Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Contents available at ScienceDirect

Diabetes Research and Clinical Practice

journal homepage: www.elsevier.com/locate/diabres

The DAR 2020 Global survey: Ramadan fasting during COVID 19 pandemic and the impact of older age on fasting among adults with Type 2 diabetes

Mohamed Hassanein [a,b,c], Zanariah Hussein [d,*], Inass Shaltout [f], Wan Juani Wan Seman [d], Tong Chin Voon [e], Nurain Mohd Noor [d], Mehmet Akif Buyukbese [g], Lobna El Tony [h], Gamal Mohamed Shaker [i], Reem M. Alamoudi [j], Khadija Hafidh [k], M. Fariduddin [l], Mohammed A. Batais [m], Shehla Shaikh [n], Pr Rachid Malek [o], Majid Alabbood [p], Rakesh Sahay [q], Abdulwadod M. Alshenqete [r], Muhammad Yakoob Ahmedani [s]

[a] Dubai Hospital, DHA, United Arab Emirates
[b] Gulf Medical University, United Arab Emirates
[c] Postgraduate Diabetes Education, Cardiff University, UK
[d] Department of Internal Medicine, Hospital Putrajaya, Putrajaya, Malaysia
[e] Faculty of Medicine, Cairo University, Cairo, Egypt
[f] Department of Internal Medicine, Hospital Melaka, Melaka, Malaysia
[g] Medistate Kavacik Hospital, Internal Medicine Department, Istanbul, Turkey
[h] Assiut University, Egypt
[i] Strategic Data Analysis, Research and Studies Department Dubai Health Authority, United Arab Emirates
[j] Department of Medicine, King Abdulaziz Medical City, King Saud Bin Abdulaziz University for Health Sciences, King Abdullah International Research Center, Ministry of National Guard Health Affairs, Jeddah, Saudi Arabia
[k] Rashid Hospital, Diabetes Unit, Dubai Health Authority, United Arab Emirates
[l] Department of Endocrinology, Bangabandhu Sheikh Mujib Medical University (BSMMU), Dhaka, Bangladesh
[m] Diabetes & Chronic Disease Management, Department of Family and Community Medicine, College of Medicine, King Saud University, Riyadh, Saudi Arabia
[n] Saifee Hospital, India
[o] Internal Médecine, CHU, Setif 19000, Algeria
[p] Alzahraa College of Medicine, University of Basra, Iraq
[q] Department of Endocrinology, Osmania Medical College & Osmania General Hospital, Hyderabad, India
[r] Nutrition Department, King Fahd Hospital, Madinah Munawarah, Saudi Arabia
[s] Baqai Institute of Diabetology & Endocrinology (BIDE)/Baqai Medical University (BMU), Pakistan

ARTICLE INFO

Article history:
Received 14 December 2020
Received in revised form
8 January 2021
Accepted 12 January 2021
Available online 23 January 2021

ABSTRACT

Objectives: The DAR Global survey of Ramadan-fasting during the COVID-19 pandemic aimed to describe the characteristics and care in participants with type 2 diabetes (T2D) with a specific comparison between those <65 years and ≥65 years.

Methods: Participants were consented to answer a physician-administered questionnaire following Ramadan 2020. Impact of COVID-19 on the decision of fasting, intentions to fast and duration of Ramadan and Shawal fasting, hypoglycaemia and hyperglycaemia events

* Corresponding author.
E-mail addresses: zanariahh@hotmail.com (Z. Hussein), gmibrahim@dha.gov.ae (G.M. Shaker), amoudir@ngha.med.sa (R.M. Alamoudi), kahafidh@dha.gov.ae (K. Hafidh), myakoob@bide.edu.pk (M. Yakoob Ahmedani)zanariahh@hotmail.com (Z. Hussein).
https://doi.org/10.1016/j.diabres.2021.108674

were assessed. Specific analysis comparing age categories of <65 years and ≥65 years were performed.

Results: Among the 5865 participants, 22.5% were ≥65 years old. Concern for COVID-19 affected fasting decision for 7.6% (≥65 years) vs 5.4% (<65 years). More participants ≥65 years old did not fast (28.8% vs 12.7%, <65 years). Of the 83.6%, participants fulfilling Ramadan-fasting, 94.8% fasted ≥15 days and 12.6% had to break fast due to diabetes-related illness. The average number of days fasting within and post-Ramadan were 27 and 6 days respectively, regardless of age. Hypoglycaemia and hyperglycaemia occurred in 15.7% and 16.3% of participants respectively, with 6.5% and 7.4% requiring hospital care respectively. SMBG was performed in 73.8% of participants and 43.5% received Ramadan-focused education.

Conclusion: During the COVID-19 pandemic, universally high rates of Ramadan-fasting were observed regardless of fasting risk level. Glycemic complications occurred frequently with older adults requiring higher rates of acute hospital care. Risk stratification is essential followed by pre-Ramadan interventions, Ramadan-focused diabetes education and self-monitoring to reduce and prevent complications, with particular emphasis in older adults.

1. Introduction

The number of Muslims around the world is projected to be 1.9 billion in 2020, which is 24.9% of the global population with an estimated 463 million adults living with diabetes in 2019, of which almost one third, an estimated 150 million are Muslims [1,2]. Even though fasting is exempted for Muslims with serious health issues including diabetes, a high proportion of Muslims with T2D choose to fast during Ramadan. Up to 79% of Muslims with diabetes fast for at least 15 days during Ramadan [3,4]. Ramadan 2020 occurred during the global COVID-19 pandemic which potentially can pose many challenges for people fasting with diabetes. Fasting may increase the risk of complications such as acute glycaemic events; hypoglycemia, hyperglycemia and diabetic ketoacidosis as well as dehydration, and thrombosis [5], which may be exacerbated by concurrent COVID-19 infection. Well established guidelines have recommended that physicians perform risk stratification of patients intending to fast during Ramadan based on status of glycaemic control, hypoglycaemia risk, glycaemic lowering medications, diabetes related complications and comorbidities. Individuals in the high and very high risk categories for developing complications related to fasting should be advised against fasting [3,4,6]. The high rates of fasting observed in previous multi-national and regional studies indicate that many patients who are considered to be at high or very high risk of adverse events still fast during Ramadan [5,7,8].

