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Ramadan fasting in people with type 1 diabetes during COVID-19 pandemic: The DaR Global survey



Mohamed Hassanein^{a,*}, Reem M. Alamoudi^b, Majd-Aldeen Kallash^c, Naji J. Aljohani^d, Eman M. Alfadhli^e, Lobna El Tony^f, Ghofran S. Khogeer^g, Abdulaziz F. Alfadhly^h, Ahmed ElMamoon Khaterⁱ, Muhammad Yakoob Ahmedani^j, Mehmet Akif Buyukbese^k, Inass Shaltout^l, Jamal Belkhadir^m, Khadija Hafidhⁿ, Tahseen A. Chowdhury^o, Zanariah Hussein^p, Nancy Samir Elbarbary^q

^a Department of Endocrinology and Diabetes, Dubai Hospital, Dubai, United Arab Emirates

^b Department of Medicine, King Saud Bin Abdulaziz University for Health Sciences, Jeddah, Saudi Arabia

^c King Fahad Medical City Riyadh, Saudi Arabia

^d Department of Obesity, Endocrine and Metabolic Center, King Abdulaziz bin Saud University for Health Sciences, Saudi Arabia

^e Department of Medicine, Medical College, Taibah University Madinah, Saudi Arabia

^f Department of Diabetes and Endocrine Centre, Assiut University, Egypt

^g King Abdulaziz Medical City, Ministry of National Guard Health Affairs, Jeddah, Saudi Arabia

^h Department of Family Medicine, Prince Mansour Military Hospital, Taif City, Saudi Arabia

ⁱ Studies & Research & Data analysis Department, Dubai Health Authority, Dubai, United Arab Emirates

^j Department of Medicine, Baqai Institute of Diabetology & Endocrinology, Baqai Medical University, Karachi, Pakistan

^k Department of Internal Medicine, Medistate Kavacik Hospital, Istanbul, Turkey

^l Department of Internal Medicine and Diabetes, Faculty of Medicine, Cairo University, Cairo, Egypt

^m Moroccan League for the Fight Against Diabetes, IDF Middle East and North Africa, Morocco

ⁿ Diabetes Unit, Rashid Hospital, Dubai Health Authority, Dubai, United Arab Emirates

^o Department of Diabetes and Metabolism, The Royal London Hospital, Whitechapel, London, United Kingdom

^p Department of Internal Medicine, Hospital Putrajaya, Putrajaya, Malaysia

^q Department of Pediatrics, Ain Shams University, Cairo, Egypt

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ABSTRACT

Objectives: The DaR Global survey was conducted to determine the impact of the COVID-19 pandemic on the intentions to fast and the outcomes of fasting in <18 years versus ≥ 18 years age groups with type 1 diabetes mellitus (T1DM).

Methods: Muslim people with T1DM were surveyed in 13 countries between June and August 2020, shortly after the end of Ramadan (23rd April–23rd May 2020) using a simple questionnaire.

Results: 71.1% of muslims with T1DM fasted during Ramadan. Concerns about COVID-19 were higher in individuals ≥ 18 years ($p = 0.002$). The number of participants who decided not to fast plus those who received Ramadan-focused education were significantly higher in the ≥ 18 -year group ($p < 0.05$). Hypoglycemia (60.7%) as well as hyperglycemia (44.8%) was major complications of fasting during Ramadan in both groups irrespective of age.

* Corresponding author.

E-mail address: mhassanein148@hotmail.com (M. Hassanein).

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Conclusion: COVID-19 pandemic had minor impact on the decision to fast Ramadan in T1DM cohort. This was higher in the age group of ≥ 18 years compared to those < 18 years group. Only regional differences were noted for fasting attitude and behavior among T1DM groups. This survey highlights the need for Ramadan focused diabetes education to improve glucose control and prevent complications during fasting.

