels effectively and know when it is appropriate to break their fast when it is unsafe to continue.

In the DAR 2020 Global Survey, it was shown that approximately 21% of participants with T2DM aged ≥ 65 years checked their blood glucose levels once or less than once a week. Only around 10% checked their blood glucose levels 3-4 times a day. It was also shown that the occasion of Ramadan did not lead to people changing their frequency of SMBG in both age groups of ≥ 65 and < 65 years [5]. This highlights the importance of providing proper guidance on the frequency and timing of SMBG and it must be an important aspect of pre-Ramadan education.

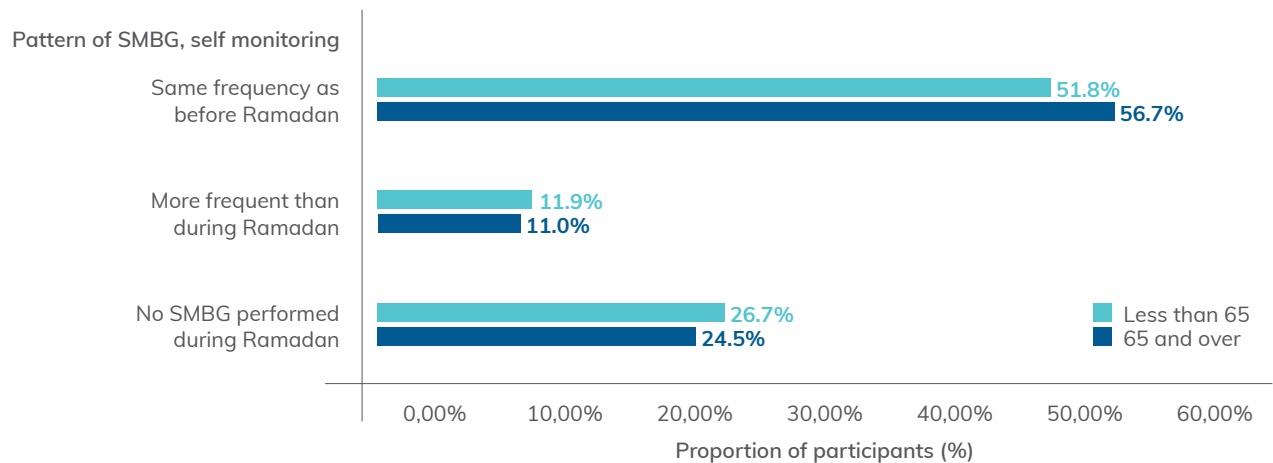


FIGURE 2
Pattern of SMBG in people with T2DM during Ramadan,
figure adapted from the DAR 2020 Global Survey [5]

3.3 Recommendations for treatment medications in the elderly

There is a lack of research available on elderly individuals that fast during Ramadan and as such it is difficult to provide specific recommendations on medications. The DAR 2020 Global Survey also looked into the use of medications that can increase the risk of hypoglycaemia and noted that the use of sulfonylureas was equal among both age groups (both at 39%). Moreover, the use of insulin was higher in those ≥ 65 years (32.7%) compared to < 65 (26.3%), perhaps in part due to a longer duration of diabetes.

In general, elderly individuals are at a higher risk of hypoglycaemia and any medications or treatment regimens that can increase this risk should be adjusted. It is recommended that a thorough assessment with a diabetes specialist takes place where medications and their risk towards hypoglycaemia can be discussed.

In individuals that are being treated with oral antidiabetic medications the following recommendations should be considered:

- Where sulfonylureas are used, gliclazide and glimepiride should be used instead of glibenclamide.
- SGLT2 inhibitors doses should be reviewed in accordance with advice from a specialist and considerations must be given to benefit vs risks of adverse events **especially in elderly people with impaired renal function or those that are treated with diuretics.**

Among individuals using insulin therapy it is recommended that analogue insulins are considered over human insulins.

3.4 Top tips for elderly individuals seeking to fast during Ramadan

MEDICATIONS AND REGIMENS

- Have an assessment and discussion with your diabetes specialist prior to Ramadan
 - Choose medications that have a lower risk towards hypoglycaemia
 - Make dose adjustments to lower the risk of hypoglycaemia.

SMBG

- Increase the frequency of SMBG when fasting during Ramadan than before Ramadan.
- Consider the using a continuous means of monitoring blood glucose levels if available.

DIET

- There needs to be an emphasis on staying properly hydrated, particularly in individuals prone to diabetes related comorbidities.
- It is important to have an adequate intake of nutrients when breaking the fast.
- An individualised nutrition plan should be made prior to Ramadan and adhered to during the Ramadan fast.

PHYSICAL ACTIVITY

- Physical activity levels should be curtailed but not halted during fasting hours.
- Activities should be planned ahead of time and thought of holistically — i.e., in conjunction with nutrition plans and medication regimens.

SOCIAL CONSIDERATIONS AND COMMUNITY SUPPORT

- Adequate support mechanisms should be in place to ensure that elderly individuals with diabetes wishing to fast receive adequate support from family members, friends, carers or community members. This should provide greater levels of safety and confidence.

RISKS OF COMPLICATIONS AND AWARENESS

- There needs to be an active effort to increase personal awareness of symptoms of hypoglycaemia and hyperglycaemia
 - Symptoms and events should be documented to help with recognition.
- The effects of fasting in people with comorbidities such as dementia, impaired renal function, CVD and others should be considered and discussed with a medical specialist prior to conducting Ramadan fasting.

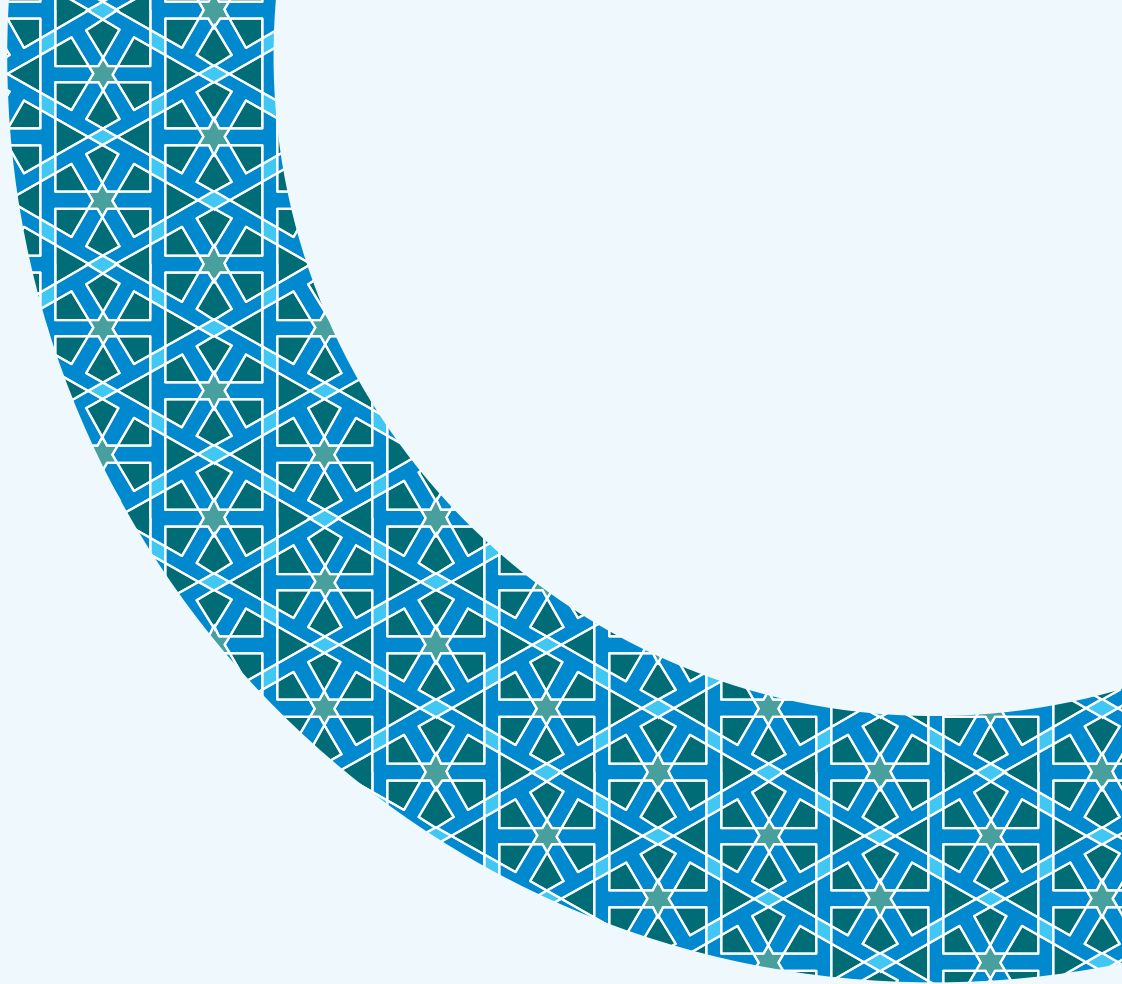


SUMMARY

- Lower proportions of elderly individuals fast than their younger counterparts.
- Diabetes related complications such as hypoglycaemia and hyperglycaemia can be more frequent in elderly individuals than in younger individuals during the Ramadan fast.
- Greater and more careful planning pre-Ramadan is needed in elderly individuals to ensure a safe fast during Ramadan can be achieved.
- There must be a greater emphasis on SMBG in elderly individuals during the Ramadan fast to ensure safety.
- Antidiabetic drugs with lower risks of hypoglycaemia are preferred in elderly individuals.
- There is a significant need for more research into elderly individuals with T1DM, T2DM and differing comorbidities that fast during Ramadan.

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CHAPTER 13

Risks of fasting during Ramadan: Cardiovascular, Cerebrovascular and Renal complications

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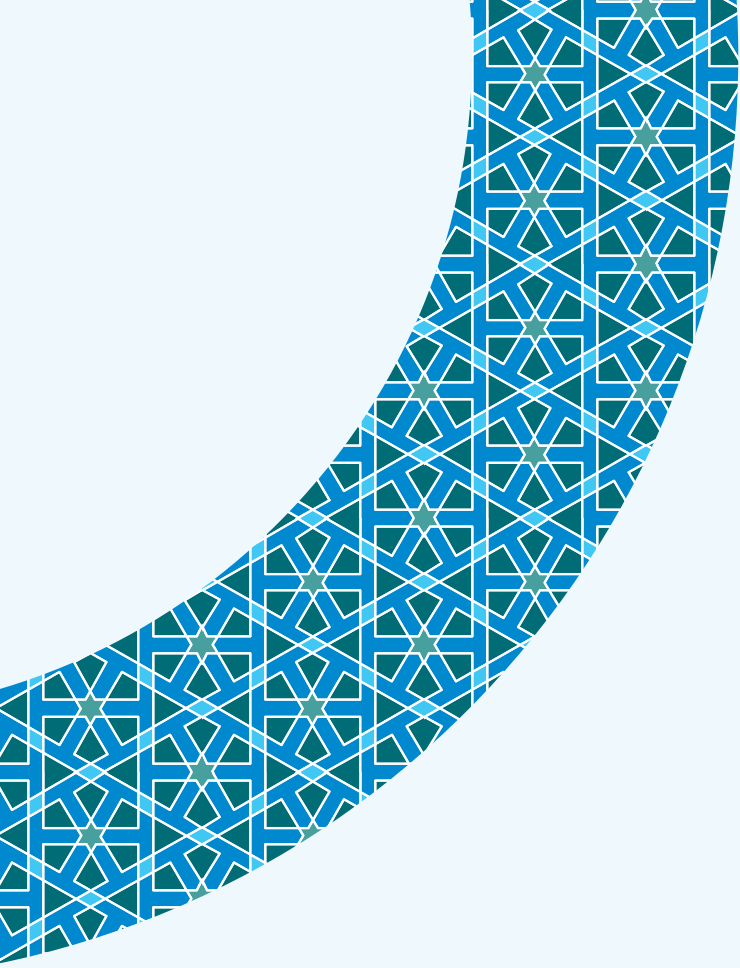
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CHAPTER 13

INDEX

1. INTRODUCTION	275
2. MACROVASCULAR COMPLICATIONS	
Impact of fasting during Ramadan for people with diabetes on cardiovascular disease (CVD)	275
2.1 Fasting during Ramadan and congestive heart failure (CHF)	275
2.2 Fasting during Ramadan and acute coronary syndrome (ACS)	276
2.3 Fasting during Ramadan and cardiac arrhythmias	278
3. MACROVASCULAR COMPLICATIONS	
FASTING DURING RAMADAN AND STROKE	278
4. CONSIDERATIONS AND RECOMMENDATIONS (CVD AND STROKE)	280
5. MICROVASCULAR COMPLICATIONS	
Impact of fasting during Ramadan for people with diabetes on Chronic Kidney Disease	282
5.1 Fasting during Ramadan and Renal function	282
5.2 Fasting during Ramadan in individuals on dialysis	285
5.3 Fasting during Ramadan in individuals that have undergone a renal (kidney) transplant	285
6. CONSIDERATIONS AND RECOMMENDATIONS (CKD, Dialysis and Kidney Transplants)	289
SUMMARY	290
REFERENCES	
Macrovascular – CVD or Stroke complications	291
REFERENCES	
Microvascular – CKD, dialysis or kidney transplant	292



WHAT IS KNOWN?

- Diabetes is a risk factor towards cardiovascular disease (CVD) and stroke.
- Individuals with pre-existing CVD or stroke and diabetes are at greater risk of complications when fasting and should be cautious.
- Individuals with chronic kidney disease (CKD) stage 3 and diabetes are of high-risk for fasting during Ramadan.
- Individuals with chronic kidney disease (CKD) stage 4-5 and diabetes are of very high-risk for fasting during Ramadan.
- Fasting in these individuals should generally be discouraged.

WHAT IS NEW?

- New research has been conducted highlighting the effect of fasting on CVD and stroke. However, further evidence is yet needed from study populations with pre-existing type 1 and type 2 diabetes and CVD and/or stroke in order to make specific recommendations regarding fasting during Ramadan.
- Individuals with diabetes and unstable CVD or stroke are high risk and should be discouraged from fasting.
 - Those that choose to fast must receive individualised guidance from a diabetes specialist and cardiologist or neurologist and must undertake pre-Ramadan education on safe fasting with diabetes (see **chapter 7: Pre-Ramadan Assessment and Education**)
- There is some evidence showing fasting could be conducted safely during Ramadan in individuals with stable CKD, on dialysis or having undergone a kidney transplant. However, more research is needed on individuals with pre-existing type 1 and type 2 diabetes in order to make specific recommendations regarding fasting during Ramadan.
- Individuals with stage 3 or higher CKD and diabetes are at high risk of fasting and should be discouraged from doing so.
 - Those that choose to fast should consult a diabetes specialist, keep hydrated and avoid foods with a high potassium or phosphorous content.

WHAT IS MISSING?

- Further research is needed into the effects of CVD, stroke and CKD in individuals with type 1 and type 2 diabetes.
 - These studies should also include information on social backgrounds, ethnicity and climates.
 - Likewise, this research should also include the effects of fasting in individuals that have any associated complications of diabetes including poorly controlled glycaemia, frequent episodes of hypoglycaemia (with and without unawareness), hypertension and in individuals on different treatment regimens.
- Further studies need to be conducted that investigate the effect of fasting on neuropathy and retinopathy in people with diabetes.