During Ramadan, there may be a temporary change in lifestyle practices which may differ according to geographical regions and countries. The EPIDIAR study reported that approximately 50% of participants with diabetes experienced a change in lifestyle and adjustments in diabetes-related treatments [5]. The study highlighted the various challenges for people with diabetes who fast during Ramadan and the need to improve their diabetes management, by providing pre-Ramadan structured patient education along with specific management guidelines for health care providers. Several guidelines and recommendations for the management of diabetes during Ramadan have been developed along with educational programs [4,9]. Ramadan-focused education can enable individuals to adjust their lifestyle during Ramadan to minimise the risk of complications [10,11]. The DAR-MENA T2DM study conducted during Ramadan 2016 in the Middle East and North African region reported that 97.4% of participants performed lifestyle changes during Ramadan with more than half (60.6%) having had access to education on diabetes management during Ramadan [8]. To date, there has been no published data to specifically characterize Ramadan fasting among older adults with diabetes. This is an area of specific concern as older adults have higher rates of diabetes-related complications and co-morbidities, longer duration of disease and higher risk to develop the specific complications known to occur during Ramadan fasting such as hypoglycaemia, hyperglycaemia, dehydration and thrombosis.

This cross-sectional, observational survey currently represents the largest recent multinational epidemiological analysis of Ramadan fasting among T2D almost two decades after the EPIDIAR study in 2001 and a decade after the CREED study in 2010. It will enable us to better understand the current fasting practices among individuals with T2D living in the different geographical regions of Asia, Gulf and Middle East, North Africa and Europe and assess the impact of Ramadan-focused management guidelines and education initiatives, as well as newer glycaemic-lowering therapies towards improving safety outcomes of Ramadan fasting particularly hypoglycaemia and hyperglycaemia events. The additional analysis according to age categories will further allow us to appreciate similarities and differences among individuals <65 years and those ≥65 years to indicate specific management issues and guide specific lifestyle and treatment recommendations in older individuals with T2D who fast during Ramadan.

The primary objective of this survey is to describe the characteristics and patterns of care of people with T2D fasting during and after Ramadan 2020 amidst the COVID-19 global

pandemic, with a specific comparison between those <65 years and ≥65 years.

2. Materials and methods

2.1. Study design

A total of 20 countries with a predominant Muslim population participated in this cross-sectional survey to assess fasting practices among people with T2D during Ramadan 2020 (23rd April to 23rd May 2020) amidst the global pandemic of COVID-19 infection. The participating countries from 5 geographical regions were as follows; South Asia (Bangladesh, Pakistan and India), Southeast Asia (Brunei and Malaysia), Gulf nations (Kingdom of Saudi Arabia (KSA), United Arab Emirates and Qatar), Middle East (Egypt, Iraq, Jordan, Lebanon and Palestine) North Africa (Algeria, Cote d'Ivoire, Morocco, Sudan, Tunisia) and Europe (Turkey and United Kingdom). In each country, Muslim people with diabetes were invited to participate in the survey during their routine clinic consultation in the 10-week post-Ramadan period, between June and August 2020. These included those being managed in both community-based and hospital-based diabetes care. Healthcare professionals that included primary care physicians, physicians and endocrinologists that represented different levels of diabetes care in each country were selected to participate in this study.

The inclusion criteria were Muslim adults with a known diagnosis of diabetes, attending their routine diabetes clinic consultation and able to provide informed consent.

2.2. Data collection

Participating physicians from each country were familiarized and trained on the study questionnaire and administration by their respective country chief investigators. During the routine clinic consultation, the attending physician conducted a guided interview based on a questionnaire about their disease status and management, fasting practices during and following Ramadan 2020. The survey included questions to determine (i) intention to fast during Ramadan: number of fasting days, occurrence and reasons of breaking fast during Ramadan (ii) whether the COVID-19 pandemic influenced decisions to fast, (iii) occurrence of complications of hypoglycemia and hyperglycemia during Ramadan fasting and their related details such as frequency, timing, duration and need for attendance to emergency department (ED) and hospital admission, (iv) level of Ramadan-focused diabetes education and SMBG practices during Ramadan. Hypoglycaemia was reported based on presence of typical symptoms and hyperglycaemia was defined as blood glucose >300 mg/L(16.6 mmol/l). Questions regarding physical activity and dietary practices were not specifically addressed in this survey.

Information regarding disease status such as duration of disease, presence of diabetes-related complications and comorbidities, status of glycaemic control and current diabetes-related medications were provided by their attending doctors from the patient's records. Specific risk categorization for Ramadan fasting usually performed at pre-Ramadan assessment was not assessed as the survey was administered post-Ramadan. Responses were recorded either directly into an online questionnaire during the interview or transcribed subsequently from paper-based questionnaire onto the online platform. The survey had the approval of the local research and ethics authorities in each participating country, in accordance with local regulations in each country.

2.3. Statistical analysis

Data were stratified by the overall participants of T2D and age categories of <65 years and ≥65 years. Descriptive analyses were performed to characterize patient demographic and clinical characteristics and all outcome measures. The data are presented as mean and standard deviations (SD) for continuous variables unless mentioned otherwise. Descriptive categorical data were summarized by number and percentage of the population. The proportion of participants experiencing hypoglycaemia and hyperglycaemia or any categorical variable were described in terms of their frequency and percentage for each event (the basis of percentage being the number of participants who provided data). Not all data were available for all measurements and, therefore, total n values differ between measurements. Missing data were not imputed.

Differences in demographic characteristics and clinical outcomes between participants aged <65 years and ≥65 years were tested using Pearson Chi-Squared test for categorical variables. All applied statistical tests were two-sided, p-values < 0.05 were considered as statistically significant. The data were analysed using IBM SPSS Statistics Version 26.

3. Results

3.1. Population demographics and baseline clinical characteristics

A total of 5865 people with T2D agreed to participate in the survey with 51.0% female participants and 22.5% aged ≥65 years. The countries with the highest numbers of participants were Pakistan (15.9%), Egypt (14.0%), KSA (13.1%) and Malaysia (12.8%) as seen in Supplement. South Asia region had the highest rate of participants (26.3%) followed by Gulf region (19.1%), Middle East region (18.8%), South East Asia (16.1%), North Africa (11.2%) and Europe (8.2%) (Supplement Table 1a, Fig. 1).

There were few notable differences in characteristics of participants aged <65 years, compared to those aged ≥65 years as seen in Table 2. The mean age of participants was 55.1 ± 11.83 years with a mean diabetes duration of 10.5 ± 7.66 years and more than half (50.7%) of those <65 years had diabetes for less than a decade whereas one third (33.6%) of those ≥65 years had disease for 20 years and more.

