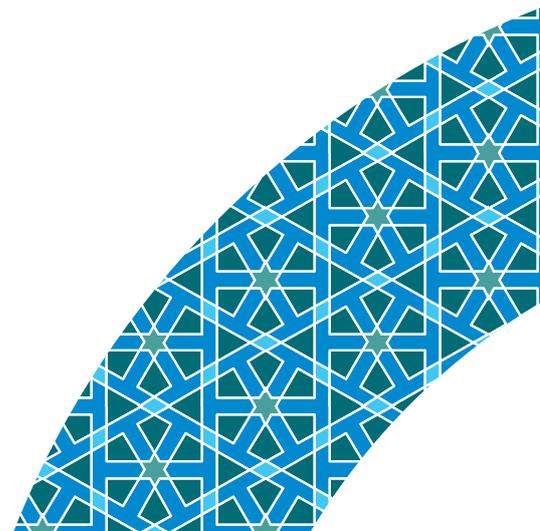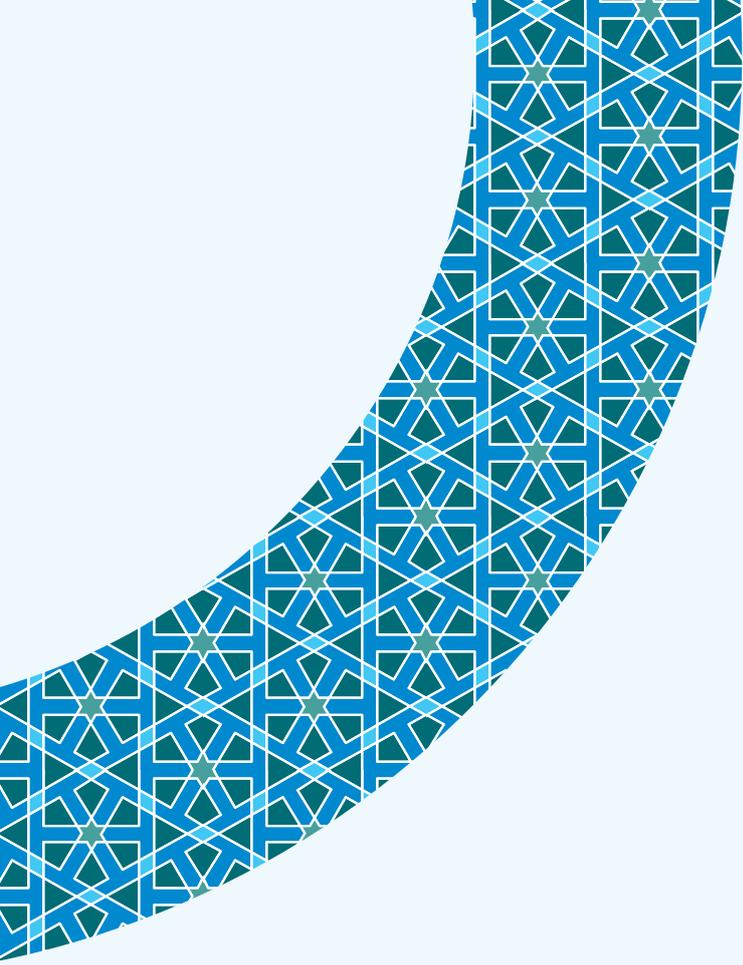# CHAPTER 2