1. INTRODUCTION

Macrovascular disease can occur as a complication of diabetes; it affects the larger blood vessels including the coronary arteries, aorta and arteries within the brain and limbs and can lead to cardiovascular disease (CVD) or cerebrovascular disease including stroke. Likewise, microvascular disease can also occur whereby the smaller vessels that branch off of the larger arteries are affected and this can cause issues such as a loss of renal function.

People with diabetes that choose to fast during Ramadan could potentially exacerbate these complications, if conducted unsafely, and therefore these individuals are classified as high risk [1]. This chapter outlines the guidance for individuals with diabetes that have these complications and includes specific guidance for those with:

1. Cardiovascular and Cerebrovascular complications;
2. Chronic kidney disease (CKD).

2. MACROVASCULAR COMPLICATIONS

Impact of fasting during Ramadan for people with diabetes on cardiovascular disease (CVD)

Diabetes has been frequently associated with an increased risk of CVD [2, 3]. In addition, people with diabetes also have a heightened risk of stroke [4]. Importantly, the practice of unsafe fasting including a high intake of carbohydrates, low levels of activity, poor sleeping patterns, inadequate hydration, and missing doses of essential medicines could have an impact on the risk of CVD or stroke in people with diabetes [5, 6].

On the other hand, when fasting is conducted safely (see **chapters 9** and **10**) these risks could be mitigated. It has been demonstrated that proper glycaemic control can reduce the number of cardiovascular events [7]. Likewise, fasting has also been shown to significantly increase levels of nitric oxide (NO) and decrease markers of oxidative stress [8, 9], with a variable effect on lipoprotein levels, high sensitivity C-Reactive protein (hsCRP) levels and blood pressure [10, 11].

The last two decades have seen an increase in the awareness of the risks that diabetes poses to CVD. However, it is important to understand the impact that fasting during Ramadan has on the risk of CVD.

2.1 Fasting during Ramadan and congestive heart failure (CHF)

One particular form of CVD is congestive heart failure (CHF); **Table 1** has summarised several studies that have investigated the effect of fasting during Ramadan on the risk of CHF in people with diabetes.

A multi-centre study conducted in the Gulf region found no difference in the proportion of patients that were hospitalised for heart failure with diabetes during Ramadan and outside of Ramadan, 52% and 48.4% respectively [12]. Similarly, in a study of patients with heart failure,



18 had worsening symptoms due to non-compliance with dietary advice and medications while 209 remained stable or improved. Diabetes was found not to be associated with the worsening of symptoms [13]. A retrospective review of clinical data also found that there were no differences in the number of hospitalisations when comparing the month prior to Ramadan, the period of Ramadan and the month after Ramadan [14].

TABLE 1: STUDIES INVESTIGATING THE EFFECT OF FASTING DURING RAMADAN ON CONGESTIVE HEART FAILURE (CHF)

Author (Date)	Sample size and study details	Study population and CHF measures related to Ramadan	Key outcomes
Amar M. Salam et al. (2018) [12]	N=4,157 patients hospitalised – 306 (7.4%) during Ramadan; 3851 (92.6%) outside of Ramadan Prospective observational study Location: 7 countries in the Middle East	All participants were hospitalised for acute heart failure Outcomes of hospitalisation during Ramadan and outside of Ramadan were investigated	No significant differences between hospitalisations during Ramadan and outside of Ramadan were found, 52% and 48.4% respectively (p=0.23) Diabetes was not a risk factor for in hospital mortality, Odds Ratio 1.05 p=0.78
Rami M. Abazid et al. (2018) [13]	N=249 – 227 fasted for the entire month of Ramadan Prospective observational study Mean Age 54 years old (±12.83) Location: Kingdom of Saudi Arabia	Patients that were hospitalised with chronic heart failure Symptoms related to CHF were investigated	Diabetes was not associated with the worsening of symptoms during hospitalisation
Swaidi et al. (2006) [14]	N=2160 Mean Age 64.2 years old (±11.5) Retrospective review Location: Qatar	Patients that were admitted to hospital with CHF during Ramadan, the month prior to Ramadan and the month after Ramadan – 56.5% had diabetes The number of hospitalisations were investigated in each period	No significant differences in the number of hospitalisations were between the three periods

2.2 Fasting during Ramadan and acute coronary syndrome (ACS)

Acute coronary syndrome (ACS) is a term that refers to a range of conditions that involve a restriction of blood flow to the coronary arteries. Such conditions include unstable angina and myocardial infarction (MI). **Table 2** has outlined several studies that have investigated the effect of fasting during Ramadan on the risk of ACS in people with diabetes.

Evidence suggest that there is no clear association between fasting during Ramadan an increase in acute cardiac events [15, 16]. Suwaidi *et al.* demonstrated no true differences in the percentage of people with diabetes that were admitted with ACS before (51%), during (56%) and after (59%) Ramadan [17]. Indeed, echocardiographic and angiographic measurements found no clear differences between people that were fasting and people that were not fasting during Ramadan [18].

In addition, there were some protective effects of fasting during Ramadan found in some studies. Temizhan *et al.* found a significant reduction in the number of ACS events during Ramadan when compared to times outside of Ramadan [19]. Likewise, Burazeri *et al.* found protective associations between a composite measure of religiosity and ACS in a cross-sectional study [20].

TABLE 2: STUDIES INVESTIGATING THE EFFECT OF FASTING DURING RAMADAN ON ACUTE CORONARY SYNDROME (ACS)

Author (Date)	Sample size and study details	Study population and ACS measures related to Ramadan	Key outcomes
Chamsi-Pasha <i>et al.</i> (2004) [21]	N=86 Prospective observational study Location: Kingdom of Saudi Arabia	All participants were patients with stable cardiac disease Measures were taken of biochemical markers and all patients were monitored for any deterioration	There were no significant changes to biochemical markers or deterioration measured using the Ney York Heart Association classifications
Khafaji <i>et al.</i> (2012) [10]	N=56 Prospective observational study Location: Qatar	All participants in the study were stable but had suffered from CVD Electrocardiography, angiography and biochemical measurements were assessed before, during and after Ramadan	All participants finished the total duration of fasting without any cardiac or non-cardiac events
Al Suwaidi <i>et al.</i> (2006) [22]	N=465 Prospective observational Location(s): Various medical centres Kuwait, Qatar, United Arab Emirates, Bahrain	All participants were outpatients with acute heart disease Clinical assessments were performed before, during and after Ramadan	91.2% of patients were able to fast for the duration of Ramadan; only 6.7% felt worsening symptoms due to fasting Most participants were stable and able to safely fast
Mousavi <i>et al.</i> (2014) [15]	N=148 Prospective observational study Location: Iran	Fasting and non-fasting groups were compared for symptoms of coronary artery disease	There were no differences among both groups in terms of occurrences of chest pain No differences were observed in the composite measure of chest pain and dyspnoea
Turker <i>et al.</i> (2012) [18]	N=151 - 55 fasting during Ramadan; 96 non-fasting Cross-sectional study Location: Turkey	All participants in the study were diagnosed with acute ST-elevated MI The diurnal variation in MI was measured during the period of Ramadan	No clear differences were found between those that fasted and those that didn't during Ramadan in echocardiographic and angiographic measurements
Temizhan <i>et al.</i> (1999) [19]	N=1665 Retrospective study from 1991 - 1998 Location: Turkey	All participants were hospitalised with acute myocardial infarction ACS events were measured before, during and after Ramadan	There was a significant reduction seen in the number of ACS events during Ramadan when compared to before or after Ramadan (p=0.03)

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TABLE 2: STUDIES INVESTIGATING THE EFFECT OF FASTING DURING RAMADAN ON ACUTE CORONARY SYNDROME (ACS)

Author (Date)	Sample size and study details	Study population and ACS measures related to Ramadan	Key outcomes
Burazeri et al. (2008) [20]	N=936 Cross-sectional study Location: Albania	467 nonfatal ACS patients were compared to 469 controls and assessed for ACS using a composite measure made up of the frequency of prayers, mosque attendance, and fasting	A protective effect was observed in the composite score on the odds of having ACS; odds ratio 0.45 (95% CI 0.26-0.77)
Al Suwaidi et al. (2004) [17]	N=8446 Retrospective clinical review Location: Qatar	Patients that were hospitalised with unstable angina or MI Percentages of hospitalisations in the months prior to Ramadan, during Ramadan and after Ramadan were assessed	The number of admissions with ACS was not significantly different in either of the three periods

2.3 Fasting during Ramadan and cardiac arrhythmias

There have been few studies assessing the impact of fasting during Ramadan on cardiac arrhythmia and further research into this condition is needed. A retrospective review from 1991 – 2010 looking into patients that were hospitalised with atrial fibrillation found no significant differences in the time periods of admission when comparing times prior to, during and after Ramadan. There was even the finding in a subgroup of patients that had underlying ischemic heart disease that showed a reduction in hospitalisations during Ramadan [23]. Al Suwaidi et al. also found no additional cardiac arrhythmia episodes in patients with hypoglycaemia that utilised continuous glucose monitoring (CGM) during Ramadan [14].

3. MACROVASCULAR COMPLICATIONS

Fasting during Ramadan and stroke

Diabetes is an independent risk factor for stroke and the effect of fasting during Ramadan in people with diabetes needs to be established. There have been several studies that have investigated this and are outlined in **Table 3**.

Assy et al. in a cross-sectional designed study found that people with type 2 diabetes mellitus (T2DM) were no more likely to be hospitalised for ischaemic or haemorrhagic stroke during Ramadan than in the months before or after Ramadan [24]. Moreover, El-Mitwalli et al. confirmed these results in a longitudinal study in Egypt [25]. A retrospective review by Bener et al. also reported similar findings in Qatar where 50% of the cohort had diabetes, although no subgroup analyses were shown to see this effect in those with diabetes [26].

Conversely, others found the opposite showing fasting during Ramadan was associated with a significantly higher risk of stroke. Selcuk et al., in a retrospective review, found a greater frequency of ischaemic stroke during Ramadan than compared to before or after Ramadan [27]. Yazdeen et al. found in a cohort that were primarily middle aged that was some evidence that fasting was associated with a higher risk towards stroke ($p=0.03$) [28]. Zimhony et al. built

on this in a study in Israel and found that the risk of stroke was greatest during the first fortnight of Ramadan [29].

It is clear that there are conflicting findings on the impact of Ramadan on the risk of stroke. Some have found that there is a greater risk during Ramadan and others have found no difference in the risk. Greater research is needed in randomised cohorts where confounding can be removed and the specific effects of fasting on the risk of stroke can be assessed. Also, studies should aim to follow up individuals that have pre-existing stroke and diabetes and assess whether these patients can safely fast during Ramadan.

TABLE 3: STUDIES INVESTIGATING THE EFFECT OF FASTING DURING RAMADAN ON STROKE

Author (Date)	Sample size and study details	Study population and stroke measures related to Ramadan	Key outcomes
Assy et al. (2019) [24]	N=220 Longitudinal cross-sectional study across different time periods Location: Egypt	People with T2DM were asked to participate in this study The frequency of hospitalisations was assessed in all individuals during the time periods of before, during and after Ramadan	No significant differences were noted in the frequency of hospitalisations due to stroke (ischaemic or haemorrhagic) between all time periods
Selcuk et al. (2003) [27]	N=793 Retrospective review of clinical data Location: Turkey	Patients that were hospitalised for ischaemic or haemorrhagic stroke were reviewed Measures were taken during the time periods of before, during and after Ramadan	Approximately 20% of patients had diabetes It was found that there were greater ischaemic stroke hospitalisations during Ramadan than before or after Ramadan (statistically significant)
Zimhony et al. (2018) [29]	N=4727 564 from the Bedouin population Retrospective clinical review Location: Israel	All patients reviewed were admitted to hospital with acute ischaemic stroke Stroke incidence was compared to the time period of Ramadan	Overall, there was a statistically significant association between stroke incidence and the time period of Ramadan; this effect was higher during the first fortnight of Ramadan
Yazdeen et al. (2016) [28]	N=120 Case control study; 1:1 split Location: Iraq	Patients that were middle aged and had clinical or radiological features of stroke were included The rates of stroke were assessed for an association with fasting during Ramadan in both groups and compared	Fasting was a significant risk factor towards stroke; 66.7% of cases and 40% in controls (p=0.03) This was also confirmed using logistic regression
El-Mitwalli et al. (2009) [25]	N=517 Prospective longitudinal study Location: Egypt	Patients that were admitted to the stroke unit of hospitals were recruited into the study Measurements were taken before and during Ramadan	No statistically significant differences were found across the time periods in ischaemic or haemorrhagic stroke

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TABLE 3: STUDIES INVESTIGATING THE EFFECT OF FASTING DURING RAMADAN ON STROKE

Author (Date)	Sample size and study details	Study population and ACS measures related to Ramadan	Key outcomes
Saadatina et al. (2008) [30]	N=162 Retrospective study Location: Iran	All patients admitted to neurological centres participating in the study were included The month of onset was assessed with the incidence of cases	The mean number of diagnoses was 5.5 during fasting months and approximately 2 during non-fasting months Analyses also showed a statistically significantly increased risk of cerebral venous sinus thrombosis when fasting during Ramadan when compared to outside of Ramadan
Bener et al. (2006) [26]	N=335 Retrospective clinical review Location: Qatar	Patients that were hospitalised for stroke were included in the study from 1991 – 2003 The frequency of hospitalisations was compared before, during and after Ramadan	Almost 50% of the cohort had diabetes There were no clear differences found in the frequency of hospitalisations based on the time periods of before, during and after Ramadan
Akhan et al. (2000) [31]	N=1579 Retrospective study Location: Turkey	All patients admitted to the participating sites for stroke between 1991 – 1995 A comparison of the frequency of stroke was made during Ramadan and other months	No statistically significant differences were found in the frequency of stroke across the two groups of during Ramadan and outside of Ramadan

4. CONSIDERATIONS AND RECOMMENDATIONS (CVD AND STROKE)

It is important to caveat the results shown above with their limitations. Many of these studies assessed hospitalisations in retrospective reviews and these have inherent biases; those that were most ill or likely to suffer macrovascular complications of CVD or stroke may have not made it into hospital. There could also be factors that confounded the association between Ramadan and macrovascular complications.

Additionally, many studies did not specifically assess the act of fasting during Ramadan and its association with CVD or stroke and only looked at aggregate data during time periods in and around Ramadan. This makes it difficult to truly assess the impact of fasting. It is also important to note that there were not many studies that directly investigated the impact of fasting during Ramadan in a population of individuals with diabetes, much less the different types.

It is recommended that all people with diabetes and pre-existing CVD, that are seeking to fast during Ramadan should receive a specific risk assessment and individualised advice.

Further randomised controlled studies in populations that have diabetes, including type 1 and type 2 diabetes need to be conducted in order to gain a better understanding of the risks of CVD or stroke in people with diabetes and the true effect of fasting during Ramadan.

Individuals with diabetes that have macrovascular complications such as stable or unstable CVD or stroke should remain classified as high risk. These individuals should generally be discouraged from fasting.