With respect to risk stratification based on guidelines [4,6], fewer participants aged ≥65 years had HbA1c > 9.0%, 28.5% (N = 325) vs 33.4% (N = 1362) in < 65 years age category. On the other hand, it was well evident that complications such as macrovascular disease and nephropathy, both indicating

high and very high risk categories, were more frequent in those aged ≥65 years as seen in Table 1.

There were lower rates of use of Metformin, SGLT-2 inhibitors and GLP1- receptor agonists in participants ≥65 years compared to <65yrs. Insulin use was higher in participants aged ≥65 years (53.1%) compared to those <65 years (42.7%). 9.1% for prandial insulin and 32.7% for pre-mixed insulin.

3.2. *Intentions and abilities to fast*

Of the overall participants, 4906 (83.6%) intended to fast with no gender difference in the rates of fasting (Table 2). A significantly higher proportion of those ≥65 years did not fast, 28.8% vs 12.7% of those <65 years. The decision to fast during Ramadan varied widely among the countries ranging from the lowest in Morocco (42.6%) and highest in KSA and Bangladesh, 97.1% and 98.1% respectively.

With regards to glucose lowering medications, overall, 79% of those on insulin, and 88% of those on sulphonylurea decided to fast during Ramadan 2020. Of those who fasted in Ramadan, 94.8% were able to complete more than 15 days of Ramadan fasting with 61.9% able to complete a full month of fasting (30 days). Greater proportion of those aged ≥65 years completed 30 days of fasting, 69.0% vs 60.2% of those aged <65 years. The average number of days of Ramadan fasting in the overall group and in both age categories was similar at 27 days.

3.3. *Impact of COVID-19 on decision to fast*

Concern for the ongoing Covid-19 pandemic did not influence the decision to fast in 91.5% of the overall survey participants, however significantly more participants ≥65 years agreed that it affected their decision to fast, 7.6% vs 5.4% of those <65 years (P = 0.006) (Table 2).

3.4. *Breaking of fast due to diabetes-related illness*

Breaking of fast due to diabetes-related illness occurred in 12.5% (n = 613) of the overall survey participants who performed Ramadan fasting, with a significantly higher proportion among those ≥65 years, 17.0% vs 11.5% in <65 years (P = 0.000). Among those with a break of fast due to diabetes-related illness, almost three quarters (71.9%) was

Table 1 – Baseline sociodemographic and clinical characteristics of study population.

Characteristics	Overall n (%)	<65 years n (%)	≥65 years n (%)	p-value
No of participants, n(%)	5865 (1 0 0)	4536 (77.5)	1314 (22.5)	
Male	2858 (48.7)	2170 (47.9)	688 (52.6)	0.003
Female	2978 (51.0)	2357 (52.1)	621 (47.4)	
Mean Age, (years)	55.1 ± 11.83	50.7 ± 9.27	70.3 ± 5.17	0.000
< 10 years, n(%)	2874 (50.7)	2525 (57.6)	345 (27.1)	
10–19 years, n(%)	1912 (33.8)	1409 (32.2)	500 (39.3)	0.005
≥20 years and above, n(%)	879 (15.5)	449 (10.2)	428 (33.6)	
Mean duration (years)	10.5 ± 7.66	9.1 ± 6.65	15.1 ± 8.95	0.000
HbA1c				
< 7.5%, n(%)	1883 (36.1)	1459 (35.8)	421 (37.0)	0.005
7.5% – 9.0%, n(%)	1652 (31.6)	1256 (30.8)	393 (34.5)	
Above 9.0%, n(%)	1689 (32.3)	1362 (33.4)	325 (28.5)	
Mean (%)	8.4 ± 1.88	8.4 ± 1.92	8.2 ± 1.74	0.001
Anti-diabetic medications, n(%)				
Metformin	4843 (82.6)	3847 (84.8)	996 (75.8)	0.000
Sulphonylurea	2279 (38.9)	1764 (39.2)	515 (39.6)	
Repaglinide	67 (1.1)	45 (0.9)	22 (1.7)	
Acarbose	94 (1.6)	71 (1.6)	23 (1.7)	
DPPIV inhibitors	2091 (35.7)	1659 (36.6)	432 (32.9)	
Thiazolidinediones	127 (2.2)	94 (2.1)	33 (2.5)	
SGLT2- inhibitors	835 (14.2)	713 (15.7)	122 (9.3)	
GLP1- receptor agonists	161 (2.8)	139 (3.1)	22 (1.7)	
Insulin				
Basal insulin	1625 (27.7)	1195 (26.3)	430 (32.7)	
Prandial insulin	1003 (17.1)	739 (16.3)	264 (20.1)	
Premixed insulin	910 (15.5)	665 (14.7)	245 (18.7)	
Insulin pump	2 (0.03)	2 (0.04)	0	
Co-morbidities, n(%)				
Hypertension	2914 (49.7)	2038 (45.3)	867 (66.7)	0.000
Hyperlipidemia	2380 (40.6)	1747 (38.8)	627 (48.2)	
Retinopathy	815 (13.9)	511 (11.4)	302 (23.2)	
Neuropathy/CKD†	1271 (21.7)	894 (19.9)	374 (28.8)	
Nephropathy	589 (10.0)	357 (7.9)	230 (17.7)	
CAD, Stroke	635 (10.8)	371 (8.2)	263 (20.2)	
Diabetic foot problems	190 (3.2)	125 (2.8)	63 (4.8)	

HbA1c, Glycated hemoglobin; CAD, Coronary Artery Disease; †CKD, Chronic Kidney Disease includes abnormal eGFR or serum creatinine.

Table 2 – Fasting practices during and after Ramadan.