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1. Introduction

People with type 1 diabetes mellitus (T1DM) are considered at increased risk for various complications during Ramadan, and most expert professional guidelines advise against undertaking the fast [1,2]. Islamic authorities agree with medical experts to provide explicit exemptions from fasting for people with T1DM. Despite the clear exemptions from both medical and religious authorities being available, 43% of this population continues to fast during Ramadan [3]. Often, they do so without medical guidance putting themselves at risk for acute complications.

Coronavirus disease-2019 (COVID-19) caused by coronavirus-2 (SARS-CoV-2), is a global public health emergency that has so far led to over a million deaths worldwide [4]. Although safe fasting is possible during Ramadan through various measures (self-glucose monitoring, proper change in insulin doses, timing of insulin and Ramadan focused diabetes education), the COVID-19 pandemic represents an additional new concern for Muslim people with T1DM wishing to fast primarily because diabetes has emerged as a significant risk factor for adverse outcomes of COVID-19 infection [5–8].

Guidance has suggested that people with T1DM should be actively discouraged from fasting during the COVID-19 pandemic; given the likelihood of encountering more adverse outcomes if they were to contract the illness. Indeed, people with diabetes are considered as the high-risk group for catching the new COVID-19 disease [9].

The practice of Ramadan Fasting among people with T1DM from North Africa, the UK, the Middle East, and other Asian countries is largely not understood. The last epidemiological study looking into a people with T1DM during Ramadan was in 2016 and included 136 patients [10]. Indeed, clinical studies have reported that with appropriate patient selection, many people with T1DM would be able to fast [11,12]. Hence, this survey aims at looking into the behavior and attitudes of people with T1DM during Ramadan, to determine the outcomes of their fast, and whether the COVID-19 pandemic had any impact on their intentions to fast.

2. Methods

A total of 13 countries with a predominantly muslim population participated in the survey: Algeria, Bangladesh, Brunei, Egypt, India, KSA, Malaysia, Morocco, Pakistan, Tunisia, Turkey, UAE, and the UK. In each country, muslim people with diabetes were invited during their routine clinical consultation post-Ramadan to participate in the survey. People with T1DM were surveyed during 10 weeks between June and

August 2020, shortly after the end of Ramadan (23rd April – 23rd May 2020). We here report on people with T1DM. The survey had the approval of the local research and ethics authorities. The criteria of inclusion were a diagnosis of T1DM and consenting to complete a brief questionnaire about their disease and Ramadan. People with T1DM were surveyed to determine whether the COVID-19 pandemic affected their decision to fast or not, distribution of days that were fasted at the end of Ramadan and after Ramadan, evaluate the risk of hypoglycemia and hyperglycemia during Ramadan fasting, and to identify the level of education and SMBG in the management of diabetes during Ramadan using a questionnaire. They were asked about adverse events, including hypoglycemia, hyperglycemia, attendance to accident and emergency, or admission to hospital. Hypoglycemia was defined as a blood glucose level of less than 70 mg/dl, and significant hyperglycemia as blood glucose level ≥ 300 mg/dl [13,14]. Other information was provided by their doctors from the patient's records. Differences in demographic characteristics and clinical outcomes between participants < 18 years and ≥ 18 years old were tested using chi-squared analysis. All applied statistical tests were two-sided, p-values < 0.05 were considered as statistically significant. No adjustment or weighted for comparisons was made. Statistical analyses were performed in SPSS version 26.

3. Results

A total of 1483 people agreed to participate in the survey. Of these, 1054 (71.1%) intended to fast, and 792 (53.5%) were females. 60.2% of those who fasted were from KSA, 15.1% from Egypt, 7.1% from UAE, 4.3% from Pakistan, 3.2% from Malaysia, 2.1% from UK, 1.7% from Algeria, 1.7% from Morocco, 0.8% from Turkey and 3.9% from others (Bangladesh, Brunei, India and Tunisia). Majority of participants (88.2%) were on basal-bolus therapy, and 6.9% were treated with the insulin pump and 4.9% participants were treated with mixed insulin regimens. There were few notable differences in characteristics of patients who intended to fast among those aged < 18 years, compared to those aged 18 years or more (Table 1).