THOSE THAT ARE IN THE HIGHER RISK CATEGORIES FOR FASTING AND STILL CHOOSE TO FAST MUST:

- Receive a thorough risk assessment from their diabetes specialist, cardiologist and/or neurologist well in advance of Ramadan.
- Obtain individualised advice based on their current health status and treatment regimes.
- Receive pre-Ramadan education and understand how to properly conduct safe fasting with diabetes (see **chapter 7: Pre-Ramadan Assessment and Education**).
- Practice safe fasting as discussed in these guidelines wherever applicable.
- Receive pre-Ramadan screening.
- Make appropriate adjustments to therapies in accordance with their symptoms of CVD or stroke. For example, diuretics, antihypertensives, anti-diabetes medication and insulin regimens will need adjusting to give the greatest chance of achieving safe fasting during Ramadan.
- Make a concerted effort to stay hydrated and get an adequate amount of sleep and nutrition prior to conducting fasting.



5. MICROVASCULAR COMPLICATIONS

Impact of fasting during Ramadan for people with diabetes on Chronic Kidney Disease

An important microvascular complication that can arise as a result of diabetes can be chronic kidney disease (CKD) [32]; CKD can be categorised into different stages reflecting the severity of the disease, this classification has been described elsewhere [33]. The International Diabetes Federation and Diabetes and Ramadan International Alliance (IDF – DaR) guidelines stratify people with diabetes that have CKD by risk. Previously people with diabetes and CKD stage 3 were classified as high risk and those stage 4 or 5 were classified as very high risk [1]. In the new risk stratification, both are discouraged from fasting.

Kidney disease remains a huge issue to people with diabetes and in particular in countries that have large Muslim populations [32, 34], (see **chapter 2: Epidemiology of diabetes and fasting during Ramadan**).

Despite the associated risks, many people with diabetes and CKD may still wish to fast during the month of Ramadan and recommendations need to be made to help allow these individuals to practice the fast safely [35].

5.1 Fasting during Ramadan and Renal function

There have not been many studies conducted that have investigated the direct effect of fasting during Ramadan in people with diabetes on renal function. However, some studies that have investigated this, directly or indirectly, have been summarised in **Tables 4** and **5**.

El-Wakil *et al.* showed in a comparative prospective study that those with CKD were more likely to have increased levels of urinary NAG compared to healthy individuals that fasted during Ramadan. Importantly, they showed that the increase in urinary NAG levels were associated with blood glucose levels, highlighting the importance of glycaemic control among those with diabetes [36]. Mbarki *et al.* also showed that individuals with CKD that fasted during Ramadan could experience deterioration in renal function, particularly in those with an estimated glomerular filtration rate (eGFR) of less than 60 mL/min/1.73m² [37]. Bakhit *et al.* also showed that the higher the stage of CKD the worse the renal outcomes during Ramadan [38]. Importantly, others also noted that CKD can lead to an increased risk of CVD in individuals that fast during Ramadan [39].

On the other hand, Bernieh *et al.* showed an improvement in eGFR during and after Ramadan with no significant changes to biochemical measures such as urinary electrolytes, protein or osmolarity [40]. Kara *et al.* also showed similar outcomes in a comparative study of people that fasted compared to those that did not. They also highlighted that the elderly individuals could be at a higher risk of deterioration in kidney function [41], (for further information on elderly individuals please see **chapter 12: Management of diabetes among the elderly when fasting during Ramadan**). A meta-analysis conducted on the mean difference of the eGFR before and after Ramadan among several different studies; no clear or meaningful difference was found (mean difference 0; 95% CI -0.19 – 0.19) [35].

TABLE 4: STUDIES SHOWING WORSENING OUTCOMES IN RENAL FUNCTION IN PARTICIPANTS THAT FASTED DURING RAMADAN

Author (Date)	Sample size and study details	Population	Key findings
El-Wakil et al. (2007) [36]	N=21 15 with CKD and 6 healthy volunteers Prospective study Location: Egypt	All cases of CKD were evaluated pre-Ramadan and during Ramadan and the mean change eGFR was measured and compared to the healthy volunteers Roughly 20% of cases of CKD were caused by diabetes	Tubular injury correlated significantly with glycaemic control – NAG/creatinine and urinary protein/creatinine levels were correlated with percentage change in blood glucose ($p=0.001$)
Mbarki H et al. (2015) [37]	N=60 Prospective study Location: Morocco	All participants were diagnosed with CKD, approximately 8% had insulin-requiring diabetes Patients were separated into three groups based on renal function and evaluated before, during and after Ramadan	A total of 11.7% of patients that fasted during Ramadan experienced acute renal failure The main risk factor for deterioration in renal function was the presence of an eGFR < 60 mL/min/1.73m ²
NasrAllah and Osman (2014) [39]	N=106 Prospective study	All participants were patients that presented to a clinic with CKD Participants were split into two groups: 52 fasting and 54 non-fasting eGFR and biochemical measurements were taken before, during and after Ramadan and a mean difference was calculated	There was a worsening of kidney function during Ramadan and a hint that CKD could progress with worsening outcomes after Ramadan – creatinine levels rose by 60% during Ramadan and remained after Ramadan in 23% of individuals There was an increase in the risk of CVD in among that fasted during Ramadan 4 individuals continued fasting despite worsening outcomes
Bakhit et al. (2017) [38]	N=65 Prospective study Location: Kingdom of Saudi Arabia	All participants had CKD stage 3 or higher; 38% also had diabetes Clinical and biochemical measurements were taken before, during and after Ramadan	Around a third of participants that fasted during Ramadan experienced worsening renal function, this effect was increased by the stage of CKD Increases in the levels of creatinine were sustained after Ramadan



TABLE 5: STUDIES SHOWING STABLE OUTCOMES OR IMPROVEMENTS IN RENAL FUNCTION IN PARTICIPANTS THAT FASTED DURING RAMADAN

Author(s) (Date)	Sample size and study details	Population	Key findings
Bernieh et al. (2010) [40]	N=31 Prospective study Location: United Arab Emirates	Out-patients to a participating site that had stage 1-5 CKD were enrolled into this study 61% of the cohort had diabetes Clinical and biochemical measurements were taken before, during and after Ramadan	There was an improvement seen during and after Ramadan in eGFR (p=0.017) There were no statistically significant differences in urine electrolytes, protein or osmolarity
Hassan S et al. (2018) [42]	N=57 Prospective comparison study Location: Israel	All participants were with CKD stage 2, 3 or 4 There were 31 that fasted and 26 that did not fast Clinical and biochemical measurements were taken before, during and after Ramadan	eGFR did not change throughout the three time periods in fasting participants Changes in biochemical measurements were noted during Ramadan but returned back to normal after Ramadan It was concluded that participants in this study with CKD of stages 2–4 could fast throughout the month of Ramadan with no significant deterioration of renal functions
Kara E et al. (2017) [41]	N=94 Prospective study Location: Turkey	All participants had stable CKD of stages 3-5 45 individuals fasted and 49 did not fast during Ramadan; 32% of the cohort had diabetes Clinical and biochemical measurements were taken before and after Ramadan	There were no reported changes to BMI, systolic or diastolic blood pressure in both time periods in those that fasted No differences were seen in either fasting group for changes to eGFR between time periods It was found that elderly individuals were associated with a greater degree of deterioration in kidney function
Al Wakeel et al. (2014) [43]	N=39 Prospective study Location: Kingdom of Saudi Arabia	Participants included people with CKD of stage 3 or higher Clinical and biochemical measurements were taken before, during and after Ramadan	There were no notable changes in the progression of CKD or eGFR between the time periods Biochemical and clinical measurements remained relatively stable including creatinine, urine protein and blood pressure

5.2 Fasting during Ramadan in individuals on dialysis

There have been several studies conducted in individuals that have undergone dialysis, and many have found that fasting can be safely conducted during Ramadan without any added complication. Several studies have also taken into account the effect of diabetes. These studies have been summarised below.

Al-Wakeel *et al.* showed, in a study of 31 participants on peritoneal dialysis, that fasting was not associated with mortality or morbidity [44]. A study in 40 participants on haemodialysis that fasted on non-dialysis days found that fasting had no effect on weight gain, blood-pressure or electrolytes [45]. Likewise, another study on participants that underwent haemodialysis and fasted during Ramadan, showed that there was no excess mortality or morbidity as a result of fasting [46]. A large prospective, multi-centre, comparative study of individuals on haemodialysis was conducted in Saudi Arabia. More than half of the study participants had diabetes. It was found that there were no differences in pre- and post-dialysis blood pressure, serum potassium, albumin or cardiovascular events between those that fasted and those that did not fast during Ramadan [47].

A study conducted in Malaysia, in which approximately half of the participants had diabetes, found that fasting during Ramadan was associated with a reduction in weight and improvements in serum albumin and phosphate levels [48]. Another more recent study from Malaysia found that fasting in participants that were on haemodialysis was associated with reductions in BMI, inter-dialytic weight gain and improvements in serum phosphate, urea and creatinine levels, though serum albumin levels were found to fall. It was concluded that participants in their study only experienced transient changes during Ramadan and fasting could be conducted safely [49]. Similarly, Kazneh *et al.*, in a study conducted in Palestine of which almost half of participants had diabetes (46%), found fasting during Ramadan was associated with increases in inter-dialytic weight gain, even after adjusting for diabetes and other socio-demographic factors. Diabetes was associated with some biochemical changes but these were deemed clinically negligible [50].

5.3 Fasting during Ramadan in individuals that have undergone a renal (kidney) transplant

There have also been many studies that have looked into the effect of fasting during Ramadan in individuals that have undergone a kidney transplant, see **Table 6**. Generally, the consensus was that fasting can be conducted safely in these individuals, but more research is needed into people with diabetes that also have had kidney transplants to make more specific recommendations.

Ghalib *et al.* found that eGFR did not change from levels before Ramadan after fasting during Ramadan, even after adjusting for diabetes and age. They also found no differences in biochemical measurements between participants that fasted and those that did not fast [51]. These results were similar to that found by Ibrahim *et al.* who conducted a retrospective study in the Kingdom of Saudi Arabia [52]. A prospective study in Iran found that fasting was not associated with acute rejections of transplants or other complications [53].



Quarashi *et al.* also showed that fasting did not affect eGFR in different groups of baseline eGFR (categorised low, moderate and high), but did find that post-transplant periods of those that fasted were longer than those that did not fast [54]. Said *et al.* showed in a prospective study, that there were no associations between fasting during Ramadan and changes to serum creatinine levels but did find that those with type 1 diabetes mellitus (T1DM) had a tendency for higher blood glucose levels. Importantly, they also found two cases of acute rejection and three cases of chronic graft dysfunction [55].

TABLE 6: STUDIES ASSESSING THE SAFETY OF FASTING DURING RAMADAN IN INDIVIDUALS WITH KIDNEY TRANSPLANTS

Author(s) (Date)	Sample size and study details	Population	Key findings
Ghalib M <i>et al.</i> (2008) [51]	N=68 Prospective study Location: Kingdom of Saudi Arabia	Participants that underwent kidney transplants were prospectively followed for three consecutive Ramadans The study sample were split into two groups – 35 fasting and 33 non-fasting 28% of the sample had diabetes The eGFR and other clinical and biochemical measures were compared between the groups across all time periods The measurements were also compared within the same group from baseline	It was found that the eGFR in the fasting group did not differ from baseline even after adjusting for age and diabetes status There were no statistically significant differences observed between groups for eGFR, mean arterial pressure or in urinary protein excretion No rejection episodes were seen Conclusions based on those with <150 µmol/L creatinine
Abdulla AH <i>et al.</i> (1998) [56]	N=23 Prospective study Location: Kingdom of Saudi Arabia	All participants had undergone kidney transplant – 17 with normal renal function and 6 with impaired but stable renal function All participants had undergone their transplant at least 1 year before entering the study Biochemical measurements were taken before, during and after Ramadan	There were no statistically significant differences in all measurements at any time point
Einollahi <i>et al.</i> (2005) [57]	N=39 Prospective study Location: Iran	All participants had undergone kidney transplants and the groups were split into fasting (19) and non-fasting (20) All fasting individuals had consecutively fasted for three years Biochemical measurements were taken before, during and after Ramadan	There were no significant differences in the changes to serum creatinine levels across the time periods between fasting and non-fasting groups All fasting participants had stable renal function and safely practiced fasting during Ramadan

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TABLE 6: STUDIES ASSESSING THE SAFETY OF FASTING DURING RAMADAN IN INDIVIDUALS WITH KIDNEY TRANSPLANTS

Author(s) (Date)	Sample size and study details	Population	Key findings
Einollahi et al. (2009) [53]	N=82 Prospective study Location: Iran	All participants had undergone a kidney transplant There were two groups of people fasting (41) and non-fasting (41) 11% of participants had diabetes Clinical and biochemical measurements were taken before, during and after Ramadan	There were no acute complications, acute rejections or differences in serum creatinine and eGFR levels between both groups across all time periods
Ibrahim et al. (2003) [52]	N=565 Retrospective study Location: Kingdom of Saudi Arabia	All participants had undergone a kidney transplant at least one year before fasting outcomes were measured and presented for follow up at a renal transplant clinic Participants were split into two groups – 280 who fasted and 285 that did not fast eGFR and other biochemical measurements were taken from baseline and during and after Ramadan	There were no statistically significant differences found between the fasting and non-fasting groups for eGFR, urinary protein levels or in mean arterial pressure after adjusting for age and diabetes There were no acute rejection episodes reported in either group
Said et al. (2003) [55]	N=145 Prospective study Location: Kuwait	All participants had undergone a kidney transplant and had at least 6 months of stable function The sample was split by those that fasted (71) and those that did not fast (74) 10% of participants had T1DM and 16% had T2DM Biochemical measurements were taken before during and after Ramadan and then for a period after the study for follow up	There were no differences in the change in serum creatinine between both groups across all time periods Blood pressure remained the same and was similar in both groups There was a tendency for higher blood glucose in those with T1DM There few two cases of acute rejection and three cases of chronic graft dysfunction

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TABLE 6: STUDIES ASSESSING THE SAFETY OF FASTING DURING RAMADAN IN INDIVIDUALS WITH KIDNEY TRANSPLANTS

Author(s) (Date)	Sample size and study details	Population	Key findings
Qurashi T et al. (2012) [54]	N=80 Prospective study Location: Kingdom of Saudi Arabia	All participants had undergone kidney transplants 43 fasted during Ramadan and 47 did not fast The eGFR and other biochemical was calculated before during and after Ramadan (1 month and 6 months after Ramadan) and compared between and within groups	Fasting did not adversely affect renal function Serum creatinine were similar when compared to baseline within groups This was also the case for eGFR; after subgrouping participants by levels of eGFR (low, moderate, high) no differences were found in eGFR All measurements of kidney function were also similar between groups Those that had fasted did have longer post-transplant times compared with non-fasters (p=0.0001)
Salem et al. (2010) [58]	N=25 Prospective study Location: Libya	All participants were stable and had undergone kidney transplants, all had normal graft function prior to the study All had a transplant prior to entering the study for at least 1 year (1.5-26 years) Clinical and biochemical measurements were taken before, during and after Ramadan	All participants completed the month of fasting, non-experienced abnormal symptoms Body weight, blood pressure and cyclosporine levels were stable during Ramadan Creatinine and urea levels remained similar through all periods
Boobes et al. (2009) [59]	N=22 Prospective study Location: United Arab Emirates	All participants had undergone a kidney transplant and had a post-transplant period for at least one year prior to entering the study 73% had a baseline eGFR of >50 mL/min/1.73m ² Clinical and biochemical measurements were taken before, during and after Ramadan	All participants managed to fast during the whole month of Ramadan Fasting was not associated with any adverse events No statistically significant changes were found across the time periods in weight, blood pressure or in measures of creatinine, urea and electrolytes

6. CONSIDERATIONS AND RECOMMENDATIONS (CKD, Dialysis and Kidney Transplants)

Many of the studies conducted in the area of CKD including individuals with a previous diagnosis of CKD, on dialysis and having undergone a kidney transplant were conducted in populations which included people without pre-existing diabetes. This is an important consideration and further research is needed specifically into individuals that have pre-existing diabetes, both T1DM and T2DM.