Fasting Practices		Overall n (%)	<65 years n (%)	≥65 years n (%)	p-value
Intention for Ramadan fasting, n (%)		4906 (83.6)	3958 (87.3)	935 (71.2)	
Impact of COVID-19 pandemic on decision to fast, n(%)					
	No	5359 (91.5)	4163 (91.9)	1182 (90.2)	
	Yes	346 (5.9)	247 (5.4)	99 (7.6)	0.006
	Unsure	151 (2.6)	122 (2.7)	29 (2.2)	
Duration of Ramadan fasting, n(%)					
	1–7 days	128 (2.6)	96 (2.4)	31 (3.4)	
	8–14 days	123 (2.5)	101 (2.6)	22 (2.4)	
	15–21 days	267 (5.5)	225 (5.7)	42 (4.6)	
	22–29 days	1332 (27.5)	1141 (29.1)	188 (20.6)	
	30 days	3001 (61.9)	2361 (60.2)	631 (69.0)	
	Mean duration (days)	27.3 + 6.06	27.3 + 5.85	27.1 + 6.86	0.000
Breaking of Ramadan fasting due to diabetes related illness, n (%)		613 (12.5)	454 (11.5)	158 (17.0)	0.000
Duration of break of Ramadan fasting, n(%)					
	1–7 days	359 (71.9%)	276 (75.0%)	81 (62.8%)	
	8–14 days	60 (12.0%)	44 (12.0%)	16 (12.4%)	
	15–21 days	42 (8.4%)	26 (7.1%)	16 (12.4%)	
	22–29 days	22 (4.4%)	16 (4.3%)	6 (4.6%)	
	30 days	16 (3.2%)	6 (1.6%)	10 (7.7%)	
	Mean duration (days)	6.89 + 7.49	6.23 + 6.78	8.84 + 9.01	0.003
Intention for Shawal (post) Ramadan) fasting, n (%)		1271 (26.1)	998 (25.5)	271 (29.2)	0.020
Duration of Shawal fasting					
	Mean duration (days)	6.15 + 2.68	6.2 + 2.83	6.1 + 2.02	0.592

for a short duration of 1–7 days, with a mean of 6.9 days. Greater proportion (24.7%) of participants aged ≥65 years experienced break of fasting ≥15 days during Ramadan compared to those aged <65 years (13%) with a mean duration of break in fasting of 8.8 ± 9.02 days (≥65 years) as compared to 6.2 ± 6.78 (<65 years), respectively (P = 0.003) (Table 2).

3.5. *Fasting post Ramadan during Shawal*

Voluntary fasting in the weeks after Ramadan was observed by 26.1% (n = 1271) of the overall participants. This was higher in ≥65 years age category (29.2%) compared to those <65 years (25.5%), though not statistically significant (Table 2).

Of those who performed fasting in Shawal, 91.6% (n = 1084) fasted for 1–7 days and 6.4% (n = 76) fasted for 8–14 days. The average duration of the voluntary fast post-Ramadan was 6.2 ± 2.68 days in the overall group and no statistically significant difference between both age categories.

3.6. *Hypoglycaemia during Ramadan fasting*

Among those participants fasting, 15.6% (n = 764) reported experiencing symptoms of hypoglycaemia during Ramadan. This was significantly higher among those aged ≥65 years (17.4%) compared to those <65 years (15.2%) (p = 0.000). The mean number of days with hypoglycaemia was 4.6 ± 5.18 days in those <65 years and 4.8 ± 4.37 days in those ≥65 years (P = 0.594) (Table 3).

Hypoglycaemia occurred most frequently between 3 pm and Maghreb (sunset), in 54.6% of those age <65 years and 46.7% of those ≥65 years. This was followed by the time range between mid-day and 3 pm affecting 23.4% (<65 years) and 20.5% (≥65 years), respectively. Meanwhile, 14.2% and 21% of those age <65 years and ≥65 years, respectively, reported hypoglycaemia between 9.00am and mid-day. The least frequent timing of symptomatic hypoglycaemia was between Suhur and 9am, reported by 7.7% (<65 years) and 11.8% (≥65 years), respectively (Supplement Fig. 2).

Breaking fast due to hypoglycaemia was more common among participants ≥65 years. In this group, 67.7% had to break fast compared to 55.4% of those <65 years (p = 0.017). Among those experiencing hypoglycaemia, 5.5% (n = 42) attended ED and 1.0% (n = 8) required hospital admission. This was much higher in the older vs younger age category, 9.9% vs 4.3%, respectively. The most frequent response (25.9%) to the question addressing actions taken following hypoglycaemia was to continue the same monitoring and treatment-related practices with no additional change. This was more frequent among participants <65 years (30.5%) compared to those ≥ 65 years (17.1%) (Supplement Table 2a).

3.7. *Hyperglycaemia during Ramadan fasting (blood glucose >16.6 mmol/L, 300 mg/dL)*

A total of 796 (16.3%) participants reported hyperglycaemia during Ramadan. The proportion of participants who experi-

Table 3 – Hypoglyceamia and hyperglycaemia during Ramadan, number of days.

	Participants who experienced hypoglycaemia			Participants who experienced hyperglycaemia		
	Overall	<65 years	≥65 years	Overall	<65 years	≥65 years
	n = 757 *n* (%)	n = 595 *n* (%)	n = 162 *n* (%)	n = 771 *n* (%)	n = 507 *n* (%)	n = 174 *n* (%)
Incidence rate*	15.6%	15.2%	17.4%	16.3%	19.3%	15.6%
No of days						
1–7 days	639 (84.4)	511 (85.9)	128 (79.0)	482 (62.5)	369 (61.8)	113(64.9)
7–14 days	76 (10.0)	49 (8.2)	26 (16.0)	153 (19.8)	120 (20.1)	33 (19.0)
15–21 days	26 (3.4)	19 (3.2)	7 (4.3)	81 (10.5)	64 (10.7)	17 (9.8)
22–29 days	12 (1.6)	11 (1.9)	1 (0.6)	21 (2.7)	17 (2.9)	4 (2.3)
30 days	5 (0.6)	5 (0.8)	0 (0)	34 (4.4)	27 (4.5)	7 (4.0)

*$p < 0.005$ compared between 2 groups.

enced hyperglycaemia was higher in those age ≥65 years compared to <65 years, 19.3% vs 15.6% (p = 0.006). The mean number of days with hyperglycaemia were 8.1 ± 7.38 days and were not different between the two groups.

Majority of participants (79.1%) who experienced hyperglycaemia did not break fast. About 5.5% (n = 44) of participants attended ED and 1.9% (n = 15) required hospital admission. Higher percentage of those ≥65 years compared to <65 years needed to get hospital care for hyperglycaemia, (8.4% vs 7.0%) but the difference was not statistically significant (p = 0.526). The different actions taken by participants in response to episodes of hyperglycaemia during Ramadan are detailed in Supplement Table 2a.

3.8. *Self- monitoring of blood glucose (SMBG)*

The percentage of participants who performed SMBG was 73.8% (n = 4287). Majority of the participants performed SMBG at the same frequency as before Ramadan. Majority of participants performed SMBG less than once weekly (23.6%), followed by twice daily (19.6%), 2–4 times weekly (17.5%), once weekly (16%), once daily (14.6%) and 3–4 times daily (8.8%). The same pattern was also seen in those participants <65 years and ≥65 years. There was no significant difference in pattern of SMBG in these 2 groups (P > 0.05) (Supplement Fig. 3).

