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Diabetes education and medication adjustment in Ramadan (DEAR) program prepares for self-management during fasting with tele-health support from pre-Ramadan to post-Ramadan

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Abstract

Background: We evaluated the outcome for fasting Muslims with diabetes prepared with pre-Ramadan optimization through education and medication adjustment, tele-support and intervention up to post-Ramadan.

Methods: Muslims with diabetes planning to fast were recruited into a focused diabetes program for Ramadan fasting.

It consisted of (a) a pre-Ramadan assessment and test fasting to optimize glycemic control, (b) education on diabetes management during fasting, (c) tele-monitoring from pre-Ramadan and (d) a post-Ramadan review. Their metabolic profiles and diaries for meals, activities and glucose monitoring were evaluated.

Results: Twenty-nine participants were enrolled, with mean age 58.4 ± 9.2 years, 75.9% female, 79.3% Malays and 93.1% type 2 diabetes. A total of 92% needed medication adjustment and 93% fasted for at least 14 days. Glycated hemoglobin (HbA1c) and weight decreased from 8.8 ± 1.8% (72.7 mmol/mol) pre-Ramadan to 8.5 ± 1.7% (69.4 mmol/mol) post-Ramadan and 76.6 ± 20.3 kg pre-Ramadan to 75.9 ± 21.3 kg post-Ramadan, respectively. There were decreased complications of hypoglycemia from 13.8% to 10.3% and several-fold improvement in hyperglycemia from 31.0% to 3.5% during Ramadan fasting when compared with pre-Ramadan.

Conclusions: Muslims with diabetes were able to self-manage when fasting using tele-monitoring support and intervention, with decreased complications during Ramadan compared with pre-Ramadan.

Keywords: diabetes mellitus, fasting, health education, self-management

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Introduction

Ramadan is a month on the Islamic calendar where Muslims around the world fast from predawn to sunset. The duration of the fast varies depending on the geographical location. Daylight hours vary from year to year in view of a shorter Islamic calendar compared with the Gregorian calendar, which runs approximately 11 days earlier each consecutive year. As this month-long 29 consecutive-day fasting is one of the five tenets of Islam, most Muslims observe the fast with fervor. During this month, not only are there changes in the dietary routines, but also in the daily activities due to increased night-time prayers and shorter sleeping hours.

The daily fasting commences with a meal at predawn and ends with the breaking of fast at sunset. However, without proper meal planning,

there may be excessive caloric consumption during the nonfasting hours due to the perceived need for compensatory consumption. This month-long consecutive day fasting is also followed by a month of celebration in Syawal, which may result in further excessive caloric consumption. To complicate matters, some continue to perform nonobligatory fasting after Ramadan. Hence, proper preparation prior to Ramadan is prudent to manage these fasting and nonfasting periods in order to debunk the compensatory practice during nonfasting periods.

For people with diabetes mellitus, the changes in daily routines for meals, physical activities and sleep during Ramadan affect their metabolic control.[1] Dietary instruction and social learning interventions were previously shown to be the most effective instructional methods in the management of diabetes.[2] In an international multicenter observational study by Salti and colleagues,[3] a multifold increase in diabetes complications was observed during the fasting month, although the participants self-reported maintaining their food intake, physical activity, and sleep duration for half of them, and treatment regimen for most. Consequently, a consensus on expert recommendations was convened for the management of diabetes during this critical period of fasting in Ramadan in 2005.[4]

Subsequent interventional studies emphasized the importance of appropriate risk assessment and preparation prior to Ramadan.[5] With these preparatory sessions, glycemic control was maintained or improved while the expected increased diabetes complications[5–8] were reduced. The sessions were conducted by trained healthcare professionals either in the form of focused groups or individualized education sessions at the hospital or in community settings. The involvement of a multidisciplinary team was imperative in contributing important educational components focused on fasting for people with diabetes.[6–9] In addition, subsequent interventional studies suggested the diabetes treatment type which would further reduce complications of hypoglycemia and weight gain during fasting.[10,11]

A more recent international study had found that most physicians were apt in using the available expert recommendations, thus enabling more Muslims with diabetes to be able to fast for at least 15 days.[12] There were regular updates on international recommendations, culminating with that by International Diabetes Federation in collaboration with the Diabetes and Ramadan International Alliance in 2017.[13]

Yet, there remains a lack of large studies during Ramadan fasting likely due to the difficulty in monitoring during the month where there are increased religious routines. With the availability of tele-monitoring studies showing improved glycemic control when used for reviewing self-glucose monitoring records during fasting to supplement focused Ramadan diabetes education,[14,15] tele-monitoring may be a tool to ease glucose monitoring during Ramadan when it would otherwise be difficult to monitor patients' glucose levels and detect complications.