The general consensus among the studies was that individuals with stable renal function could safely fast with, at most, transient changes occurring during Ramadan that do not last after Ramadan. It remains to be seen whether these results are applicable to people with type 1 or type 2 diabetes and the risk for fasting remains high. Alongside poorly controlled diabetes fasting could be unsafe. It is, therefore, paramount the following recommendations are **considered**:

- All individuals with diabetes (both T1DM and T2DM) and CKD should discuss their intentions to fast during Ramadan with diabetes and renal specialists at least three months prior to Ramadan and attend Ramadan focused education (see **chapter 7: Pre-Ramadan Assessment and Education**). As a pre-requisite, the recommendations for the practice of safe fasting discussed in these guidelines must also be met where applicable.
- Individuals with stable renal transplants and diabetes (both T1DM and T2DM) may be able to fast safely providing they are monitored carefully by their transplant team before, during, and after Ramadan, and given careful advice on how to take immunosuppressive and anti-diabetes medication.
- Individuals with diabetes (both T1DM and T2DM) and CKD of stages 3-5, or on dialysis should be considered high-risk, and fasting should be discouraged.
- Those that are considered high risk and still choose to fast must:
 - be carefully monitored and have weekly reviews during Ramadan
 - make a concerted effort to stay hydrated outside of fasting periods
 - monitor electrolyte and creatinine levels at various points during Ramadan to ensure safe fasting is being conducted and whether it should continue
 - avoid foods with high potassium or phosphorous content.



SUMMARY

- Fasting during Ramadan with stable CVD does not increase hospitalisations or worsening of the underlying heart condition. However further research is needed into individuals with diabetes and pre-existing CVD to carry any specific recommendations to individuals with diabetes and CVD.
- Studies investigating the risks of fasting on stroke are conflicting and greater research is needed in individuals with diabetes with pre-existing stroke.
- Fasting during Ramadan with stable CKD or having undergone a kidney transplant does not increase eGFR and any biochemical changes are transient. This may also apply to individuals with diabetes, but further research is needed into individuals with pre-existing diabetes and CKD.
- Individuals that have undergone a kidney transplant or have stage 3-5 CKD are at high-very high risk of fasting during Ramadan. These will require careful monitoring and specialised tailored advice before fasting during Ramadan. The conditions required to safely fast in other chapters of these guidelines must be met as a pre-requisite.
- Larger prospective studies are needed; these include randomised trials and studies assessing the effect of fasting in individuals with diabetes and its complications on microvascular and macrovascular complications.

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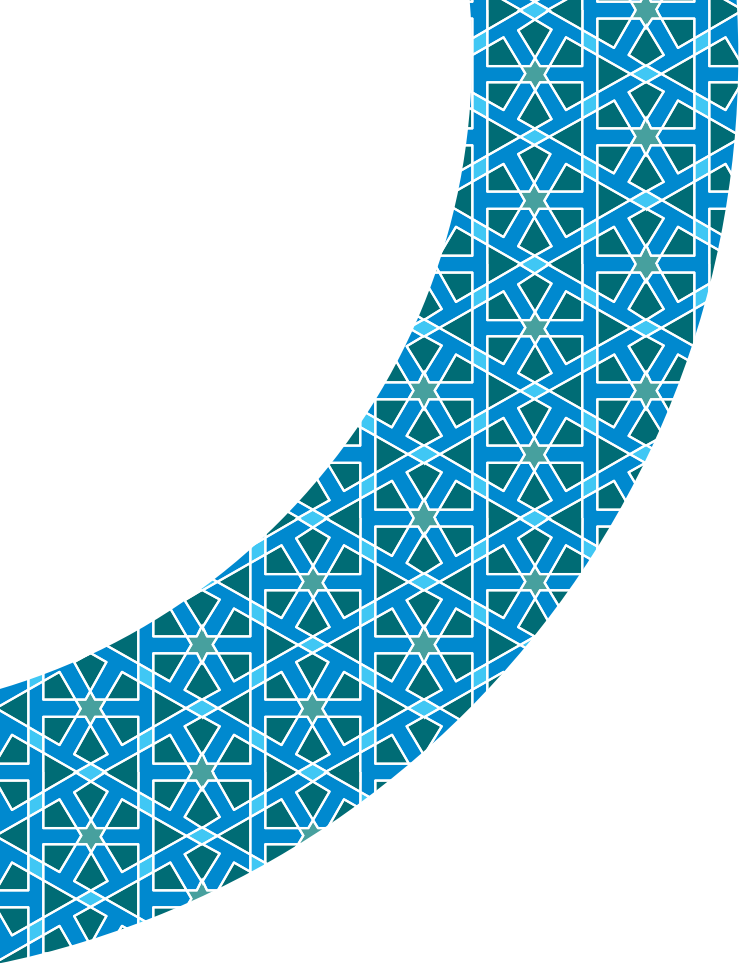
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CHAPTER 14

Identifying and overcoming barriers to guideline implementation

Chapter lead:

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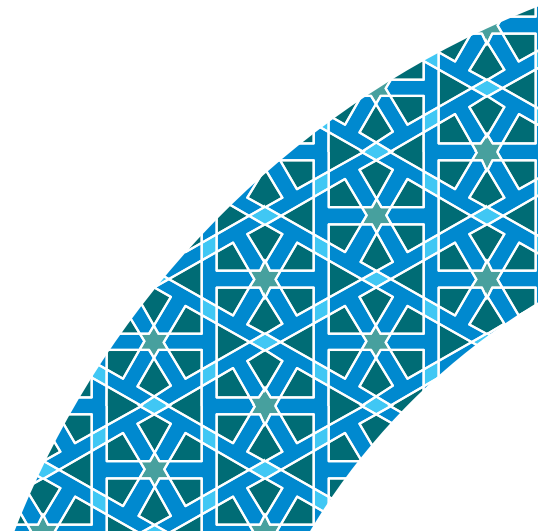
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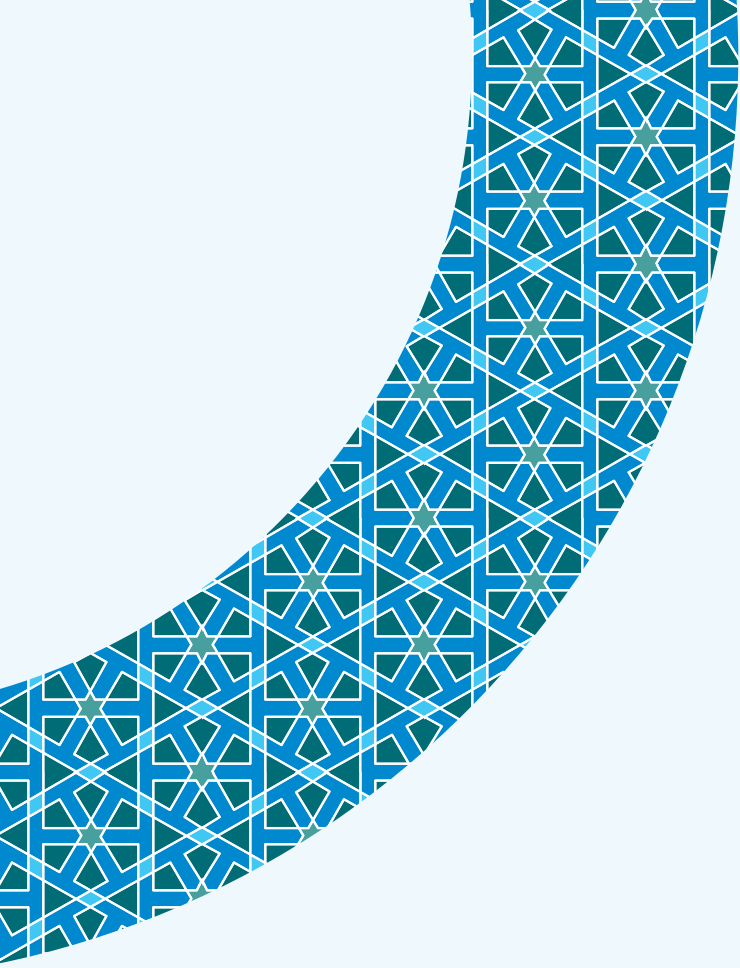
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CHAPTER 14

INDEX

1. INTRODUCTION AND THE IMPLEMENTATION OF GUIDELINES FOR DIABETES MANAGEMENT	299
1.1 Identifying barriers to guideline implementation	300
1.1.1 Community and patient barriers	300
1.1.2 Barriers involving HCPs and healthcare systems	303
1.2 Overcoming barriers to guideline implementation	303
SUMMARY	307
REFERENCES	308



WHAT IS KNOWN?

- Guidelines are important but only if they are adhered to and that is where implementation becomes key.
- Several barriers to guideline implementation exist including healthcare professional (HCP) awareness; socio-cultural sensitivity; and community, patient and healthcare system barriers.
- Innovative solutions to these barriers may include the use of technology.

WHAT IS NEW?

- In light of the Corona virus disease 2019 (COVID-19) pandemic, access to healthcare and guidance has plummeted.
 - This has led to new issues and barriers to guideline implementation
 - New innovative tools including telecommunication have become more prominent to improve access, but these are still not far-reaching enough.
- Work within communities including with community workers and Imams can prove to be beneficial in facilitating guideline implementation.

WHAT IS MISSING?

- Further research is needed on the impact of the COVID-19 pandemic and what it means for healthcare access, social interactions and ultimately guideline implementation.
- The use and access of telecommunication tools need to be improved to see its benefits for people with diabetes that fast all over the world during Ramadan.
- Understand how to integrate guidance into different healthcare systems across the world



1. INTRODUCTION AND THE IMPLEMENTATION OF GUIDELINES FOR DIABETES MANAGEMENT

Diabetes is a chronic disease requiring lifelong management [1]. Optimal management relies on the person with diabetes and healthcare professional (HCP) working in collaboration to control the patient's blood glucose levels and reduce diabetes-associated risks. For the individual with diabetes, this involves lifestyle changes, glucose-monitoring and often medical interventions [1]. Individual self-management is therefore key, and a supportive healthcare service is necessary to facilitate this. A number of global and national guidelines for the management of diabetes have been created to aid effective disease management and provide standards of care [1-4]. Furthermore, awareness of socio-cultural circumstances that may impact on diabetes management has increased. For example, several recommendations for the management of diabetes during the fasting period of Ramadan have been developed recently, along with educational programmes [5-8]. However, guidelines and educational resources are only of value if they are adhered to and several barriers to guideline implementation have been identified across communities, in both Muslim-majority and Muslim-minority countries.

The COVID-19 global pandemic, formally declared by the WHO since March 2020 has disrupted usual care and added additional barriers to the implementation of guidelines [9]. The effect of a global pandemic, and the changes to life that accompany it, need to be considered when producing, implementing and disseminating guidance.



1.1 Identifying barriers to guideline implementation

Barriers may arise on an individual level, for example with the person with diabetes or HCP or they may originate within the wider cultures of the community or healthcare system (**Figure 1**).

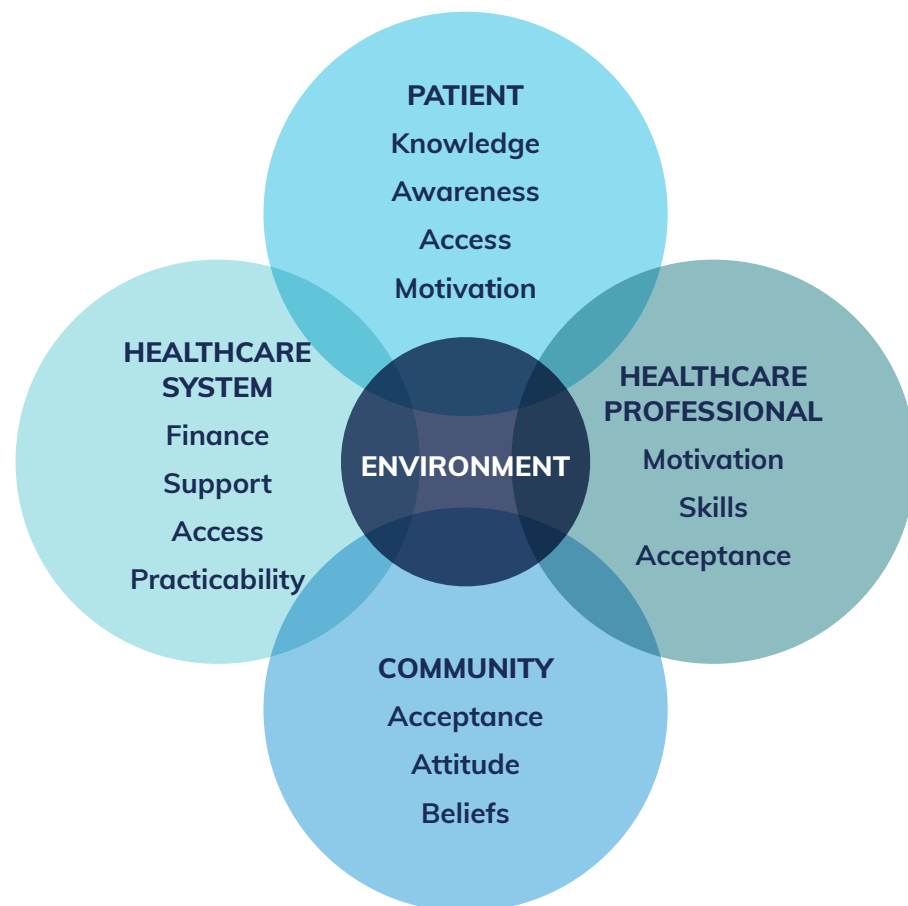


FIGURE 1

Barriers to guideline implementation span people with diabetes, healthcare professionals, healthcare systems and communities

Modifying established behaviour to achieve guideline recommendations is difficult; it can require changing personal beliefs and practices, as well as reshaping complex relationships within health services and within communities. A full understanding of these issues is critical for tailoring practical solutions. Some of the barriers to diabetes guideline implementation in communities, particularly during Ramadan, will be outlined in this chapter, alongside suggested strategies for overcoming them. This will also include the impact of the recent COVID-19 pandemic and the subsequent restrictions that have been placed on communities.