3.9. *Ramadan focused diabetes education*

Only 43.5% of participants in this survey received education on Ramadan fasting with no significant difference between the two age categories, 43.5% and 43.8%, among participants aged <65 years and ≥65 years, respectively. The Ramadan-focused education were obtained from different health care professionals; doctors (70.7%), nurses (15.3%), dieticians (9.4%) and others (4.6%). There was no significant difference with regards to the source of education between the 2 age groups. The educational sessions were mostly during routine clinic consultations (69.5%). Those participants ≥65 years old commonly received education during clinic consultations and group sessions whereas the participants <65 years old received education through leaflets, online or through apps. The difference was significant (p = 0.000).

4. Discussion

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 better understand the differences and similarities with regards to patterns of fasting in different geographical regions, primarily Middle East, Gulf nations, North Africa, Europe and Asia. The results of the DAR Global Survey for individuals with T2DM during Ramadan 2020 showed that overall rates of fasting in Ramadan were high at 83.6%. Rates of fasting between countries varied with majority being above 75% with the exception of Turkey, Morocco and Tunisia, the latter having only small numbers of participants (n = 15). In this study, overall 94.8% participants reported fasting for at least 15 days and 61.9% were able to complete 30 days of fasting. This is similar with the T2D cohort in the CREED study for Ramadan 2010 with 94% reported fasting for at least 15 days and 63.6% of patients fasting the full month [7]. In the EPIDIAR study of Ramadan 2001, a lower number of participants (78.7%) fasted for at least half the month [5]. The DAR-MENA T2DM study of Ramadan 2016 had a total of 1749 participants with type 2 diabetes where 86.3% fasted at least 15 days of Ramadan and 57.3% of participants were able to complete the full month of fasting [8]. The mean number of fasting days in Ramadan were similar in this study and all the multinational studies mentioned previously, which was 27 days. This demonstrates that over the last two decades, the patterns of Ramadan fasting among individuals with T2D has not changed very much with the large majority able to complete fasting at least half the month of Ramadan [5,7,8].

For 2020, Ramadan coincided with COVID-19 outbreak making it potentially one of the most challenging fasting periods for all Muslims. WHO recommendations indicate that adults get a balanced diet and drink adequate fluids throughout the day as protective measures against COVID-19 [11,12]. In healthy individuals, there is no direct evidence to suggest any adverse effect of Ramadan fasting during the COVID −19 pandemic but individuals with diabetes should be advised by their treating physicians as recommended by guidelines based on their risk stratification [4,6,13]. A recent study of individuals with T2D and fasting in Ramadan 2020 found that more individuals were advised not to fast and

fewer people fasted in 2020 compared to a similar survey in 2016 [14,15]. The study reported that fasting was not associated with an increased risk of COVID-19 and results of fasting were largely positive for those who fasted, with few adverse outcomes. In our survey, the presence of the COVID −19 pandemic during the month of Ramadan did not negatively influence the decision to perform Ramadan fasting in the majority of participants.. This is likely due to the ability to continue fasting in the safe home environment during the lockdown and movement control measures that were put in place in different countries.

Of consideration is the majority of participants in the study were in the high (HbA1c 7.5–9.0%) or very high risk (HbA1c > 9.0%) category groups based on HbA1c levels and are generally recommended to consider abstaining from fasting in Ramadan in view of an elevated risk of developing adverse symptoms and diabetes related complications if fasting [6]. Risk stratification also necessarily takes into account a recent history of hypoglycaemia and hyperglycaemia severity and frequency, the type of glucose lowering medications as well as comorbidities and complications, particularly macrovascular disease and nephropathy [3,4]. Despite advice and recommendations from their treating physicians, many individuals will insist and decide to perform Ramadan fasting regardless of their risk category. It is important that their treating physicians are able to perform a pre-Ramadan medical review, administer appropriate Ramadan-focused diabetes education and institute treatment adjustments to enable safe fasting during Ramadan for these individuals at elevated risk [3,4]. In our study which was carried out post Ramadan, specific risk categorization was not performed, as usually assessed in pre-Ramadan medical review.

In this study, participants with T2D were mostly on combinations of oral glucose lowering medications with or without injectables (insulin and/or GLP-1 receptor agonists). Clinical data with regard to safety of multi-drug regimens during fasting are scarce. Individualised adjustments to timing, frequency and dose of glucose lowering medications are recommended prior to and during Ramadan and has been shown to impact on reducing complications particularly hypoglycaemia and hyperglycaemic emergencies [16]. With the availability of newer anti-diabetic therapies, hypoglycaemia risk can potentially be minimised. It is notable that this study demonstrates the changing pattern and increasing use of newer glucose lowering medications with more than a third of participants, 35.7% treated with DPPIV-inhibitors and 1 in 7 (14.1%) treated with SGLT2-inhibitors, both of which have minimal risk of hypoglycaemia. There was also substantial use of insulin analogues among the insulin users which are also associated with lower hypoglycaemia risk as compared to human insulin preparations. Use of medications associated with high risk of hypoglycaemia were 39% for sulphonylureas, similarly in both age categories and much higher for insulin therapy, 42.3% in those <65 years and 52.5% in those ≥65 years, with some participants on combinations of both, placing a substantial number of individuals at increased risk of hypoglycaemia while fasting in Ramadan [7]. The higher use of insulin in those ≥65 years old could be explained by their longer duration of illness.

An important component of the Ramadan focused diabetes education is to impart awareness and knowledge to individuals with diabetes regards safe fasting and when to consider breaking the fast due to medical reasons related to diabetes such as hypoglycaemia, hyperglycaemia and dehydration [3,4,9]. In this study, 1 in 8 participants who fasted during Ramadan experienced a break in fasting, being more common in those ≥65 years (1in 5) compared to those <65 years (1in 9). This is expected as those individuals who are older are at a greater risk of adverse outcomes related to complications and have been advised accordingly by their healthcare providers to have a lower threshold to break their fast to prevent acute and serious complications.

With regards to voluntary fasting during the month of Shawal, more than a quarter (26.1%) participants in this study performed this practice which is comparable to the CREED study which reported that 30% of patients fasted outside of Ramadan. Interestingly the mean number of days of Shawal fasting in this study was 6 days which is the preferred duration recommended, following in the footsteps of the Prophet Muhammad (Peace be Upon Him). Fasting six days in Shawal is very special as it completes the fast in Ramadan and educates Muslim individuals to have high self-discipline and perseverance [17].