Interestingly, in our previous study, despite good general knowledge levels of diabetes and specific knowledge on diabetes management during fasting, there appeared to be a knowledge–practice gap in people with diabetes, resulting in unsafe diabetes self-management practices during fasting in Ramadan.[16] Factors contributing to this gap could be perceived as those affecting the healthcare professional and the people with diabetes.

Factors affecting the healthcare professional could be deficiencies in the doctor's medical or religious knowledge and cultural sensitivity[17] resulting in an ethical conflict,[18] and the lack of support from relevant healthcare professionals, such as pharmacists, due to inadequate knowledge.[19] In contrast, studies looking at the perspective of fasting for people with diabetes found that most regarded fasting as beneficial to their well-being[20] with social pressures influencing the decision to fast.[21,22] Hence, they would either not consult doctors or continue fasting despite being discouraged by their doctors, even though almost half of patients experienced hypoglycemic symptoms during the period, with some self-adjusting their medication or performing compensatory binge eating.

On the contrary, healthcare professionals who were able to overcome these barriers with support from an experienced specialist multidisciplinary team may improve this gap.[23] Hence, there needs to be a multipronged approach for improving diabetes care during Ramadan fasting, not only through healthcare professional education and support, but also regular focused patient education and support.

Locally, the higher prevalence of diabetes[24] and diabetes complications[25] among the Muslim population, which is also the minority population, needs a more targeted approach. We had previously suggested the need for a focused program to prepare Muslims with diabetes for fasting and to intervene complications to optimize self-management during Ramadan.[16]

We initiated the Diabetes Education and medication Adjustment in Ramadan (DEAR) program to optimize glycemic control prior to Ramadan, and provide risk assessment, preparation, monitoring and intervention from pre-Ramadan, during Ramadan and up to the festive post-Ramadan period, and evaluated the outcome.

Participants, materials and methods

The protocol for this cross-sectional study had been approved by the local institutional ethics committee and performed in accordance with the ethical standards of the Declaration of Helsinki.

It was conducted between March to September 2016 at the Diabetes and Metabolism Center of Singapore General Hospital. The study participants were recruited from Muslims with diabetes planning to fast during Ramadan who attended the outpatient clinic in Diabetes and Metabolism Center in Singapore General Hospital 3–4 months before Ramadan and were referred by their endocrinologist.

Informed consent was obtained from all participants. If they agreed to participate in the DEAR program and informed consent was obtained, they were included. Those who were not fasting or not able to follow the program were excluded.

This was the first run of the DEAR program, which was jointly run by a Muslim endocrinologist and Muslim diabetes specialist nurses. It consisted of four components over a 4-month period.

Firstly, there was a pre-Ramadan clinic visit 4–6 weeks before Ramadan. During this visit, there was assessment of metabolic profile, risk category and optimization of glycemic control and medication adjustment for Ramadan fasting by a Muslim endocrinologist, based on the recommendations.[13,19,26] This was followed by a session on general diabetes education and knowledge assessment by the Muslim diabetes specialist nurse at the same sitting, in a conjoined room. The participants were provided the contact details and time points for feedback of glucose monitoring records *via* electronic mail and phone calls. Test fasting and glucose monitoring was performed to optimize glycemic control for those whose glycemic control could be improved further to individualized target, or those with a new medication regimen prescribed to reduce the risk of complications during fasting. Glucose feedback *via* tele-monitoring was reviewed through phone consultation or electronic mail for advice on medication adjustment or diabetes complications to be provided by the team.

The participants were informed to record their capillary glucose profile through self-monitoring performed at the predawn meal, noon time, the presunset meal and at bedtime 3 h after the sunset meal, upon developing symptoms of complications or during sick days. They performed the daily glucose monitoring 1 week before, during and 1 week after Ramadan. During Ramadan, the participants continued to monitor their glucose levels at the specific timings mentioned until week 4, where they monitored their glucose levels when symptomatic and at the specific timings daily if they had been developing hypoglycemia in the previous weeks of fasting. They had also recorded diaries for meals, activity levels and any diabetes complications or other illness.

Subsequently, a second visit was conducted 2 weeks before the start of fasting for a focused group education session on the management of diabetes during Ramadan. The session was conducted as interactive talks by a religious leader and the Muslim endocrinologist, followed by a workshop by the Muslim diabetes specialist nurses and a physiotherapist. The talks consisted of a patient-sharing session, and topics on religious perspective of fasting, diabetes-related complications during fasting and dietary advice. The workshop consisted of an exercise session and an interactive hands-on session on topics of glucose monitoring and sick-day management using a conversation map, paying attention to the knowledge deficiencies and queries raised by the participants.[15]

Thirdly, tele-monitoring of glycemic control was done through phone consultation and electronic mail before and during Ramadan. The team contacted the participants for feedback of their glucose profile, dietary and physical activity records and upon receiving the records, the team provided advice on medication adjustment or diabetes complications.