1.1.1 Community and patient barriers

To identify the barriers to diabetes guideline implementation related to the people with diabetes themselves, it is first important to understand individual perceptions of their condition,

both in general and in the context of Ramadan. There are several important physical barriers to achieving proper management of diabetes during Ramadan that include diet and physical activity. There are also important psychological factors that need to be considered as they can be more difficult to overcome, and these include longstanding personal beliefs, cultural practices and traditions.

Diet and exercise

Consumption of a high-fat and high-protein diet during Ramadan is a traditional behaviour that can be difficult to modify [10]. A prospective study of the dietary patterns of people with type 2 diabetes during Ramadan, who also underwent dietary counselling, revealed an increase in calorie intake during Ramadan with a significant increase in fat intake [10]. The study demonstrated that despite repetitive counselling on diet guidelines for Ramadan, compliance was poor [10]. Following a day of fasting, not only is there a desire to eat larger than normal meals, there is often an urge to eat them more quickly. Eating rates have been positively correlated with food intake, and eating too quickly can lead to overconsumption [11]. Eating habits, such as the frequency and timing of meals, also varies between countries, and this can impact the management of diabetes and the relevance of guidelines. For example, in some countries, the fast is broken with a light snack, followed by a large meal later in the evening, whereas in others a main meal is used to break the fast [7]. Increased exercise is also an important lifestyle modification for people with diabetes but this might be avoided in Muslim communities, both due to practical considerations, such as lack of time and services, as well as cultural circumstances and social expectations [12]. Moreover, the recent outbreak of SARS-CoV-2 leading to the COVID-19 pandemic has led to greater anxiety and fear over catching the virus and with government-imposed lockdowns and restrictions, marked reductions to physical activity have been seen.

Injections and skin pricks

In some communities, a social stigma may be attached to injecting insulin and alongside fears and misconceptions surrounding insulin treatment itself. These include ideas such as insulin being a forbidden substance, or insulin being able to cause disease [13, 14]. Indeed, over half of people with diabetes that were surveyed in Pakistan (N=210) felt that insulin would not reduce complications [15]. In the same survey, 41% had the impression that, even if absolutely necessary, they could not self-inject [15]. Moreover, women prefer not to expose parts of their body in public, which can limit the times that they can inject insulin or worse, this can lead to the injecting of insulin through clothing which can compromise needle sterility [13]. Moreover, it is believed by some that injecting insulin invalidates Ramadan fasting [7]. Many also feel that pricking the skin, an integral part of the blood glucose test, breaks the fast [7, 16]. In a retrospective observational study of glucose testing during Ramadan, 860 people with diabetes were surveyed in Pakistan [16]. The survey revealed that almost 40% of respondents who were taking insulin for their diabetes did not perform blood glucose tests during Ramadan, as they felt it would void the fast [16]. This problem also exists outside of Ramadan, where regular monitoring of blood glucose is insufficiently practised by people with diabetes in Muslim communities [17]. Therefore, it is imperative to explain to all people with diabetes, through culturally appropriate educational programmes, that insulin injection and/or blood glucose monitoring do not invalidate fasting during Ramadan.



Insulin injections or blood glucose monitoring through the piercing of skin

DO NOT INVALIDATE FASTING DURING RAMADAN

It is of vital importance that insulin treatment is taken and blood glucose levels are monitored frequently

Beliefs and attitudes

Many people with diabetes may not be aware that the Quran specifically exempts the sick (including those with diabetes) from fasting during Ramadan [14]. Of those that are aware, many still wish to honour their tradition and beliefs and insist on fasting [5].

In some countries, people with diabetes may be dismissive of non-medical doctor HCPs such as pharmacists, nurses and dieticians [14]. There may also be differences in cultural backgrounds and the primary spoken language between HCPs and people with diabetes, both within Muslim-majority and Muslim-minority countries where Muslim migrants are a key demographic [18, 19]. Moreover, female individuals with diabetes may be particularly uncomfortable consulting male physicians [13]. As such these factors can significantly obstruct the development of a strong patient-doctor relationship, which is necessary for effective diabetes management.

Cultural differences can also make the implementation of diabetes guidelines within Muslim communities more difficult.

The government restrictions imposed on communities due to the COVID-19 pandemic, such as lockdown and self-isolation policies to reduce physical contact, hampered the ability of individuals to access healthcare facilities. This was further compounded during times when viral transmission was at its highest and efforts were made to reduce visits to hospitals. Indeed, the effects of the pandemic are far-reaching, with it causing significant changes to the daily lives of individuals including economic hardship, social deprivation [20] and detrimental effects to mental health [21]. Importantly from the perspective of diabetes, the effects of COVID-19 may include reductions in the adherence to medical treatment and lifestyle changes, but also to motivation in that access to a large portion of their support network was reduced. Though telecommunication strategies were adopted to improve healthcare access, this did not provide full coverage, and many were left without access. Face-to-face meetings and assessments remain very important in providing the maximum level of care.

1.1.2 Barriers involving HCPs and healthcare systems

Barriers to guideline implementation originating among HCPs can arise from numerous factors, such as a lack of skills or knowledge, cultural competence and awareness of patient needs [22]. Indeed, a lack of medical knowledge of fasting and diabetes among general practitioners in France resulted in the provision of inaccurate advice to patients during Ramadan, alongside inadequate patient education [23]. The EPIDIAR study, which was carried out across 13 Muslim-majority countries, revealed that around a third of HCPs did not provide any recommendations at all about fasting to their Muslim diabetes patients during Ramadan [17]. There are signs that awareness of Ramadan recommendations and guidelines are increasing; however, in Muslim-minority countries the evidence suggests that use of guidelines remains low [24, 25]. Studies have also shown a lack awareness of Ramadan guidelines among pharmacists [26, 27]. One study in Qatar found that less than half of pharmacists referred to published practice guidelines and only 20% and 8.3% were aware of and had read the American Diabetes Association (ADA) Consensus document on fasting during Ramadan and the decree of the Organisation of Islamic conference respectively [26]. Interestingly, 20% of pharmacists interviewed were concerned about offering advice that was contradictory to that provided by the physician [26]. The views of others may play a significant role in guideline implementation and some HCPs may find it hard to accept guidance that conflicts with the opinions of colleagues or indeed their own religious beliefs. A lack of training, both in general diabetes management and Ramadan diabetes management is also a critical issue [28].

Barriers to guideline implementation within the wider healthcare systems will vary across and within countries, but typically comprise issues relating to service availability, accessibility and acceptability, continuity of care and finance [19, 29, 30]. Location (rural versus urban), healthcare infrastructure and patient awareness of services on offer can all affect the availability and accessibility of services to patients. Accessibility can also be affected by financial and linguistic barriers, preventing patients accessing adequate care once in a service [19, 30]. Indeed, low- and middle-income countries often do not have the resources to provide adequate medical care, diagnosis and testing for diabetes [30]. Barriers to acceptance arise from the patients' perception of a service, reflecting key elements in the development of patient-doctor relationship such as trust, cultural awareness and mutual respect [19]. Poor communication between primary and secondary care, high staff turnover, or lack of consistent messaging (for example on lifestyle and medication) will prevent continuity of care, which in turn can prevent the formation of an effective relationship between patient and doctor. Telecommunication has increased as a direct result of the COVID-19 pandemic. This includes more telephone triage and remote consultations which can be very useful for quick initial assessments. HCPs should have training to become more adept in these new methods of working to ensure primary care is sustainable and that workloads can be manageable [31].

1.2 Overcoming barriers to guideline implementation

There are several important barriers that need to be considered in attempting to implement guidelines. The first step in overcoming these barriers is to fully understand them; this enables appropriate practical responses to be configured and implemented (see **Table 1**).



Technological barriers

Technology has proved to be a very useful tool in helping to implement guidance in communities. The use of mobile phones is a great example of this; text messaging has been successful in acting as reminders and providing follow up to people with diabetes. Text messaging can help access communities quickly and conveniently and can help cross language barriers where written information can easily be translated into different languages. Senegal is a great success story in being the first country within Sub-Saharan Africa to implement the mDiabetes programme successfully and have seen great benefits to people with diabetes fasting during Ramadan [32]. The specialised International Telecommunication Unions (ITU) United Nations (UN) agency and the World Health Organization (WHO) have teamed up to push these initiatives to help overcome technological barriers but also to provide innovative solutions to access and education. The recent launch of the ITU-WHO Technology should, therefore, be prioritised as a means to not only enhance guidance but also to help facilitate the implementation of guidelines.

Working within communities

It is very important to get involved at the community level to help overcome barriers to guideline implementation. Working together with Imams is a good example of where efforts must be focused. In a study conducted in London it was shown that pregnant women with diabetes sought advice from Imams rather than from HCPs [33]. This also highlights the fact that HCPs need to be more proactive in reaching people with diabetes prior to Ramadan rather than waiting for them to seek advice.

In addition, equally important is making use of community workers. Community workers can help spread awareness to people in their community and ultimately enhance access to guidelines. They can also act as points of education if they are appropriately trained themselves to provide guidance or advice. (Please see **chapter 7: Pre-Ramadan Assessment and Education** for further information).

TABLE 1: BARRIERS TO GUIDELINE IMPLEMENTATION AND SOLUTIONS ON HOW TO OVERCOME THEM

Barriers to guideline implementation	Overcoming these barriers	Who are the actors?
Patient beliefs and attitudes about injections, blood monitoring and Ramadan fasting exemption	Ramadan-focussed diabetes education is widely recommended and has proven to be effective [8, 34]. In both Muslim-majority and Muslim-minority countries, it may be necessary to first provide education to HCPs, to both increase their awareness of the range of guidelines available which will then ensure they are providing optimal advice to patients.	<ul style="list-style-type: none"> • Regional, national and international organisations • Teamwork between HCPs and Imams ensuring that their diabetes and Ramadan knowledge is sound. Many patients prefer asking the imam and not the healthcare professionals • HCP should be more proactive to address Ramadan related issues rather than wait for patients to ask. • Community and family-centric educational programmes can also help to reshape traditional views and drive successful outcomes [8].

table continued on next page ►

TABLE 1: BARRIERS TO GUIDELINE IMPLEMENTATION AND SOLUTIONS ON HOW TO OVERCOME THEM

Barriers to guideline implementation	Overcoming these barriers	Who are the actors?
HCP barriers: Lack of skills, knowledge, cultural competence and awareness of patient needs	<ul style="list-style-type: none"> • HCPs may need additional training to ensure they have the appropriate skills to deliver optimal diabetes management strategies. • Patient beliefs should be used as a foundation for building educational programmes and education should be tailored to the recipient's culture and literacy [29, 35]. For example, when educating about diet, HCPs should have the knowledge to ensure traditional foods and foods compatible with the patient's economic situation are included within dietary plans [35]. 	<ul style="list-style-type: none"> • Specialists should be motivated to advocate guidelines in order to both educate and motivate other health workers, as well as provide confidence among staff that a unified message is being disseminated. • Religious leaders should be involved in community-level educational programmes, to ensure that patients receive advice combining religious and medical directives [14].
Communication barriers between patients and HCPs	<ul style="list-style-type: none"> • HCPs must take care to convey the importance of the patient's role in the management of diabetes, while being sensitive to socio-cultural circumstances [29]. • Cultural competency minimises misunderstandings, resulting in better communication and overall care [36]. • HCPs should take practical steps to respond to patient values, for example, providing a female doctor or chaperone to female patients who may be uncomfortable seeing a male physician [13]. • HCPs should monitor the adherence of patients to diabetes advice (e.g. through the use of patient diaries); [37]. 	Efforts from both HCPs and patients to build a trusting therapeutic alliance
Lack of access to care. This barrier is exacerbated during lockdown restrictions in the midst of the COVID-19 pandemic	<ul style="list-style-type: none"> • Cross-discipline communication and continuity of care can help with the implementation of guidelines, by providing consistent messages to patients and ensuring the development of a trusting therapeutic alliance [29]. • Technology can also be used to improve diabetes management [38]. • In the absence of head-to-head consultation due to lockdowns or other restrictions that are in place to limit the transmission of SARS-CoV-2, mobile messaging and applications (including medication reminders and diet and lifestyle plans) and webinars through social media can promote disease awareness and provide support for self-management [38]. The effectiveness of mobile phone-based short message service (SMS) intervention is currently being tested [39]. 	<ul style="list-style-type: none"> • Health care services should take responsibility to raise awareness of available materials, both among staff and patients. Services could adopt reminder systems, for example, the provision of prompts to remind HCPs to provide Ramadan fasting advice to each patient in their pre-Ramadan consultations. • Technology services to help implement and improve accessibility to mobile applications and webinars through social media platforms.
A lack of resources in some low- or middle-income Muslim-majority countries (this is more evident in COVID-19 pandemic)	Effective resource management is necessary to ensure the provision of optimum diabetes care.	Collaboration within medical teams and the use of agreed protocols can be beneficial [40]

Many of the barriers outlined in **Table 1** could be overcome by the provision of comprehensive diabetes education, both for patients and HCPs (**Figure 2**). Combining targeted education with a series of further actions across communities and health services, such as skills training,



improved communication, use of planning aids, establishment of support networks and resource management, can together help foster stronger patient-doctor relationships; the basis for effective guideline implementation (**Figure 2**). In addition, the evaluation and audit of guideline implementation strategies can provide opportunities to re-assess and improve upon implementation plans to help become more efficient and resourceful [41].

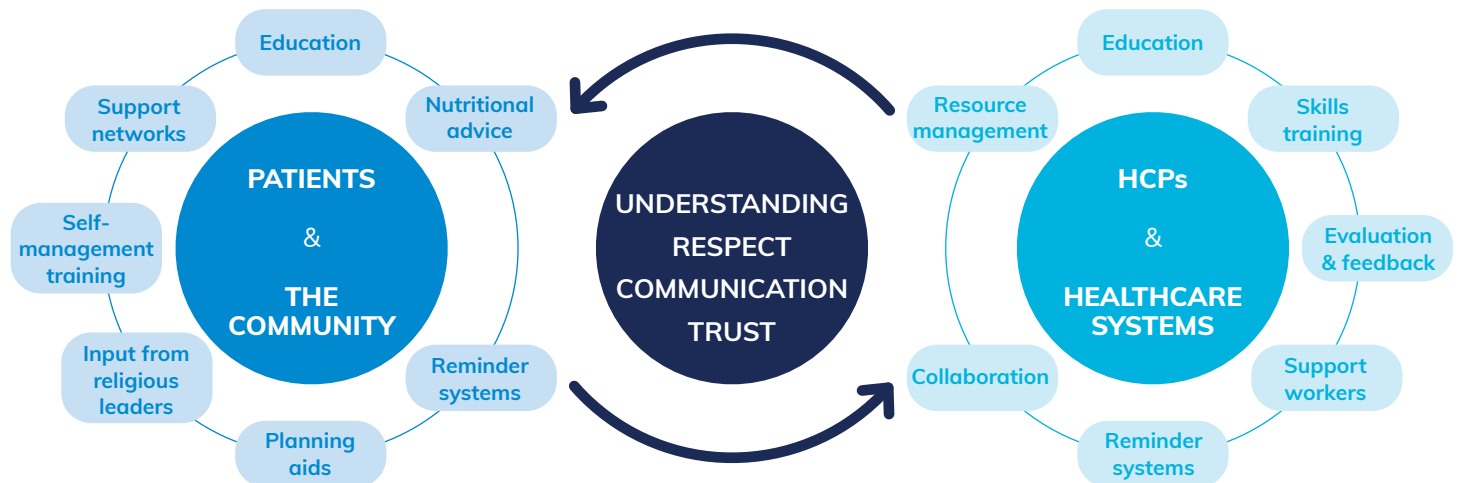


FIGURE 2

Multiple approaches for overcoming barriers to guideline implementation

In one study, HCPs attended an educational Ramadan and diabetes workshop to gain an understanding of the issues surrounding diabetes and fasting alongside a culturally specialised dietician, before providing pre-Ramadan education to patients. Patients were recruited and motivated to attend the sessions by a community link worker [8]. The study found that patient education was associated with weight loss and a significant reduction in hypoglycaemic events during Ramadan [8]. Similar findings were seen in other studies evaluating different approaches to pre-Ramadan education including one-to-one education sessions and group sessions but also through different professionals delivering the pre-Ramadan education such as medical doctors, dieticians or community link workers; all proved to be successful in improving outcomes in people with diabetes that fasted during Ramadan [33, 42-44] (for further information please see **chapter 7: Pre-Ramadan Assessment and Education**). Overall, multiple strategies for raising awareness of the issues that people with diabetes face during Ramadan should be encouraged.