Hypoglycemia is an important complication to be evaluated during Ramadan. In the previous landmark study, EPIDIAR, the frequency of admission for severe hypoglycemia among participants with T2D was 9% [5]. In CREED, the incidence of patient-reported hypoglycemia was 8.8% [7] whereas the DAR-MENA T2DM study reported a 10.4% incidence of confirmed hypoglycemia during Ramadan [8]. In our study, a higher rate of hypoglycemia, 15.6% was reported, based on symptoms. This higher rate could be due to the different definitions used compared to previous studies. Overall, one in fifteen (6.6%) participants with hypoglycemia required either ED care or hospital admission. The majority of participants with hypoglycaemia were able to self-treat at home probably reflecting the lesser severity of hypoglycaemia experienced as well as the improved awareness, knowledge and ability for self-management. On the other hand, the relatively low attendance for hospital care related to hypoglycaemia can also be explained by avoidance of ED visits due to fear of COVID-19 infection [18].

Comparatively, it is important to highlight that one in ten (12.4%) participants aged ≥65 years with hypoglycemia reported requiring ED care or hospitalization suggesting that they may have experienced more severe episodes. Older age is a known risk factor for hypoglycemia [19,20]. The findings of higher proportion of hypoglycemia among our participants aged ≥65 years is an important reminder to take in account age when assessing a patient's risk for fasting during Ramadan.

Not surprisingly, hypoglycaemia was more frequent towards the end of the fast. More emphasis should be given to monitoring at this time of the day. A rather alarming finding from this study was participants' actions in response to hypoglycaemia. A quarter of participants did not take any additional action following an episode of hypoglycaemia. There was a small proportion of patients who experienced hypoglycaemia every day during Ramadan. Improving hypo-

Table 4 – Key Parameters in participants with T2D fasting in Ramadan.

Key Parameters in those with type 2 diabetes who fasted Ramadan (n = 4906)		
61.9% fasted for full 30 days	Mean number of days fasting in Ramadan was 27 days	94.8% fasted at least 15 days during Ramadan
84.8% reported no symptoms of hypoglycaemia	84.3% with hypoglycaemia had events over 1–7 days	6.6% with hypoglycaemia required ER or hospital admission
84.4% reported no episodes of hyperglycaemia (BG > 300 mg/dl)	62.5% with hyperglycaemia had episodes over 1–7 days	7.4% with hyperglycaemia required ER or hospital admission
Key Parameters in those with T2D > 65 yrs old who fasted Ramadan (n = 935)		
69% fasted for full 30 days	Mean number of days fasting in Ramadan was 27 days	94.2% fasted at least 15 days during Ramadan
82.6%% reported no symptoms of hypoglycaemia	79.0% with hypoglycaemia had events over 1–7 days	12.4% with hypoglycaemia required ER or hospital admission
84.4% reported no episodes of hyperglycaemia (BG > 300 mg/dl)	64.9% with hyperglycaemia had episodes over 1–7 days	8.4% with hyperglycaemia required ER or hospital admission

glycemia awareness and knowledge would enhance safety of fasting among individuals with T2D. Future area of research could include creation of a risk calculator for assessment of suitability to fast which takes into account specific age categories, use of insulin and insulin secretagogues, presence of diabetes-related complications as well as hypoglycemia knowledge.

In this survey, the proportion of participants with T2D experiencing hyperglycaemia during Ramadan was 16.3%. In the DAR-MENA T2DM study, the reported incidence of hyperglycaemia was 11.6% [8]. The EPIDIAR study revealed that 4% of T2D participants experienced hyperglycaemia requiring hospitalisation, with an increase in the rate of hospitalisation from 1 to 5 events/100 people/month, comparing prior and during Ramadan [5]. In this study, 7.4% (1 in 13) of participants who experienced hyperglycaemia required either ED care or hospital admission and a higher rate (8.4%) was seen in participants aged ≥65 years (see Table 4). This can be an underestimation due to fear of exposure to COVID-19 infection at healthcare facilities and movement restrictions during the pandemic [18].

The combined rates of both hypoglycaemia (15.6%) and hyperglycaemia (16.3%) demonstrate that about 1 in 3 (31.9%) participants were affected with a more frequent rate in those aged ≥65 years compared to <65 years (36.7% vs 30.8%). Among those experiencing the combined glycaemic complications, the need for ED care or hospital admissions were higher in the those ≥65 years, affecting 1 in 5 (20.8%) compared to 1 in 8 (12.0%) of those <65 years. For the overall group, 1 in 7 (14.0%) of those with hypoglycaemia and hyperglycaemia combined had to attend hospital care. These figures portray the real and frequent occurrences of glycaemic complications that place Muslim individuals with diabetes at great threat with unsafe fasting. Despite an increase in awareness, understanding and knowledge among patients and clinicians on the management of diabetes during Ramadan, greater actions are needed to reduce these complication rates in future.

SMBG during fasting is an important self-care practice to reduce complications and 73.8% of participants in our study reported this practice which is considerably higher than reported in prior studies. A study in Pakistan described that only 32.6% participants performed SMBG, mostly monitoring infrequently, 1–3 times /month [20]. Similarly, the EPIDIAR study reported that 37% of T2D participants performed SMBG during Ramadan [5]. In our study, 43% participants performed SMBG daily either once, twice or thrice daily. The increasing awareness of the importance of SMBG is likely the reason for regular monitoring. A higher percentage of participants aged ≥65 years performed SMBG either at the same frequency or more often during Ramadan, compared to pre-Ramadan. This is of importance as older individuals, having longer duration of disease, higher use of insulin therapy and greater burden of co-morbidities and complications are at higher risk of blood glucose abnormalities [19].

The development and utilisation of Ramadan-focused diabetes education programs is essential to provide better care and ensure the safety of people with diabetes who fast during Ramadan. Our study showed limited accessibility to this recommended intervention with only 43.5% participants with T2D having received education for Ramadan 2020 which is not optimal. The common source of these education sessions were mainly from doctors during routine clinic consultations. In DAR-MENA T2DM study, more than half (60.6%) of the population had access to Ramadan-focused diabetes education. The most common education format provided included diabetes educational sessions (55.3%), diabetes education programs (30.3%), and diabetes self-education (26.9%); 50.1% had access to educational material [8]. In our study, only 15% had educational leaflets as compared to 50.1% in the DAR MENA T2DM study and only 6.5% had educational sessions via apps or online. The possible reason for this pattern is probably the older age of the participants with preference for the conventional methods of education delivery. However in the era of modern and digital technology, there should be other innovative ways for delivery of Ramadan-focused diabetes education for better accessibility of information.