3.1. Intentions and abilities to fast

Of 1054 people intended to fast, 26.5% belong to < 18 years age group and 73.5% to ≥ 18 years age group. The fasting decision varied widely among the countries. Fig. S1, in country-wise analysis, shows the percentage of people with T1DM fasting

Table 1 – Baseline sociodemographic and clinical characteristics of study population, according to age.

Characteristics of the study population	<18 Years	≥18 years	P value
Total participants, n (%)	370 (25%)	1113 (75%)	0.000
Participants fasted, n (%)	279 (26.8%)	761 (73.2%)	0.000
Mean Age (Years); Mean ± SD	14.5 ± 2.5	28.2 ± 9.0	0.000
Male (%)	168 (45.4%)	525 (47.1%)	0.461
Female (%)	202 (54.6%)	590 (52.9%)	
Duration of diabetes (Years); Mean ± SD	6.2 ± 4.01	11.8 ± 7.00	0.000
HbA1c (%); Mean ± SD	9.5 ± 2.00	8.5 ± 1.80	0.000
Treatment regimens; n (%)			
Basal Bolus	256 (93.8%)	40 (84.9%)	0.004
Pump	13 (4.8%)	71 (9.4%)	
Mix insulin	4 (1.5%)	43 (5.7%)	
Co-morbidities; n (%)			
Hypertension	3 (0.8%)	87 (7.8%)	0.000
Hyperlipidemia	5 (1.4%)	125 (11.2%)	0.000
Retinopathy	11 (3.0%)	139 (12.5%)	0.000
Neuropathy	16 (4.3%)	105 (9.4%)	0.001
Nephropathy	18 (4.9%)	100 (9.0%)	0.006
CAD, Stroke	0 (0.0%)	12 (1.1%)	0.045
Foot problems with diabetes	1 (0.2%)	21 (1.9%)	0.026

*HbA1c, Glycated hemoglobin; CAD, Coronary Artery Disease.

in Ramadan ranged from 13% in Turkey to 85% in Malaysia and 90% in KSA.

Age-wise comparison (<18 years vs. ≥18 years) of people with T1DM who were intending to fast or not showed significant difference. Overall, 71.1% (n = 1054) of the participants (75.4% of <18 years and 69.6% of ≥18 years), surveyed, reported their intention to fast. However, 26.8% managed to fast the full month; and 45%, 16.3%, 6.1%, and 5.9% could fast 22–29 days, 15–21 days, 8–14 days, and 1–7 days respectively. 59.9% and 59.1% of <18 years and ≥18 years of age broke their fast due to diabetes-related illnesses (Table 2).

3.2. Impact of COVID-19

On questioning the participants with T1DM about whether the COVID-19 pandemic had influenced their choice on whether or not to fast, significant difference was found for the response to this question, between patients aged <18 and 18 years or more. In this survey, 0.4% (1/279) of <18 years and 5.5% (43/775) of ≥18 years participants said it had influenced their decision not to fast (Table 2).

4. Rates of hypoglycemia and participants response during Ramadan fasting

A total of 640 (60.7%) participants reported hypoglycemia. Rates of daytime hypoglycemia were 55.6% in those <18 years and 62.6% in those ≥18 years, however, this difference was not statistically significant (p = 0.096) (Fig. 1). Of 640 participants, 79.2% experienced it between 1 and 7 days, 12.5% between 8 and 14 days, 5.4% between 15 and 21 days, 2.2% between 22 and 29 days, and 0.6% on 30th day. The majority of hypoglycemic episodes were encountered between 3 pm and Maghreb (sunset) time (40%), followed by between Suhur (predawn meal) and 9 am (23.6%), then between 12 pm and

3 pm (22.5%), and the least between 9 am and 12 pm (14%) as shown in Fig. 1. There was an impact of age on the average days of hypoglycemia, as participants aged <18 years had hypoglycemia on 6.2 ± 5.9 days compared to 5.2 ± 5.3 days for participants of 18 years or more (p = 0.040).