Taken together, the recognition of barriers to guideline implementation is crucial in establishing targeted solutions to overcome them. Ultimately, the education of all stakeholders involved in guideline development and implementation is fundamental in ensuring the provision of optimal diabetes management, particularly during Ramadan.

SUMMARY

- Diabetes guidelines and educational resources are only of value if they are adhered to by both HCPs and people with diabetes.
- Several barriers to guideline implementation have been identified, originating with the individual (the person with diabetes or the HCP) or within the wider cultures of the community or healthcare system.
- Barriers to guideline implementation include a lack of awareness of guidelines, poor patient-HCP communication such as any disconnects between expectations and goals, difficulties in changing individual behaviours associated with tradition and individual misconceptions of Ramadan and diabetes.
- The COVID-19 pandemic restrictions including lockdowns and limitations to access of face-to-face consultations is an additional barrier for the implementation of guidelines. Promoting technology to access to live webinars, phone messages and application may be solutions, although these cannot be used with all patients (for example in low- and middle-income regions or the elderly).
- Key solutions to overcoming barriers include raising HCP awareness of the key issues surrounding diabetes and Ramadan and providing effective, socio-culturally sensitive education.
- Technology such as live webinars, phone messages and applications may provide solutions. Although these may not be available to all individuals (such as those in low- or middle-income countries or some elderly people) and access must also be improved.



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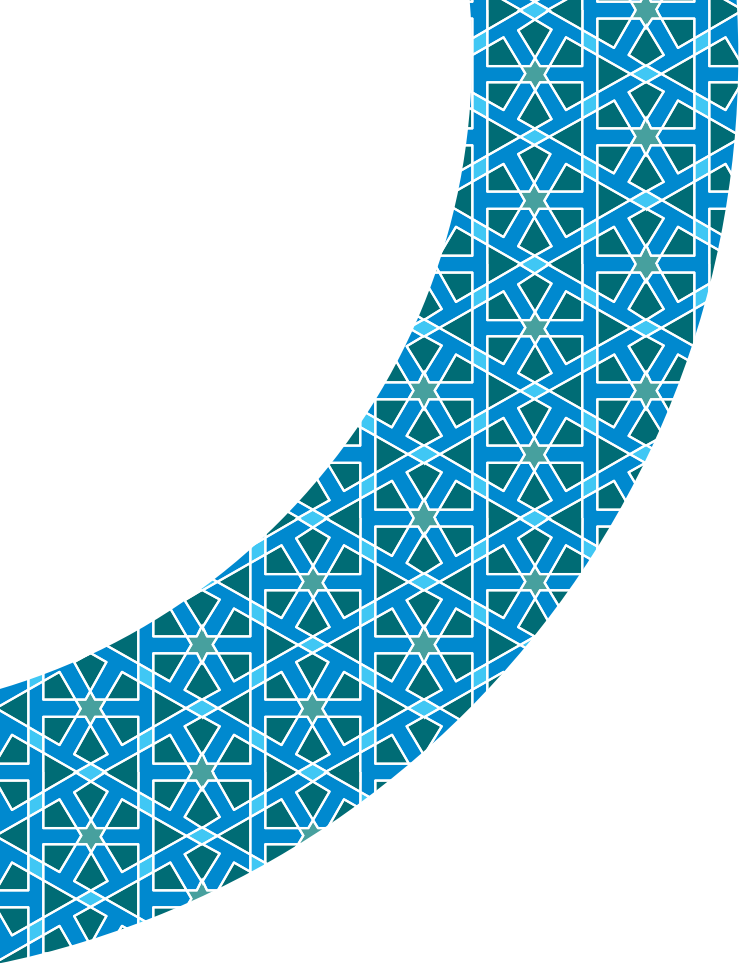
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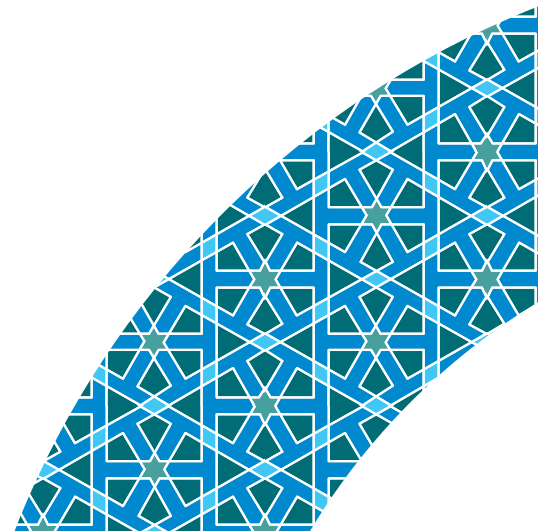


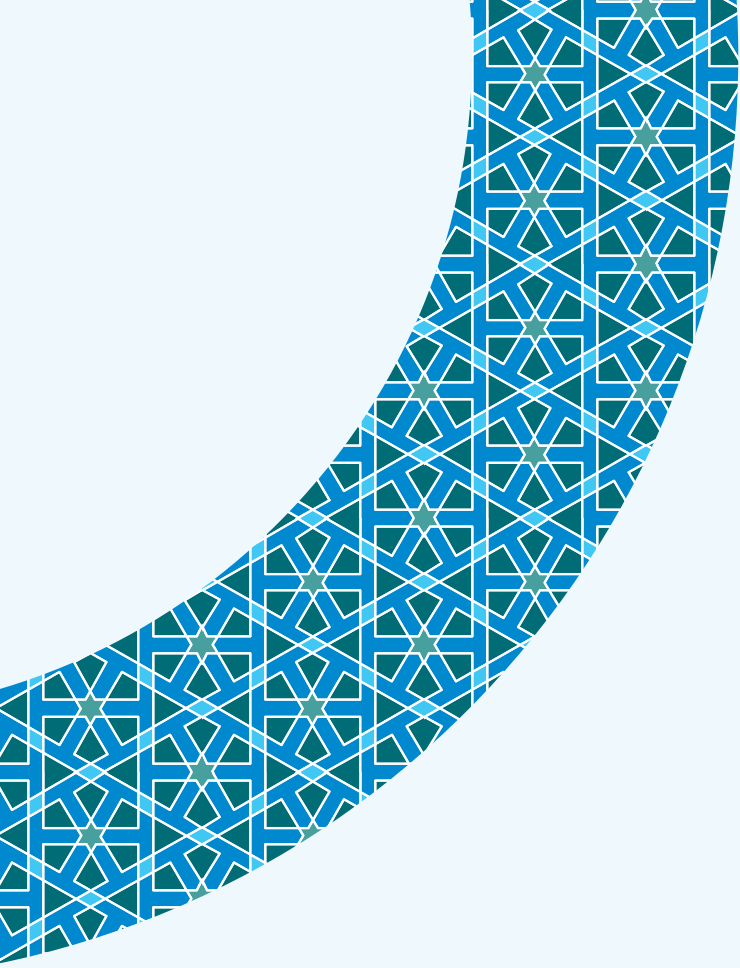
CHAPTER 15

Grading of evidence & areas
of future research in diabetes
and fasting during Ramadan

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CHAPTER 15

INDEX

1. INTRODUCTION	314
2. KEY RECOMMENDATIONS FROM THE 2021 IDF-DAR PRACTICAL GUIDELINES AND THEIR SUBSEQUENT GRADING AND JUSTIFICATION	315
2.1 Risk stratification of people with diabetes before Ramadan	315
2.2 Pre-Ramadan education	316
2.3 The Ramadan Nutrition Plan (RNP) for people with diabetes	316
2.4 Management of Type 1 diabetes	316
2.5 Management of Type 2 diabetes	317
2.6 Management of hyperglycaemia in pregnancy when fasting during Ramadan	320
2.7 Management of diabetes among the elderly when fasting during Ramadan	320
3. AREAS FOR FUTURE RESEARCH	321
REFERENCES	323



1. INTRODUCTION

The previous iteration of the International Diabetes Foundation (IDF) Diabetes and Ramadan (DAR) practical guidelines, published in 2017 [1], provided comprehensive guidance regarding fasting with diabetes during Ramadan. The consortium acknowledged that data from well-designed and adequately powered studies assessing the safety of fasting amongst people with diabetes during Ramadan was limited and allowed recommendations to be based primarily on expert opinion.

For the 2021 IDF-DAR guidelines, chapters were shared and independently reviewed by two experts (HSB and TSK; see *authors above*), who assigned a grade based on the strength of evidence and its applicability to the general population. The grading assigned was approved by 100% consensus. The grading methodology used the guiding principles from the Diabetes Canada Clinical Practice Guidelines 2018 [2], which have also been adapted for the Diabetes Canada Position Statement for People With Types 1 and 2 Diabetes Mellitus Who Fast During Ramadan [3].

Each reference that was used to formulate guidance was critically appraised using the criteria specified for the level of evidence (see **Table 1**). These levels took into account the characteristics of the study, the presence of conflicting findings from other studies and expert review of the findings. Thereafter, each recommendation was assigned a final grade from A through D, with grade A being the highest; (see **Table 2**). In the absence of Level 1, 2 or 3 supporting evidence, or if the recommendation was based on the consensus of the guideline development consortium, the highest grade that could be assigned was D.

TABLE 1: CRITERIA FOR ASSIGNING LEVELS TO EVIDENCE USED IN DEVELOPING GUIDANCE

Level	Criteria
Level 1A	Systematic review or meta-analysis of high quality Randomised Controlled Trials (RCTs) a) Comprehensive search of evidence. b) Authors avoided bias in selecting articles for inclusion. c) Authors assessed each article for validity. d) Reports clear conclusions that are supported by the data and appropriate analyses. OR Appropriately designed RCT with adequate power to answer the question posed by the investigators. a) Participants were randomly allocated to treatment groups. b) Follow up at least 80% complete, (no more than 20% missing data). c) Participants and investigators were blinded to the treatment where applicable. d) Participants were analysed in the treatment groups to which they were assigned. e) The sample size was large enough to detect the outcome of interest.
Level 1B	Non-randomised clinical trial or cohort study with indisputable results.
Level 2	RCT or systematic review that does not meet Level 1 criteria above.
Level 3	Non-randomised clinical trial or cohort study; systematic overview or meta-analysis of Level 3 studies.
Level 4	Other

TABLE 2: CRITERIA FOR ASSIGNING GRADES TO RECOMMENDATIONS

Grade	Criteria
Grade A	The best evidence was at Level 1.
Grade B	The best evidence was at Level 2.
Grade C	The best evidence was at Level 3.
Grade D	The best evidence was at Level 4 or consensus.

2. KEY RECOMMENDATIONS FROM THE 2021 IDF-DAR PRACTICAL GUIDELINES AND THEIR SUBSEQUENT GRADING AND JUSTIFICATION

2.1 Risk stratification of people with diabetes before Ramadan

(see chapter 5: Risk stratification of people with diabetes before Ramadan, Table 1 and Figure 1)

The risk stratification of individuals is a vital part of the overall strategy in assuring a safe and successful fasting experience during Ramadan for people with diabetes. It is clear that the previous methods used in risk stratifying individuals have been too rigid. This new methodology has been developed based on a wide range of evidence including RCTs, meta-analyses, systematic reviews, other forms of longitudinal studies that have informed expert opinion from leaders in the field of diabetes across the world. Additionally, the robustness of the risk scoring has been assessed in numerous case study scenarios. However, as no single controlled study has evaluated the comprehensive recommendations, against a comparator with an alternative, grading of evidence cannot be applied to the risk stratification schema. At best, they can be considered as being **Grade D, Consensus**.



2.2 Pre-Ramadan education

Pre-Ramadan education is an essential aspect of ensuring a safe fast during Ramadan for individuals with diabetes

There have been numerous studies conducted on the effect of pre-Ramadan education on outcomes during and after Ramadan. These include comparative prospective [4-9], retrospective [10, 11] studies, systematic reviews and meta-analyses [12], which included one small, randomised trial suggesting the benefit of pre-Ramadan education. As such this has been given an evidence grade of **Level 3, Grade C**.

The use of telehealth technology is beneficial and may provide a model for future education programmes for people with diabetes seeking to fast during Ramadan

Some studies have demonstrated benefits in the use of 'telehealth' but not all directly investigated populations of people with diabetes that fasted during Ramadan [13, 14]. Randomised trials that have looked at people with diabetes fasting during Ramadan suggest beneficial effects of technology-based monitoring tools, with reduced hypoglycaemia [15, 16]. The level of evidence for the recommendation to include technology-based monitoring during Ramadan is therefore **Level 2, Grade B**. Future research is needed to assess and compare different types of 'telehealth' including remote education compared to face to face education.

2.3 The Ramadan Nutrition Plan (RNP) for people with diabetes

The use of the RNP during Ramadan has been developed to help individuals obtain optimal nutrition during Ramadan. These RNP's have been culturally adapted to ensure that Muslims across the world seeking to fast during Ramadan can do so safely. The nutrition plans and strategies in this chapter have been developed by experts on nutrition that have been guided by the latest research on medical nutrition therapy. Although intuitively one would consider a diet that helps prevent glucose excursions and ensures proper nutrition during Ramadan to be of benefit, to date there have been no RCTs or comparator studies to assess the benefit of RNP. As such the level of this comprehensive RNP overall is graded as **Grade D, Consensus**.

2.4 Management of Type 1 diabetes

Fasting during Ramadan in individuals with Type 1 diabetes mellitus (T1DM) can be safe provided that strict criteria are met as outlined in chapter 9: Management of Type 1 diabetes when fasting during Ramadan

Numerous studies cited in the **chapter 9: Management of Type 1 diabetes when fasting during Ramadan** suggest that fasting during Ramadan can be undertaken safely in people with T1DM. This provides the basis for amending the risk stratification of people with T1DM. Individual components of the risk stratification system, have been investigated in observational studies and hence the recommendation that *"Fasting during Ramadan in individuals with Type 1 diabetes mellitus (T1DM) can be safe provided that strict criteria are met"* can be graded **Level 3, Grade C**.