The feedback was provided to the team before the start of Ramadan after a day of test fasting, during Ramadan after 3 days of fasting, then weekly till the end of Ramadan. This tele-monitoring service was attended on weekdays between 8 a.m. and 5 p.m. by a diabetes specialist nurse. The records were discussed with the endocrinologist before the suggested plans were informed to the participants by the next weekday for implementation. In the case of hypoglycemia noted in the records, the patients were contacted immediately within the same day to institute the necessary changes. To ensure that the glucose profile was provided at the mentioned timings, if no glucose records were received, a phone call to the participant was made at the time points by the nurse, which was within a week of pre-Ramadan visit to check on test fasting, at the end of the fourth day of Ramadan, and at the end of each week of Ramadan.

The program ended with a post-Ramadan clinic visit 2–6 weeks after Ramadan for re-assessment of their knowledge, and a review of their metabolic profile, glycemic control and complications during the fasting month, and readjustment of medication for the subsequent nonfasting months with further advice for nonobligatory fasting in other months.

Statistical analysis

Statistical analysis was performed using the IBM SPSS Statistics version 23.0 (IBM Corp, Armonk, NY, USA). Descriptive statistics were used to describe the patient demographics and characteristics of diabetes. Percentages and frequencies were calculated for categorical variables. The variability of continuous variables was assessed by their confidence intervals, taking account of the mean and standard deviation in the calculation.

Correlation analysis was performed to determine the correlation between demographics, diabetes characteristics, and pre-Ramadan and post-Ramadan parameters. The strengths of comparative analysis was based on the correlation coefficient (r value). The stronger the relationship between two variables, the higher the r value. A correlation coefficient value of $r = 0.3$–0.5 was considered fair; 0.6–0.8 moderately strong and $\geqslant 0.8$ very strong.

The regression model was implemented for multivariate analysis. p values with 95% significance were used to determine significance of the regression model.

Results

Characteristics of study population

Twenty-nine participants were enrolled in the DEAR program. The demographics of the study population are listed in Table 1.

The mean age of the study population was 58.4 ± 9.2 years with the majority Malays (79.3%), females (75.9%) and married (72.4%). Most (86.2%) have a monthly household income below the national median monthly household income of SGD$8846 in 2016[23] but a high literacy level of at least secondary school education in 75.9%.

Diabetes characteristics of the study population

The diabetes characteristics of the study participants are listed in Table 2. Most (93.1%) had type 2 diabetes. For diabetes therapy, 6.9% were controlled on oral medication only, 44.8% on insulin therapy only, 34.5% on combined oral and insulin therapy, and 6.9% were on combined therapy with Glucagon-like peptide 1 receptor agonist (GLP 1-RA) therapy.

For those on oral therapy, only 3 (25%) were controlled on sulphonylureas, 4 (33.3%) on Sodium- glucose cotransporter 2 (SGLT2) inhibitors, 5 (41.7%) on Dipeptidyl peptidase 4 (DPPIV) inhibitors and all were on biguanides (metformin). For those on insulin therapy, 4 (17.3%) were on basal insulin, 15 (65.2%) on premixed insulin, and 4 (17.3%) were on a basal-bolus insulin regimen with insulin analogs.

Preparation for Ramadan fasting

In preparation for Ramadan fasting, 93.1% needed medication adjustment. Those who did not (8.3%), were on metformin extended-release night dosing and gliflozins only. Out of those who needed medication adjustment, 2 (9.1%) changed from premixed insulin to a basal-bolus insulin regimen while only 1 (4.5%) was changed from a basal insulin with sulphonylurea regimen to basal-plus-insulin regimen.

Comparison of pre-Ramadan and post-Ramadan parameters

During Ramadan, 27 (93.1%) participants fasted for at least 14 days. The results are presented in Table 3.

There was significant improvement from pre-Ramadan to post-Ramadan with decreased

Table 1. Baseline demographics of participants.

Variables	*n* (%)
Male	7 (24.1)
Female	22 (75.9)
Ethnicity	
Malay	23 (79.3)
Indian	6 (20.7)
Marital status	
Single	1 (3.4)
Married	21 (72.4)
Other	7 (24.1)
Occupation	
Unemployed	7 (24.1)
Government	5 (17.2)
Professional	3 (13.8)
Retired	5 (17.2)
Other	9 (31.0)
Monthly household income (SGD)	
<5000	25 (86.2)
5000–10,000	2 (6.9)
>10,000	2 (6.9)
Education level	
Lower than secondary	7 (24.1)
At least secondary	22 (75.9)

SGD, Singapore dollars.

glycated hemoglobin (HbA1c) from 8.8 ± 1.8% (72.7 mmol/mol) to 8.5 ± 1.7% (69.4 mmol/mol) post-Ramadan, weight from 76.6 ± 20.3 kg to 75.9 ± 21.3 kg and body mass index (BMI) from 31.1 ± 8.0 kg/m^2 to 29.3 ± 10.2 kg/m^2.