The replies to the questions related to the impact of the occurrence of hypoglycemia on participant's behavior (<18 years vs. ≥18 years) are presented in Fig. S2. By far the most frequent response was an increase in the frequency of monitoring (13.7% vs. 14.1%) and the stoppage of Ramadan fast (12.7% vs. 13.9%). However, nearly 10% of participants did nothing but 9% of participants aged <18 years and only 2% aged ≥18 years omitted the medications and continued fasting (Fig. S2). The breaking of the fast was reported by nearly 85% of those with hypoglycemia. Of note, 33 participants needed to attend emergency services and/or hospital admission due to daytime hypoglycemia during Ramadan fasting. The difference between the two age groups was not statistically significant (emergency departments, 3.2% vs. 4.4% and hospital admission, 0 vs. 1.4%; p = 0.096).

4.1. Rates of hyperglycemia and participants response during Ramadan fasting

A total of 471 (44.8%) participants reported hyperglycemia. Rates of hyperglycemia were 45.3% in those <18 years and 44.6% in those ≥18 years (p = 0.735) (Fig. S3). Of these, 62.7% experienced it between 1 and 7 days, 23.2% between 8 and 14 days, 9.1% between 15 and 21 days, 3.0% between 22 and 29 days, and 1.9% on 30 days. The reported incidence of hyperglycemia was 45% during eating hours, 26% during fasting hours, and 29% during both eating and fasting hours (Fig. S3). There was no impact of age on the risk of hyperglycemia. No significant difference was found in the duration of hyperglycemia occurrence during Ramadan fasting

Table 2 – Survey Questionnaire and responses.

Questions		<18 Years	≥18 Years	P value
How many days did you manage to fast this year?		22.4 ± 8.0	23.8 ± 7.6	0.011
Did you intend to fast Ramadan this year?	Yes	279 (75.4%)	775 (69.6%)	0.000
	No	91 (24.6%)	338 (30.4%)	
Did you fast any days after Ramadan (Shawal)?	Yes	41 (14.7%)	164 (21.2%)	0.043
	No	238 (85.3%)	609 (78.8%)	
If yes, please specify number		6.6 ± 2.9	6.3 ± 3.3	0.603
Did the COVID-19 epidemic affect your decision re-fasting Ramadan?	Yes	1 (0.4%)	43 (5.5%)	0.002
	No	267 (95.7%)	709 (91.5%)	
	Not sure	11 (3.9%)	21 (2.7%)	
Did you break your fast because of diabetes related illness?	Yes	167 (59.9%)	456 (59.1%)	0.567
If yes, please specify the days?		7.8 ± 6.7	6.7 ± 7.0	0.100
Did you have any day-time hypoglycemia during this Ramadan?	Yes	155 (55.6%)	485 (62.6%)	0.095
If yes, please specify the days?		6.2 ± 5.9	5.2 ± 5.3	0.040
Did you break your fast during this Ramadan because of hypoglycemia?	Yes	133 (85.8%)	410 (85.1%)	0.147
Did you need to attend emergency department or got admitted to hospital because of hypoglycemia during this Ramadan?	Yes, attended emergency department	5 (3.2%)	21 (4.4%)	0.096
	Yes, admitted to hospital	0 (0.0%)	7 (1.5%)	
If admitted, please specify days		0.0	1.4 ± 0.5	0.491
Did you have any day-time hyperglycemia during this Ramadan?	Yes	126 (45.3%)	345 (44.6%)	0.735
If yes on How Many Days?		8.5 ± 6.8	7.5 ± 6.2	0.154
Did you break your fast during this Ramadan because of hyperglycemia (BG > 300 mg/dl)?	Yes	74 (58.7%)	255 (74.3%)	0.004
Did you need to attend emergency department or got admitted to hospital because of hyperglycemia during this Ramadan?	Yes, attended emergency department	8 (6.3%)	16 (1.7%)	0.076
	Yes, admitted to hospital	4 (3.1%)	11 (3.2%)	
If admitted, please specify days		3.7 ± 2.1	2.5 ± 1.4	0.086
Did you do SMBG during Ramadan?	Yes, same as before	198 (71.2%)	454 (59.0%)	0.004
	Yes, at less frequency than before Ramadan	9 (3.2%)	50 (6.5%)	
	Yes, at less frequency than before Ramadan	65 (23.4%)	229 (29.7%)	
	No	6 (2.2%)	37 (4.8%)	
Did you receive any education specific for Ramadan fasting?	Yes	141 (50.7%)	490 (63.3%)	0.004
	No	137 (49.3%)	281 (36.4%)	