A reduction of basal insulin dose by 10-30% in people with T1DM when fasting during Ramadan

There is debate about the best practice and approach to dose modifications to insulin regimens for people with T1DM who fast during Ramadan. Studies have reported different approaches and the development of specific guidance has been difficult. The basis for such a

recommendation is to reduce the risk of hypoglycaemia during the Ramadan fast and allowing a range of 10-30% covers the approaches of most studies presented in the chapter on the Management of Type 1 diabetes and allows for individualisation of care.

The recommendation above is based on expert opinion and on some observational studies that employed different rules for insulin dose titration and follow-up. As such the most appropriate final grade for the recommendation is **Grade D, Consensus**.

The use of premixed insulin should be discouraged

This recommendation was based on the requirement of a fixed intake of carbohydrates which can prove to be inflexible during Ramadan. People with more unpredictable eating habits e.g., adolescents, might find it especially difficult. This recommendation was based on the ISPAD guidelines and expert opinion from the guideline development consortium. But without clear evidence the highest achievable grade is **Grade D, Consensus**.

The use of CGM or FGM is superior to the traditional BG monitoring and should be the method of choice if available

The results of studies which form the basis of this recommendation have been conflicting. In general, the benefit of continuous blood glucose monitoring may not be as clear among adolescents than in adults. Where applicable and appropriate, the use of continuous glucose monitoring (CGM) and flash glucose monitoring (FGM) systems can offer benefits to HCPs and individuals with T1DM (see the **chapter 9: Management of Type 1 diabetes when fasting during Ramadan – section 9**).

However, as the studies to date have been observational in nature, did not have a comparison control group, the results show conflicting outcomes and do not demonstrating superiority for CGM/FGM over conventional approaches to monitoring glycaemic control (SMBG) when fasting during Ramadan — this recommendation is primarily based on expert opinion. Therefore, the appropriate grading applied is **Grade D, consensus**.

In order to mitigate the issues identified with CGM or FGM in adolescents and adults, placing emphasis on education in the pre-Ramadan assessment that teaches the benefits of continuous methods to measure blood glucose might help with their clinical utility in lieu of or in addition to SMBG and so these methods should be considered for future research.

Guidance for Adults with T1DM who seek to fast during Ramadan

Evidence for insulin titrations in adults with T1DM who fast during Ramadan is based on expert opinion, therefore the recommendation is **Grade D, consensus**.

2.5 Management of Type 2 diabetes

Metformin and acarbose are safe and require no dose modifications for people with T2DM who fast during Ramadan

There are no RCTs with these two drugs in people with T2DM who fast during Ramadan. However, among non-fasting individuals there is a large body of evidence in relation to adverse events and the very low risk of hypoglycaemia associated with these drugs. Whilst it



is a reasonable assumption that these two drugs are safe to use during Ramadan, the lack of evidence allows us to only provide a grading of **Grade D, consensus**.

No dose modifications are needed for Thiazolidinediones for people with T2DM when fasting during Ramadan.

Given the low risk of hypoglycaemia it is reasonable to assume that no dose modifications are required. There are no studies which have directly assessed their use in people fasting during Ramadan but a double blind RCT showed favourable outcomes for Pioglitazone compared to other oral antidiabetic drugs [17], enabling a recommendation of **Level 2, Grade B** for pioglitazone, **Grade D, consensus** for other thiazolidinediones.

The daily dose of short-acting insulin secretagogues (based on a three-meal dosing) may be REDUCED or REDISTRIBUTED to two doses during Ramadan according to meal sizes

There have been two RCTs on insulin secretagogues in people with T2DM who fasted during Ramadan [18, 19] that have showed a similar or a reduced risk of hypoglycaemia with repaglinide compared to sulphonylureas. Further, three observational studies have shown similar hypoglycaemia outcomes between insulin secretagogues indicating safety. The grading of recommendation for continuation of repaglinide during Ramadan is **Level 2, Grade B**, due to conflicting outcomes between the observational studies and RCTs; and **Grade C, Level 2** for gliclazide and gliclazide MR; **Grade C, Level 3** for glimepiride. The recommendation that doses of insulin secretagogues may be reduced or redistributed during Ramadan according to meal size is based on **Grade D, consensus**.

As long as Glucagon-like peptide-1 receptor agonists (GLP-1 RAs) such as liraglutide, lixisenatide, exenatide have been appropriately DOSE-TITRATED prior to Ramadan (at least 2–4 weeks), NO FURTHER TREATMENT MODIFICATIONS are required

Observational studies and RCTs have compared GLP-1 RAs such as exenatide, liraglutide and lixisenatide against sulphonylureas in people with T2DM who fasted during Ramadan (see **Table 3** of the **chapter 10: Management of Type 2 diabetes when fasting during Ramadan**). The recommendation to continue GLP-1 RA during Ramadan is **Grade C, Level 3** for exenatide; **Grade C, Level 2** for liraglutide and lixisenatide; **Grade D, consensus** for others.

Dipeptidyl peptidase-4 (DPP-4) inhibitors can be used to reduce incidence of hypoglycaemia compared to sulphonylureas during Ramadan

Comparative RCTs as well as a meta-analysis of RCTs have compared DPP4-I such as sitagliptin and vildagliptin against sulphonylureas in people with T2DM who fast during Ramadan (see **Table 4** of the **chapter 10: Management of Type 2 diabetes when fasting during Ramadan**). The recommendation is graded as **Level 1A, Grade A** for vildagliptin; **Level 1B, Grade A** for sitagliptin; **Grade D, consensus** for other DPP-4 inhibitors.

Modern sulphonylureas are preferred over older sulphonylureas to reduce the risk of hypoglycaemia in people with T2DM who fast during Ramadan

A double blind RCT [20] and large scale observational studies [21] have been conducted

on the use of modern sulphonylureas indirectly assessing the use of these medications compared to other antidiabetic medications. Likewise, subgroup analyses in an observational study assessing the impact of different sulphonylureas on overall rates of hypoglycaemia showed a preference for more modern sulphonylureas [22]. In some of these studies the risk of hypoglycaemia was comparable to DPP4-I (see **Table 5** of the **chapter 10: Management of Type 2 diabetes when fasting during Ramadan**). The overall recommendation is graded as **Level 3, Grade C**.

Sodium-glucose co-transporter-2 (SGLT2) inhibitors should be used with CAUTION during Ramadan

Several comparative prospective and retrospective studies and RCTs have compared SGLT2I such as dapagliflozin and canagliflozin against individuals not using SGLT2I in people with T2DM fasting during Ramadan (see **Table 6** of the **chapter 10: Management of Type 2 diabetes when fasting during Ramadan**). These studies showed lower rates of hypoglycaemia when compared to SU with increasing symptoms of thirst, but no excess risk of dehydration. The recommendation that SGLT2 inhibitors can be continued during Ramadan is **Grade C, Level 2** for dapagliflozin (38); **Grade C, Level 3** for canagliflozin (34); **Grade D, consensus** for other SGLT2 inhibitors.

NO DOSE ADJUSTMENTS are required for SGLT2 inhibitors during Ramadan **Grade D, consensus**.

Dose reductions need to be made in individuals on multiple antidiabetic medications

There have been subgroup analyses in several studies assessing the additional risk of hypoglycaemia among people with T2DM on multiple antidiabetic therapies when fasting during Ramadan [23-27]. Based on subgroup analyses, expert opinion highlights the additional risk of multiple therapies and the recommendation to consider dose reductions is based on **Grade D, consensus**.

Dose reductions to long and short acting insulin therapies and premixed insulin therapies (see Figures 4 and 5 of the chapter 10: Management of Type 2 diabetes when fasting during Ramadan)

Dose reductions for insulin therapies are based on expert opinion and informed by large-scale observational studies (see **Table 7** in the **chapter 10: Management of Type 2 diabetes when fasting during Ramadan**). The effect of specific dose reductions proposed in the table have not been studied as an intervention in observational studies or in RCTs, and so this recommendation is **Grade D, consensus**.

Second generation long acting insulin analogues (IDeg/IDegAsp) have been reported to be safe with lower risks of hypoglycaemia compared to older generation mixed insulin for people with type 2 diabetes

Three studies assessing the efficacy of these newer generation insulin analogues both showed benefits. An observational study found these second generation analogues to be safe with no severe reported events of hypoglycaemia [27, 28] allowing a recommendation of **Level 3,**



Grade C. A phase III RCT of IDegAsp showed reduced hypoglycaemia compared to BIAsp 30 [29], enabling a recommendation of **Level 1B, Grade A** for IDegAsp.

The recommendation to have a post-Ramadan assessment

There are major changes to normal routines when fasting during Ramadan which have been highlighted in the **chapter 4: The effects of fasting during Ramadan on physical and mental wellbeing**; which will revert to normality once Ramadan ends. This provides a good opportunity to assess individual experiences and gain valuable information to produce better guidance. There has been no direct research on the impact of implementing lessons learnt from information collected from post-Ramadan assessments and as such this allows a recommendation of **Grade D, Consensus**.

2.6 Management of hyperglycaemia in pregnancy when fasting during Ramadan

Recommendations for the management of hyperglycaemia in pregnancy when fasting during Ramadan

The advice against the use of glibenclamide is based on observational studies and guidance from the Food and Drug Administration (FDA). Its use should be discouraged when pregnant and fasting during Ramadan. However, grading is based on the level of evidence alone; this recommendation is considered a **Grade D, Consensus**.

Insulin dose adjustment recommendations (see Table 1 in the chapter 11: Management of hyperglycaemia in pregnancy when fasting during Ramadan)

The recommendations on insulin adjustments were primarily based on expert opinion from the guideline development consortium. As such there is a need for further research and the recommendation is **Grade D, Consensus**.

2.7 Management of diabetes among the elderly when fasting during Ramadan

These recommendations were largely based on expert opinion from the guideline development consortium and from information on elderly individuals with diabetes — primarily the DAR 2020 Global Survey. This cross-sectional study informed the needs and practices of elderly individuals with T2DM who fasted during Ramadan 2020 across many different countries. It was assumed that elderly individuals are at higher risk of comorbidities such as impaired renal function, cardiovascular disease (CVD), dementia, frailty and a risk of falls and complications such as hypoglycaemia and hyperglycaemia. The grading of evidence is **Level 3, Grade C** for increased risk of hypoglycaemia and hyperglycaemia in the elderly who fast during Ramadan. These important comorbidities favour a more conservative approach to minimise the risks of hypoglycaemia and hyperglycaemia in elderly. However, as no study has investigated such an approach in a comparative manner, this second recommendation is **Grade D, Consensus**.

3. AREAS FOR FUTURE RESEARCH

To fully understand the effects of fasting during Ramadan with diabetes and enable evidence-based recommendations, further research is needed. The criteria presented in **Table 1** have been developed to grade current guidance, but also provide a good benchmark for future studies. Future studies should consider the grading schema in their planning stage and make appropriate adjustments so as to garner a higher level of evidence.

The effects of fasting during Ramadan on physiology and wellbeing

Future research will need to consider both the short-term and long-term effects of fasting during Ramadan. Much of the changes that occur during Ramadan are temporary, including metabolic, cellular and genetic changes but also of a physical and mental nature. Evidence is inconclusive as to whether these changes have a lasting impact on maintenance of weight loss and improvements in mood or levels of anxiety after Ramadan.

People with diabetes also need to be reassured that their condition will not be exacerbated by fasting. Studies need to continue follow up of individuals with diabetes and report on outcomes after Ramadan in both T1DM and T2DM. Moreover, the psychological impact of complications such as hypoglycaemia or hyperglycaemia need to be assessed and qualitative research can help understand the needs of individuals.

Risk stratification

A dynamic, easy to use risk calculator to stratify individuals with diabetes before Ramadan needs to be developed and made accessible to all healthcare professionals (HCPs) seeking to provide guidance to individuals that have diabetes and seek to fast during Ramadan. This risk tool should be updated regularly based on new evidence. Further research is required to assess additional risk factors for people with diabetes who fast during Ramadan using machine learning and artificial intelligence (AI) to include large data driven Omics and patient reported outcomes/indicators of quality of life.

Pre-Ramadan education

There needs to be further larger studies conducted into the effectiveness of pre-Ramadan education utilising online/web settings compared to in-person methods. These data will be invaluable for providing recommendations for people in circumstances where remote or online methods are the only means by which an individual can get access to patient education. This includes scenarios such as the COVID-19 pandemic whereby physical contact was reduced to help halt infectious disease transmission.

Moreover, greater evidence from RCTs are needed to compare the overall effectiveness of pre-Ramadan education against suitable controls on the successfulness of fasting during Ramadan among people with T1DM and T2DM.



The Ramadan Nutrition Plan (RNP) for people with diabetes

The RNP method needs to be assessed in RCTs to assess its benefits and to understand areas of improvement. Further research into medical nutrition therapy during Ramadan is needed to generate data in people of different ages, cultures and personal preferences to enable generalisability and tailoring of guidance.

Management of type 1 diabetes

Advanced insulin technology, such as insulin pumps, have shown promising results and this will need to be confirmed in larger scale studies, among different groups of people with T1DM. In addition, further research should also commence on the use of CGM/FGM to demonstrate superiority over conventional SMBG methods.

Outcomes in adults with T1DM who fast during Ramadan is scarce. Future studies should aim to include more heterogenous populations in terms of age, other comorbidities and insulin types and regimens in RCTs of individuals with T1DM who fast during Ramadan.

Management of type 2 diabetes

RCTs are needed for different classes of antidiabetic medications assessing dose changes to enable evidence based dose modification.

AI based machine learning techniques should be developed to predict outcomes for individuals with T2DM that seek to fast during Ramadan. Large amounts of data will be needed for these technique and sources such as continuous glucose monitoring devices could be very useful.

Management of hyperglycaemia in pregnancy when fasting during Ramadan

Specific research in pregnant women with gestational diabetes mellitus (GDM) or T2DM who fast during Ramadan are needed. Observational studies of volunteers who fast during Ramadan and their respective treatment regimens may help formulate evidence based guidance.

Management of diabetes among the elderly when fasting during Ramadan

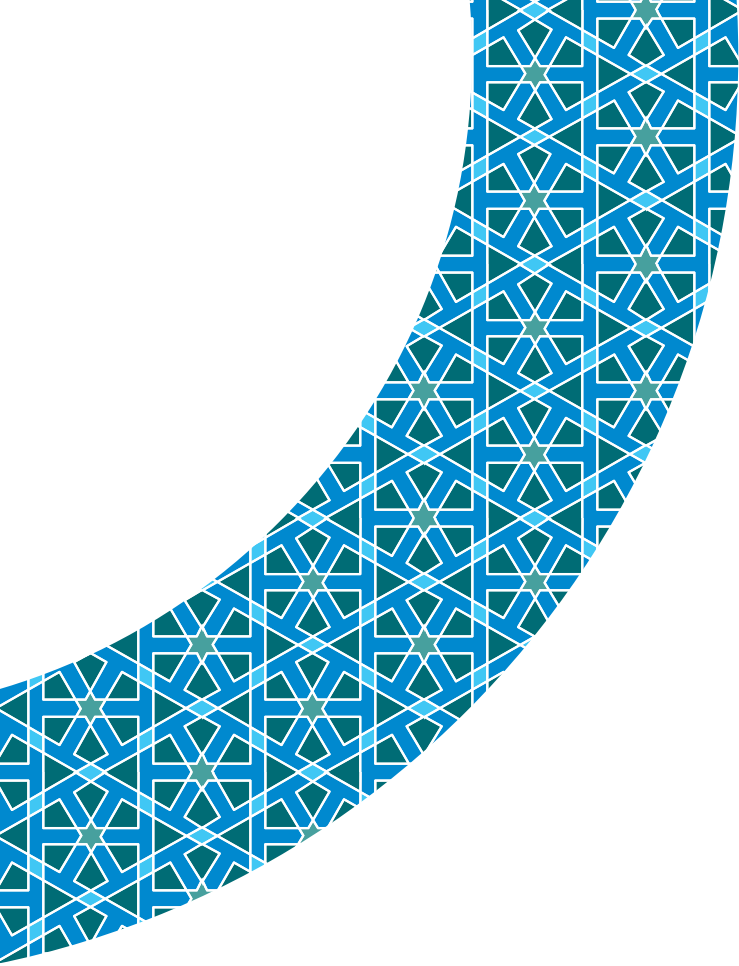
Observational studies and RCTs are required in elderly individuals with T1DM and T2DM and differing levels of comorbidities who fast during Ramadan.