Epidemiology of diabetes and
fasting during Ramadan

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CHAPTER 2

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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].
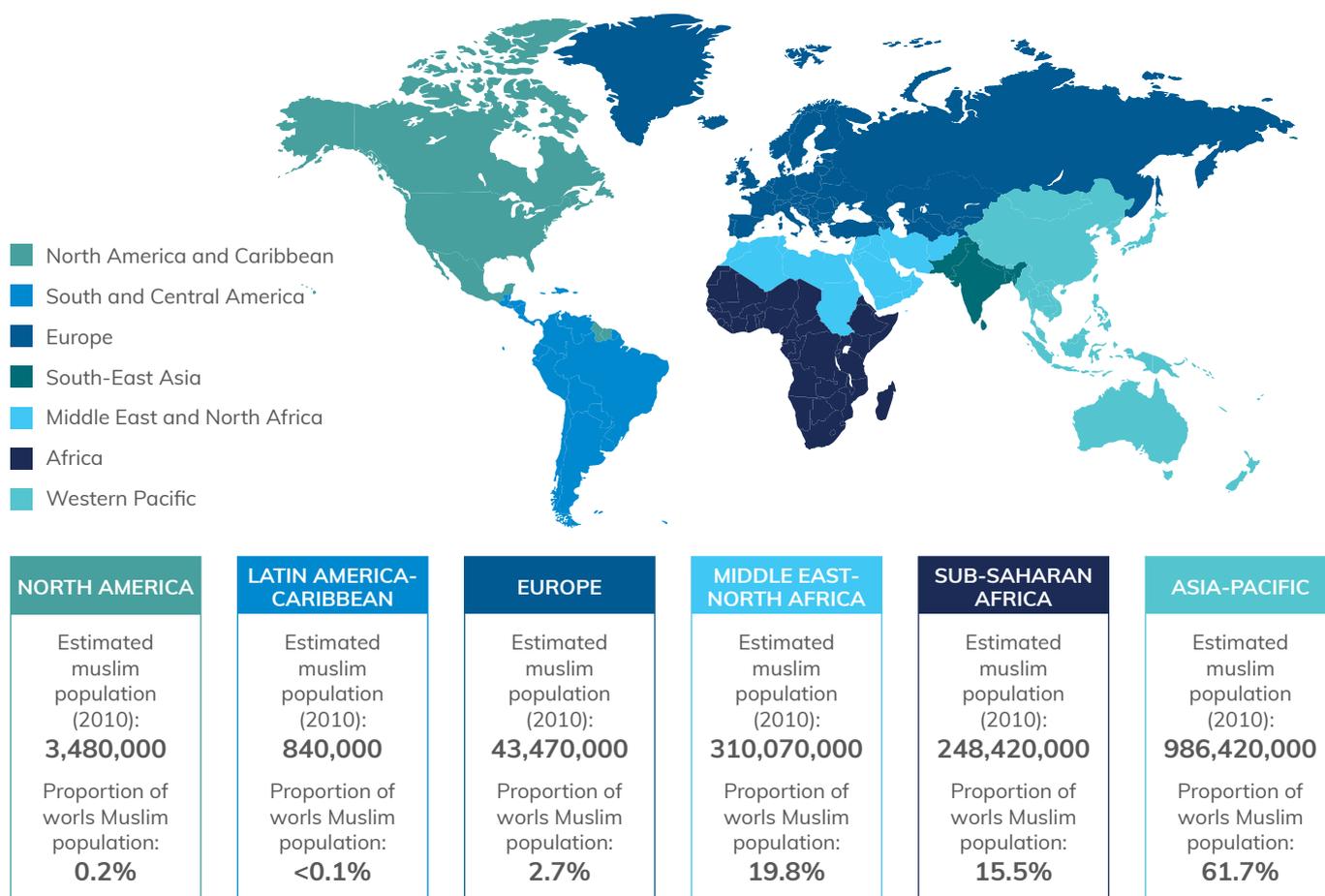

- North America and Caribbean
- South and Central America
- Europe
- South-East Asia
- Middle East and North Africa
- Africa
- Western Pacific

NORTH AMERICA	LATIN AMERICA-CARIBBEAN	EUROPE	MIDDLE EAST-NORTH AFRICA	SUB-SAHARAN AFRICA	ASIA-PACIFIC
Estimated muslim population (2010): **3,480,000**	Estimated muslim population (2010): **840,000**	Estimated muslim population (2010): **43,470,000**	Estimated muslim population (2010): **310,070,000**	Estimated muslim population (2010): **248,420,000**	Estimated muslim population (2010): **986,420,000**
Proportion of worls Muslim population: **0.2%**	Proportion of worls Muslim population: **<0.1%**	Proportion of worls Muslim population: **2.7%**	Proportion of worls Muslim population: **19.8%**	Proportion of worls Muslim population: **15.5%**	Proportion of worls Muslim population: **61.7%**

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 in to 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
Nº. of countries	13	10	13
Nº. 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 nº. 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
Nº. of countries	13	13	10	20
Nº. 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 nº. 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 ≥ 65 years old. It was clear from this study that older adults ≥ 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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