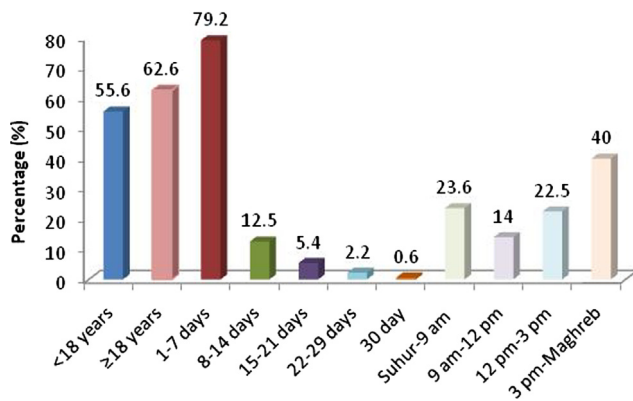


Fig. 1 – Rate, frequency and timing of hypoglycemia during Ramadan fasting.

between participants aged <18 years and 18 years or more age (8.5 ± 6.8 days vs. 7.5 ± 6.2 days; $p = 0.154$) as shown in Table 2.

The replies to the questions related to the impact of the occurrence of hyperglycemia on participant's behavior (<18 years vs. ≥ 18 years) are presented in Figure S4. By far the most frequent response was an increase in the dose of medication (35.1% vs. 32.8%) and cut down the food (16.7% vs. 13.0%). However, nearly 10% of participants under 18 years of age and 5% of participants aged 18 years or more did nothing (Fig. S4). There was a significant impact of age on the breaking of the fast due to hyperglycemia (58.7% for <18 years vs. 74.3% for ≥ 18 years). Recourse to emergency services was pursued by 39 participants with hyperglycemia (emergency departments, 8 (6.3%) vs. 16 (1.7%) and hospital admission, 4 (3.1%) vs. 11 (3.2%); $p = 0.076$).

4.2. Self-monitoring of blood glucose and education

Among the participants who fasted in Ramadan, more than half received Ramadan-focused education (60.0%). Participants with ≥ 18 years of age received Ramadan-focused education more frequently compared to participants with <18 years of age ($p = 0.004$). Of these participants, 52.6% reported receiving structured education from their doctor about diabetes management during Ramadan, followed by a dietician (20.9%), nurses (9.9%), and others (20.9%). On asking the question about the method of education, more than half of the participants (51.7%) stated that they received Ramadan-focused education from their doctors during a routine consultation. However, 23.8% received it through online apps, 13.5% through leaflets, and 11.0% through group sessions, respectively.

>60% (62.2%) of participants checked the blood glucose at the same frequency as before Ramadan fast (Table 2). Of the total 1054 participants, 59.3% monitored their blood glucose level 3–4 times daily and 18.9% twice daily, 9.2% once daily, and 5.8% two-four times daily. Of the participants, 3.4% tested their blood glucose once weekly, and 3.4% tested their blood glucose even less than once a week.