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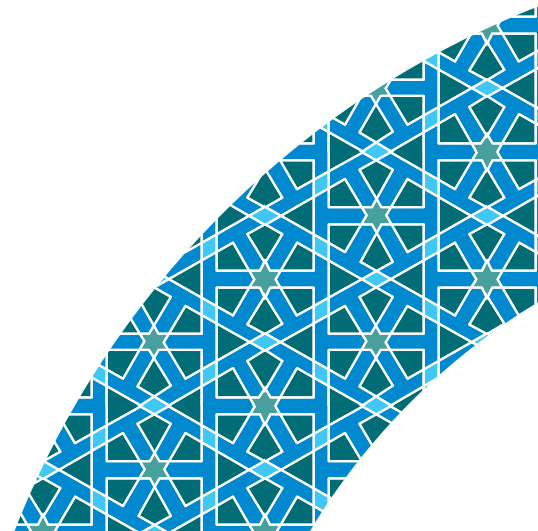
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GLOSSARY





ACRONYM/ TERM	EXPLANATION
Numbers	
7-point glucose monitoring	Fasting blood sugar, post-prandial blood sugar, pre-lunch, post-lunch, pre-dinner, post-dinner, midnight
95% CI or CI	95% confidence interval - provides information on the true population value of an estimate
A	
Acrophase	The time period in which a cycle crests or peaks - in relation to circadian rhythm
ACS	Acute coronary syndrome
ADA	The american diabetes association
Adiponectin	A hormone produced primarily in adipose tissue that plays a role in regulating glucose levels and fatty acid breakdown
AEE	Activity energy expenditure
APS	Artificial pancreas system
B	
BG	Blood glucose
BID	Twice a day insulin
C	
CAD	Coronary artery disease
Catecholamines	These are hormones made by your adrenal glands, which are located on top of your kidneys. Examples include dopamine; norepinephrine; and epinephrine (also called adrenalin or adrenaline).
CGM	Continuous glucose monitoring
CKD	Chronic kidney disease
Closed loop	Combination of a continuous glucose monitoring system and an insulin delivery system
CNS	Central nervous system
Complex carbohydrates	Made up of sugar molecules, complex carbohydrates have longer chains of sugar molecules than simple carbohydrates and have a more gradual impact on blood glucose levels
Cortisol	A steroid hormone made in the adrenal glands that has a wide range of effects including regulating insulin and decreasing hepatic glucose output
COVID-19	Coronavirus disease 2019
CSII	Continuous subcutaneous insulin infusion
CVD	Cardiovascular disease
D	
DAR	Diabetes and Ramadan - of the diabetes and Ramadan alliance
Dyslipidaemia	This is a broad term describing a number of conditions, including hypercholesterolaemia, hyperlipidaemia and mixed dyslipidaemia, in which disturbances in fat metabolism lead to changes in the concentrations of lipids in the blood

ACRONYM/ TERM	EXPLANATION
E	
eGFR	Estimated glomerular filtration rate is a measure that is used to assess kidney function
ESS	Epworth sleepiness scale
F	
FDA	Food and drug administration
FFA	Free fatty acids
FGM	Flash glucose monitoring
Fidya	Donations of money and/or food to the poor when a fast is missed or broken during Ramadan
G	
GDM	Gestational diabetes mellitus
Glucagon	A peptide hormone produced by the alpha cells of the pancreas. It works by increasing glucose levels in the blood stream.
Gluconeogenesis	This is a metabolic pathway that results in the generation of glucose from non-carbohydrate carbon substrates such as lactate, glycerol, and glucogenic amino acids.
Glycaemic index (gi)	A rating system for carbohydrates and their impact on blood glucose levels
Glycogen	A multibranched polysaccharide of glucose that serves as a form of energy storage.
Glycogenesis	This is the process of glycogen synthesis, in which glucose molecules are added to chains of glycogen for storage. This process occurs in the liver, and is also activated by insulin in response to high glucose levels.
Grhelin	A hormone made from endocrine cells of the gastrointestinal system that promotes hunger and eating
H	
HbA1c	Glycated hemoglobin is a form of hemoglobin that is chemically linked to a sugar, it can be measured in units of mmol/L or as a percentage
HCP	Healthcare professional
HDL	High-density lipoprotein, or "good" cholesterol, absorbs cholesterol and carries it back to the liver.
HF	Heart failure
HIP	Hyperglycaemia in pregnancy
HOMA-IR	Homeostatic Model Assessment of Insulin Resistance
Honeymoon period	The period in which the pancreas of a newly diagnosed person with T1DM is still able to produce its own insulin. There is no hard and fast rule as for how long this period lasts
HSCRp	High sensitivity C-reactive protein. This is a substance produced by the liver, generally when levels of inflammation are high
Hyperglycaemia	A rise in blood glucose levels above safe levels
Hypoglycaemia	A fall in blood glucose levels below safe levels
Hypothyroidism	An underactive thyroid gland (hypothyroidism) is where your thyroid gland does not produce enough hormones

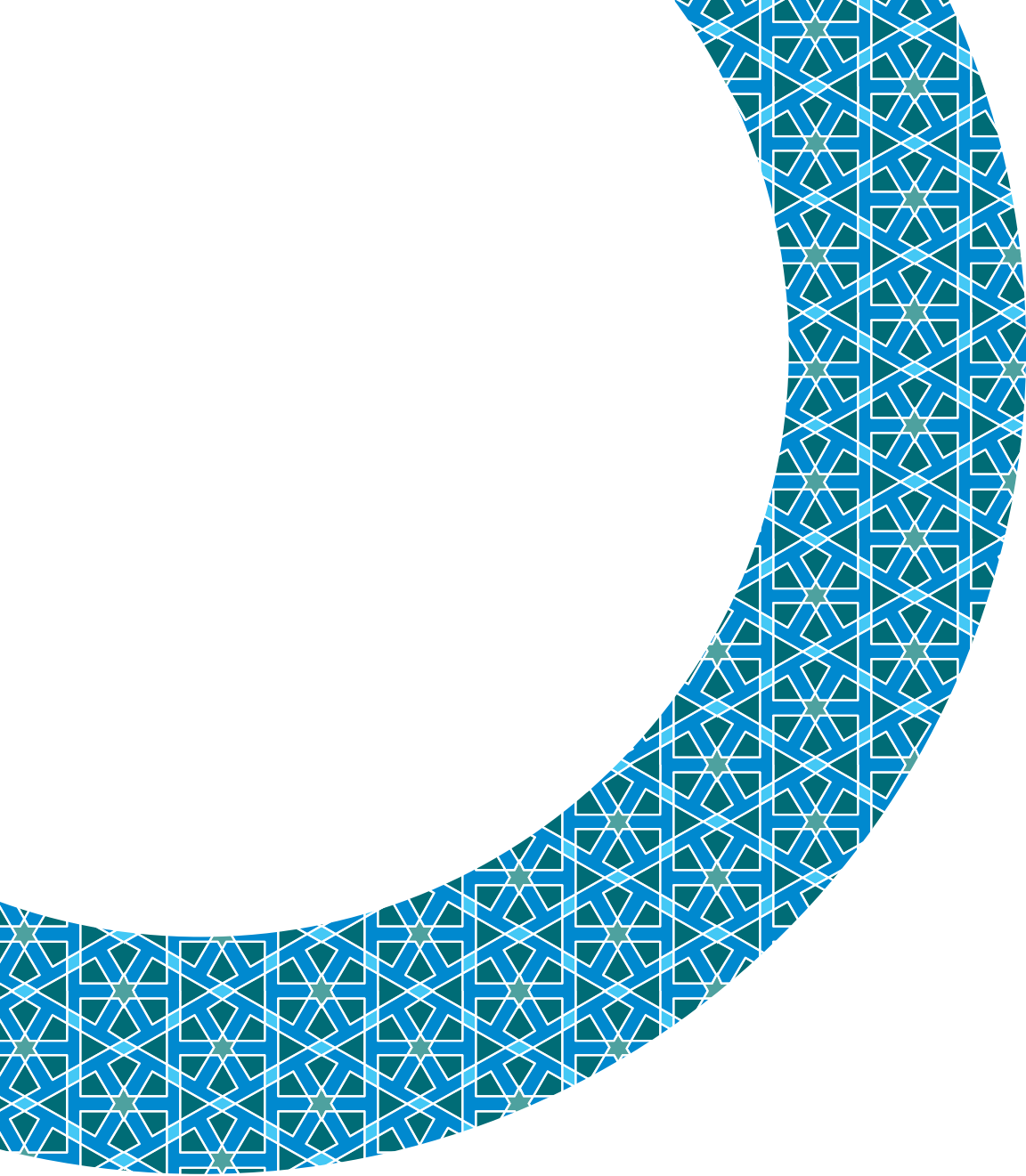


ACRONYM/ TERM	EXPLANATION
I	
ICR	Insulin carbohydrate ratio - this is a ratio of units of insulin per grams of carbohydrates e.g. 1 unit per 10 grams (1:10)
IDF	International diabetes federation
Iftar	The daily meal consumed during Ramadan before sunset
Imam	An Imam is a leadership role within Muslim communities. This includes leading prayers of worship and providing religious guidance.
Insulin	Insulin is a peptide hormone produced by beta cells of the pancreatic islets. It regulates the metabolism of carbohydrates, fats and protein by promoting the absorption of glucose from the blood into liver, fat and skeletal muscle cells
ISF	Insulin sensitivity factor - this is a factor that describes how much one unit of insulin will lower blood glucose levels. It is used to determine the correct doses to be given to patients.
K	
Ketones	Chemical produced from the breakdown of fats
Ketosis	A metabolic state in which there are elevated levels of ketones in the blood or urine
KSA	Kingdom of Saudi Arabia
L	
LDL	Low-density lipoproteins. It is sometimes called the "bad" cholesterol because a high LDL level leads to a buildup of cholesterol in your arteries.
Leptin	A hormone made from adipose tissue that helps regulate energy balance by inhibiting hunger
LGS	Low glucose suspend pumps
Lipoprotein	Are substances made up of protein and fat that help carry cholesterol through your blood stream. Higher levels of lipoprotein are generally associated with an increased risk of cardiovascular disease
Lockdown(s)	Government restrictions imposed on communities to prevent social contact and reduce viral transmission, seen in the COVID-19 pandemic
M	
Macrovascular disease	This is a result of damage to the larger blood vessels. It refers to any of the larger blood vessels including coronary arteries, aorta, and arteries within the brain and limbs
Maghrib	One of the obligatory 5 daily prayers in Islam - typically the first prayer of the day
MDI	Multiple dose injection therapy
Mean	Arithmetic mean
Melatonin	A hormone made in the pineal gland within the brain, it plays an important role in controlling the sleep cycle
Mena	Middle East and North Africa
Metformin	A drug used to treat people that have Type 2 diabetes mellitus
Mg/dl	Milligrams per decilitres this can be converted into mmol per decilitres by the conversion factor 18.018

ACRONYM/ TERM	EXPLANATION
M	
MI	Myocardial infarction
Microvascular disease	This is a result of damage the smaller blood vessels. It refers to the smaller blood vessels that branch off of the larger vasculature. Commonly causes complications in diabetes such as Retinopathy, neuropathy and Kidney disease
MNT	Medical nutrition therapy
MUFA	Monounsaturated fats
N	
N	Notation for sample size in research studies
NGS	next-generation sequencing
NPH	Natural protamine hagedorn insulin
P	
p value	P values highlight the strength of evidence against the null hypothesis, assuming the null hypothesis is true. A value below the level at which statistical significance can be taken is predetermined (usually, but not always 0.05)
PLGS	Predictive low glucose suspend pumps
Post-prandial	Occurring after a meal
Pre-prandial	Occurring before a meal
PUFA	Polyunsaturated fats
R	
RAI	Rapid analogue insulin
Raka'ahs	Iterations of movements in prayers
Ramadan	Holy Month and one of the five pillars of Islam; healthy Muslims after the age of puberty are obliged to fast for the duration of Ramadan
RCTs	Randomised controlled trials
rDNA	ribosomal deoxyribonucleic acid
REM sleep	Rapid eye movement sleep is a key stage of the sleep cycle that is linked with improving and retaining memory.
RF	Ramadan fast
RMR	Resting metabolic rate
RNP	Ramadan nutrition plan
S	
SARS-CoV-2	Severe acute respiratory syndrome coronavirus 2
SD	Standard deviation
Sha'ban	The last month before Ramadan
Shawwal/shawal	The month after Ramadan



ACRONYM/ TERM	EXPLANATION
S	
Simple carbohydrates	Made up of sugar molecules, simple carbohydrates have shorter chains of sugar molecules than complex carbohydrates and have a more immediate impact on blood glucose levels
SMBG	Self monitoring of blood glucose
Sodium-glucose Cotransporter-2 (SGLT2) Inhibitors	These can also be known as Gliflozins. There are a class of drugs that work on reducing the amount of blood glucose levels and are effective in treating people with Type 2 diabetes mellitus by acting on the kidneys. The kidneys excrete glucose to lower the levels in the blood. Drugs in this class include - canagliflozin, dapagliflozin, empagliflozin
Suhoor	The daily meal consumed during Ramadan before dawn
Sulfonylureas	A class of anti-diabetic drugs that cause release of insulin through acting on the pancreatic beta cells, usually used in people with type 2 diabetes mellitus; drugs in this class include - glibenclamide, glimepiride, gliclazide
T	
T1DM	Type 1 diabetes mellitus
T2DM	Type 2 diabetes mellitus
Taraweeh	Additional ritual prayers performed at night
TEE	Total energy expenditure = RMR+AEE+TEF
TEF	Thermic effect of food. This forms a part of energy expenditure
TG	Triglycerides
Thiazolidinediones	Commonly represented by the acronym tzd; this drug class work through activating the peroxisome proliferator-activated receptors that help in treating type 2 diabetes mellitus
TIR	Time in range - proportion of time in target glucose levels
TST	Total sleep time
U	
UAE	United Arab Emirates
UK	United Kingdom
Z	
Zakah	The practice in which muslims provide charity to people that are less fortunate



**International
Diabetes
Federation**



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