Several limitations of this survey are the reporting of hypoglycemia which was based on symptoms rather than confirmed by SMBG. Consequently, the rates of hypoglycemia reported are possibly an overestimate as prior studies with confirmed hypoglycaemia had much lower rates of hypoglycaemia. Data were captured by the retrospective recollection of events occurring in the prior few weeks. In the absence of self-recording, events like hypoglycemia and/or hyperglycemia resulting in breaking of fast or omission of fasting in Ramadan are usually recalled clearly as the individual is required to keep count and compensate for days not fasted. Nonetheless, the lack of recording of these events limit their complete accuracy. The participation of several countries in this survey allow for reflection of fasting practices in more extensive geographical regions, however, this may introduce confounders based on the differences of the social backgrounds and the different patterns of Ramadan-related medical practice between regions. Another possible limitation is the potential bias in recruitment during COVID-19 pandemic that may impact on attendance to primary care clinics and hospitals with more stable patients possibly deferring scheduled clinic consults whereas the more vulnerable patients may avoid attendance to healthcare institutions to avoid potential exposure to COVID-19.

5. Conclusion

In conclusion, this survey highlights the universally high rates of Ramadan fasting among people with T2D, even in older adults, during the COVID 19 pandemic, despite the majority having high or very high fasting risk. Glycaemic complications occurred frequently in one of every three individuals with older adults having greater requirement for acute hospital care. The findings of this study clearly emphasize the continuous need to prioritize risk stratification and to institute pre-Ramadan assessment and interventions in advance. It is essential to promote and strengthen a structured approach to Ramadan focused diabetes education and self-monitoring to ensure safe fasting, thereby preventing and reducing complications. The current challenge is making it accessible to all Muslim individuals with diabetes,

especially in older individuals, across different geographical regions and sociodemographic backgrounds.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors acknowledge all the people with T2D who participated in this survey. The authors acknowledge all the following investigators for their contributions and support towards the DaR Global survey data collection:

Abada Djihed, Abdulaziz F. Alfadhly, Abeer Theyab, Achmad Rudijanto, Adem Cakir, Adibah Salleh, Adnan Rayes, Ahallat, Ahmad Alkhatib, Ahmane Kamel, Ahmef Al Nahari, Aicha Ahmed, Aisha Elkhuzaimy, Alfadhli, Ali Alghamdi, Alice Yong, Alilouch, Allshenqete, Amal, Amira Ahmed Mahmoud, Amna Hassan, Ashraf, Asloum Zineb, Azraai Nasruddin, Azriouil Manal, Bandar Damanhori, Barakatun Nisak Mohd Yusof, Bashir Tarzi, Belkadi Mounia, Belkhadir Jamal, Ben Salah Sourour, Benabed Kebira, Benaiche Boucif, Bendjelloul, Benomar, Berchi Abdelkahar, Berra, Bidel Habiba, Bouab, Boudiaf Brahim, Boudiaf Kaouther, Bougaa Farouk, Boukadoum Affaf, Boutheina Mohamed Ali, Bouyoucef, Burhan Ates, Carolina Shalini, Chai Shu Teng, Chan Pei Lin, Chana, Chenouf Ismahen, Chikoiche Ilhem, Chooi Kheng Chiew, Chouadra Imene, Christine Shamala Selvaraj, Dalal Alromaihi, Diaddine Bouab, Diappo, Djouima Mounir, Echchad Lamya, El Moatamid Kaoutar, El Moatamid Mohammed, Elguermai Med Najib, Elliyyin Katiman, Elsheikh Farah Mohamed Elhassan, Eman Sheshah, Ercan Ozdemir, Fadel Ahmed El Amine, Farah Kamel, Faraoun Khadra, Fawaz Turkistani, Foo Siew Hui, G Uygun, Ghofran Khogeer, Gradi Nadia, Guebli, Guedmane Lamia, Guerboub Ahmed Anas, Guerra Yasmine, Guissi Loubna, Gunavathy Muthusamy, H Nafia, Hadri Nadia, Hamda, Hamid Ashraf, Hamimah Saad, Hammouti Ihsan, Hanan Ali, Hanan Khanji, Haryati Hamzah, Havva Keskin, Herbadji, Hilal Mohammed Hilal, Hinde Iraqi, Hossam Hosny, Inass Shaltout, Jeyakantha Ratnasingam, Kamel Hemida Rohoma, Karoun, Ketata Mourad, Khadija Abdullah Mohammed, Khadija Hafidh, Khaled Baagar, Khaoula Gorgi, Khentout Imed Eddine, Khitas Abdelmoulmene, Kughanishah, Laghmassi Farid, Layla, Lee Wai Khew, Leena Swaidan, Lhassani Hamdoun, Lobna F. El Toony, Lobna Kammoun Kacem, Lounnas Nouara, Luay Qunash, Lutfi Lutfi Baran, Maha Abdelrazig Mohamed Maha Rajab, Majd Aldeen Kallash, Majid Alabbood, Malek, Mallem Noureddine, Manahel Alansary, Manal Hasan Twair, Manal Khorsheed, Mansour Alharbi, Mansour Alharbi, Mashaer Omar, Masliza Hanuni Mohd Ali, Masni Mohamad, Mastura Ismail, Maxima Shegem, Md Fariduddin, Mehmet Baütemir, Merzouki Fadhila, Mesbah Kamel, Messelem Fateh, Mhamdi Zineb, Miza Hiryanti, Mohamad 'Ariff Fahmi, Mohamed Bachiri, Mohamed Benlassoued, Mohamed Hassan Hatahet, Mohamed Hassanein, Mohammed Ali Batais, Mohammed Badedi, Mohammed Basher, Mohan T Shenoy, Mokri, Mujgan Gurler, Munirah Mohd Basar, Muris Barham, Mustafa Kanat, Nadeema Shuqom, Nancy Elbarbary, Naveed Alzaman, Nesrin Mohamed Labib, Ng Ooi Chuan, Nina Matali, Noor Rafhati Adyani, Norasyikin Abd Wahab, Nor Shaffinaz Yusoff Azmi, Nora Chabane, Norlela Sukor, Nouf Alamoudi, Noufel Ali, Nouti Nassim, Nurain Mohd Noor, Oulebsir, Parag Shah, Qarni, Radjah Aicha, Rahman, Raja Nurazni, Rakesh Kumar Sahay, Reem Alamoudi, Rhandi Jamila, Rifai Kaoutar, Rizawati Ramli, Roda Abadeh, Rohayah, Saadoune Warda, Sabbar, Salah, Salma Mohd Mbarak, Sangeeta Sharma, See Chee Keong, Seham Alzahrani, Serdal Kanuncu, Shabeen Naz Masood, Shahd Anani, Shanty Velaiutham, Shartiyah Ismail, Shehla Shaikh, Sri Wahyu Taher, Suaad Ahmed, Subhodip Pramanik, Sumaeya Abdulla, Susan Jacob, Tahseen Chowdhury, Talbi Alaa Eddine, Tamene, Tarek, Tarik Elhad, Teen Alamoudi, Teh Roseleen Nadia, Terchak, Tong Chin Voon, Toulali, Tounsi, Vijiya Mala, Walid Kaplan, Wan Juani Wan Seman, Wan Mohd Izani Wan Mohamed, Wong Hui Chin, Yakoob Ahmedani, Yusniza Yusoff, Z. Asloum, Z. Degha, Zainab, Zaiton Yahaya, Zanariah Hussein, Zineb Habbadi, and Zohra Degha.