5. Discussion

Fasting during Ramadan is not merely abstinence from eating but involves a drastic change in lifestyle aspects and habits. Addressing these lifestyle changes is essential and challenging in people with T1DM. The DaR Global survey, a population-based survey conducted among 13 countries, most of them with a Muslim majority population, showed that 71.1% of participants with T1DM fasted during Ramadan, amidst the COVID-19 pandemic. KSA had the highest number of participants who chose to fast. Compared with participants aged <18 years, a significantly larger number of participants aged ≥ 18 years decided not to fast during the COVID-19 pandemic. Both hypoglycemia and hyperglycemia were significant complications of fasting during Ramadan irrespective of age.

Over the last twenty years it seems that there's been a significant increase in fasting prevalence among people with T1DM. The Epidemiology of Diabetes and Ramadan (EPIDIAR) study, which was conducted in 2001, found that as many as 42.8% people with T1DM reported fasting for at least 15 days during Ramadan [3]. However, the DAR-MENA T1DM study showed that despite the risk of various complications associated with fasting in people with T1DM ($n = 138$), 72.3% fasted for at least 15 days, and 48.5% fasted for the entire month of Ramadan [10]. The DaR Global survey found fasting in 71.1% of participants with T1DM during Ramadan. Fig. S3 shows that 29% of participants with T1DM decided not to fast, which is similar to DAR-MENA T1DM study [10]. However, the present survey also shows a pattern of high rates of fasting for the whole month (26.5%) or most of the month as 44.4% fasted 22–29 days. About 62% participants with T1DM (64% for the <18 years and 61% for those 18 or older) fasted for at least 15 days in this survey. Several studies indicated that some people with T1DM, including many adolescents, can fast when empowered with the appropriate patient education, blood glucose monitoring, insulin dose adjustment, and support by experts in the field, which collectively can lead to safer fasting during Ramadan [12,14–22].

The potential risks associated with fasting in patients with T1DM are a disruption in glycemic control revealing as hypoglycemia, hyperglycemia, and metabolic emergencies [1]. Several studies have found that the incidence of severe hypoglycemia was negligible in people with T1DM during Ramadan fasting [19,23–27]. The frequency, timing, and severity of hypoglycemia were elucidated in this survey where 55.6% of <18 years and 62.6% of ≥ 18 years had experienced at least an episode of hypoglycemia in a month. While 79.2% of these episodes occurred over 1–7 days during Ramadan fasting, 20.8% occurred at a high frequency extending from 8 to 30 days indicates the need to stress upon stopping the fast for those individuals with frequent hypoglycemia.

Most of hypoglycemic episodes were encountered between 3 pm and Maghreb time (40%), followed by between Suhur and 9 am (23.6%), then between 12 pm and 3 pm (22.5%), and the least between 9 am and 12 pm (14%). This indicates that hypoglycemia during Ramadan, occurs at all times of the day with the highest time during the period extending from mid-day to sunset time [12,21].

Table 3 – Key parameters in people with T1DM who fasted Ramadan.

(n = 1054, 71% of survey population)			
Fasting (Days)	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
Hypoglycemia (%)	39.3% reported no symptoms of hypoglycemia	48% reported symptoms of hypoglycaemia over 1–7 days	12.8% reported symptoms of hypoglycaemia over 8–30 days
Hyperglycemia (%)	55.2% reported no episodes of hyperglycemia (BG > 300 mg/dl)	28% had hyperglycemia over 1–7 days	16.8% had hyperglycemia over 8–30 days
ER or hospital admission (%)	93.2% did not require ER or hospital admission for hypo/hyperglycemia		6.8% required ER or hospital admission for hypo/hyperglycemia

The most frequent response to hypoglycemia was an increase in the frequency of monitoring and breaking of the fast followed by changes in dose or frequency of insulin. The DaR Global survey also shows a significant impact of age on the breaking of the fast due to hyperglycemia (58.7% in <18 years vs. 74.3% in ≥18 years). While 640 people with T1DM experienced at least one episode of hypoglycemia, 33 (5.15%) participants were required to attend emergency services and/or hospitalization. It is not clear how many hypoglycemic episodes required non-medical assistance as this was not asked in the questionnaire. Attending the emergency department or hospitalization during COVID-19 era with the lockdown measures and the possibility to be exposed to ER departments busy with COVID-19 patients could have impacted the decisions of many and perhaps opted to home management of hypoglycemia. Alternatively, this could reflect lower rates of severe hypoglycemia compared to 20 years ago and reflects the advances in T1DM management and the better understanding of fasting Ramadan as other studies also reported in recent years low rates of emergency department attendance or hospitalization for diabetes during Ramadan [28,29].

Much of the focus during Ramadan is related to hypoglycemia, however, the EPIDIAR study has shown a significant increase in the rate of hospitalization during Ramadan for severe hyperglycemia (with or without ketoacidosis) among those with T1DM, from 5 to 16 events/100 people/month ($p = 0.1635$) [1]. In this DaR Global survey, 44.8% (471/1052) participants reported hyperglycemia and this occurred with no significant difference in the participants aged <18 years and ≥18 years. Recourse to emergency services was pursued by 39 (8.2%) participants with hyperglycemia which is more than those requiring this level of service due to hypoglycemia. This may be explained by the high HbA1c levels of the study cohort at baseline ($9.4 \pm 2.0\%$ for the <18 years age group and $8.5 \pm 1.8\%$ for those ≥18 years).

The role of structured education in reducing the complications of diabetes is well established, and guidelines state that this structured education should be extended to Ramadan-focused education programs so that people with diabetes can make informed decisions [1,2]. In DaR Global survey, only 60.2% of participants had access to diabetes education, of whom only 50.7% (141/278) participants aged <18 years received educational sessions compared to 63.6% (490/771)

participants aged ≥18 years. Considering that Ramadan-focused diabetes education program can enable people with diabetes to reduce their risk of illness during fasts, the present survey showed that structured education is an essential strategy in diabetes management that was not optimally accessed by most participants. Of concern, some participants in the survey reported fasting despite not doing any blood glucose monitoring. A prospective study in type 1 and type 2 diabetes patients showed that active glucose monitoring, adjustment of medications; dietary counseling, and patient education significantly reduced the risk of acute complications with diabetes in fasting patients [30]. It is important for Ramadan structured education program to include health-care professionals as a study in Pakistan found that almost one-third of general practitioners lacked knowledge of basic principles needed [31].

While some of data of this survey could be influenced with COVID-19 impact that was not the case for most of the responders. Indeed, this is the largest survey on T1DM during Ramadan over the last 19 years. Table 3 summarizes some of the key parameters of those who fasted. Clearly, the results confirm that while a sizeable proportion can fast with no safety concerns, many are not and certainly an array of measures are required to improve the safety for those who opt to fast.

This survey has some noteworthy limitations. Hypoglycemia was reported as symptomatic rather than confirmed and consequently higher rates of hypoglycemia are reported here. Data were captured by the recollection of events within living memory of a few weeks. However, medical and social events like hypoglycemia, hyperglycemia and breaking of the fast cannot be forgotten readily especially in Ramadan as the person needs to compensate for days not fasted. The use of several sites reflects practices in more extensive geographical regions; however, this may introduce confounders based on the differences of the social backgrounds and the different patterns of medical practice, prescribing habits and beliefs between regions. Finally, the survey cohort includes over 52% from the Gulf region or UK where medical facilities are of high standards or through experienced physicians in many other countries. Hence, the results of the survey could not be easily generalized to all people with T1DM.

In conclusion, COVID-19 pandemic had minor impact on the decision to fast Ramadan in T1DM cohort. This was

higher in the age group of ≥ 18 years compared to those < 18 years group. The fasting attitude and behavior were not largely different between the young and the adults, however, regional differences were noted. This survey highlights the need for Ramadan focused diabetes education to improve glucose control and prevent complications during fasting.

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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.

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Appendix A. Supplementary material

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