Formatting of funding sources

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.diabres.2021.108674.

REFERENCES

[1] Pew Research Center. The Future of World Religions: Population Growth Projections, 2010–2050; 2015 http://www.pewforum.org/2015/04/02/religious-projections-2010-2050/. Accessed 17 February 2016.
[2] International Diabetes Federation. IDF Diabetes Atlas. 9th ed. Brussels, Belgium: International Diabetes Federation; 2019.
[3] Diabetes and Ramadan: Practical Guidelines International Diabetes Federation (IDF), in collaboration with the Diabetes and Ramadan (DAR) International Alliance. April 2016. https://www.idf.org/e-library/guidelines/87-diabetes-and-ramadan-practical-25.
[4] Hassanein M, Al-Arouj M, Hamdy O, Bebakar WMW, Jabbar A, Al-Madani A, et al. Diabetes and Ramadan: practical guidelines. Diabetes Res Clin Pract 2017;126:303–16.
[5] Salti I, Benard E, Detournay B, Bianchi-Biscay M, Le Brigand C, Voinet C, et al. A population-based study of diabetes and its characteristics during the fasting month of Ramadan in 13 countries: results of the epidemiology of diabetes and Ramadan 1422/2001 (EPIDIAR) study. Diabetes Care 2004;27:2306–11.
[6] Al-Arouj M, Assaad-Khalil S, Buse J, et al. recommendations for management of diabetes during Ramadan: update 2010. Diabetes Care 2010;33:1895–902.

[7] Babineaux SM, Toaima D, Boye KS, Zagar A, Tahbaz A, Jabbar A, et al. Multi-country retrospective observational study of the management and outcomes of patients with type 2 diabetes during Ramadan in 2010 (CREED). Diabet Med. 2015;32:819–28.
[8] Hassanein M, Al Awadi FF, El Hadidy KES, Ali SS, Echtay A, Djaballah K, et al. The characteristics and pattern of care for the type 2 diabetes mellitus population in the MENA region during Ramadan: an international prospective study (DAR-MENA T2DM). Diabetes Res Clin Pract 2019;151:275–84.
[9] Bravis V, Hui E, Salih S, Mehar S, Hassanein M, Devendra D. Ramadan education awareness in diabetes (READ) programme for muslims with type 2 diabetes who fast during Ramadan. Diabet Med 2010;27(3):327–31.
[10] Ahmedi MY, Haque MS, Basit A, et al. Ramadan Prospective Diabetes Study: the role of drug dosage and timing alteration, active glucose monitoring and patient education. Diabet Med 2012;27:327–31.
[11] World Health Organisation. Nutrition Advice for Adults During the COVID-19 Outbreak; 2020. http://www.emro.who.int/nutrition/nutrition-infocus/nutrition-advice-for-adults-during-the-covid-19-outbreak-html.
[12] World Health Organisation. Safe Ramadan practices in the context of COVID-19.2020 https://apps.who.int/iris/handle/10665/331767.
[13] Chowdhury Tahseen A, Waqar Salman, Hussain Sufyan, Ahmed Syed H, Syed Ateeq, Karamat Ali, et al. COVID-19, diabetes and Ramadan. Diabetes Ther 2020;11:2447–51. https://doi.org/10.1007/s13300-020-00887-x.
[14] Khan Halima, Chowdury Aisha, Lasker Shawarna S, Chowdhury Tahseen A. The effect of COVID-19 on Ramadan fasting in people with diabetes in East London 2020: the East London diabetes in Ramadan survey. Diabetes Res Clin Pract 2020;169. https://doi.org/10.1016/j.diabres.2020.108476.
[15] Chowdury Aisha, Khan Halima, Lasker Shawarna S, Chowdhury Tahseen A. A survey of patients with type 2 diabetes and fasting outcomes during Ramadan 2016 in London, UK: The East London Diabetes in Ramadan Survey. B J Diabet. 2016;2017(17):149–51.
[16] Beano Abdallah M, Zmaili Mohammad A, Gheith Zaid H, Ahmad M, Naser Munther S, Momani Al-Motassem F, et al. Predetermined ani-diabetic drug regimen adjustments during Ramadan fasting: an observational study of safety. Endocrinol Metab (Seoul) 2017;32(2):265–73.
[17] Che Sulaila Che harun, Anwar Mastor, Syaidatun Nazirah Abu Zahrin. The six days of voluntary fasting in syawal and its significance to the personality of Muslims. https://doi.org/10.17576/malim-2019-2001-07.
[18] Czisler ME, Marynak K, Clark KE, et al. Delay or avoidance of medical care because of COVID-19-related concerns – United States, June 2020. MMWR Morb Mortal Wkly Rep 2020;69:1250–7.
[19] Huang ES, Laiteerapong N, Liu JY, John PM, Moffet HH, Karter AJ. Rates of complications and mortality in older patients with diabetes mellitus: the diabetes and aging study. JAMA Intern Med. 2014;174(2):251–8. https://doi.org/10.1001/jamainternmed.2013.12956. PMID: 24322595;PMCID: PMC3950338.
[20] Naz-Masood Shabeen, Hakim Yasir Masood Rubina. Ramadan fasting related awareness, practices and experiences of a representative group of Urban Pakistani Diabetics. Pak J Med Sci 2012;28(3):432–6.