For lipid parameters, there was increased pre-Ramadan to post-Ramadan values for low-density lipoprotein cholesterol (LDL-C) levels from 2.56 ± 0.99 mmol/l to 2.61 ± 1.32 mmol/l and triglyceride (TG) levels from 1.78 ± 1.09 mmol/l to 2.13 ± 1.09 mmol/l. There were decreased high-density lipoprotein cholesterol (HDL-C) levels.

There were no significant changes in renal function.

There was good correlation between the pre-Ramadan and post-Ramadan values; with very strong correlation for the HbA1c, weight and BMI values, and moderately strong correlation for the LDL-C and TG values. There was fair correlation of pre-Ramadan HbA1c with post-Ramadan HbA1c ($r = 0.8389$) and post-Ramadan HDL-C level ($r = -0.515$). The values are presented in Table 3.

Multivariate analysis by race revealed decreased HbA1c from pre-Ramadan to post-Ramadan in Indians but increased HbA1c in Malays, with a trend toward significance ($p = 0.10$).

In addition, there was decreasing HbA1c for pre-Ramadan and post-Ramadan with increasing duration of diabetes.

Comparison of incidence of diabetes complications between pre-Ramadan and post-Ramadan

There was decreased incidence of self-reported diabetes complications from pre-Ramadan to during Ramadan, as seen in Table 3.

The incidence of hypoglycemia decreased from 13.8% pre-Ramadan to 10.3% during Ramadan.

In addition, there was remarkable improvement in the incidence of hyperglycemia which decreased from 31.0% pre-Ramadan to 3.5% during Ramadan. There was only one patient with an episode of glucose level 15 mmol/l after breaking fast meal.

One patient who was on dialysis fasted for 9 non-dialysis days, but did not fast the rest of the days due to midday hypoglycemia. The rest of the participants did not fast due to other unrelated acute illness.

Discussion

This DEAR program was initiated to focus on covering the relevant religious and medical aspects through engaging a religious leader and a Malay Muslim healthcare professional team. As our previous study had shown a knowledge–practice gap among fasting Muslims with diabetes,[16] likely contributed by deficiencies in the knowledge of

Table 2. Diabetes characteristics of participants.

Variables	*n* (%)
Type 1 diabetes	2 (6.9)
Type 2 diabetes	27 (93.1)
Diabetes duration (years)	
<5	4 (13.8)
5– 0	2 (6.9)
10–20	9 (31.0)
>20	14 (48.3)
Diabetes complications pre-Ramadan	
Hypoglycemia	5 (13.8)
Hyperglycemia	9 (31.0)
Body mass index (kg/m^2) pre-Ramadan	
<18.5	1 (3.4)
18.5–23	1 (3.4)
>23	27 (93.3)
Glucose-lowering therapy	
Diet and exercise only	2 (6.9)
Oral medication only	2 (6.9)
Insulin therapy only	13 (44.8)
Combined oral and insulin therapy	10 (34.5)
Combined therapy with GLP1 receptor agonist therapy	2 (6.9)
Diabetes medication adjustment for Ramadan	
Yes	27 (93.1)
No	2 (8.3)
Change in diabetes medication type (among those adjusted)	
Yes	3 (11.1)
No	24 (88.9)

Glucagon-like peptide 1 (GLP1).

healthcare professionals or ethical conflicts[18] in a Muslim-minority country like Singapore, the team was introduced to reduce not only religious barriers, but also language, cultural and ethnic barriers,[17] as most of our participants are Malays. Considering the patients' perspectives on fasting,[20–22] a proposed reason is that this minority population appeared to have a better comfort level to discuss and share their concerns and experiences in a smaller focused group with a culturally similar healthcare professional team.[27]

In addition, as these patients were at risk of diabetes complications during the fasting period in view of poor glycemic control and regular follow up at a tertiary center, we persisted optimizing the glycemic control through medication adjustment, and introduced test fasting in order to promote safe fasting through predicting complications, and encouraging self-empowerment through better self-management and response to diabetes complications. We used tele-monitoring to support the participants during this pre-Ramadan period by managing any complications early through ongoing support and early intervention. This was in addition to subsequent use of tele-monitoring during Ramadan, as previously reported.[15]

Furthermore, we continued monitoring up to post-Ramadan clinic visit to close the loop in diabetes management during fasting by reviewing the strategies used in preparing each participant for Ramadan and the resultant glycemic control.[26,28] This post-Ramadan monitoring and visit acted as a reminder for continued self-care during the festive period in the month after Ramadan where there was a tendency for poor control, and provided further encouragement for ongoing self-management during the subsequent nonfasting and nonobligatory fasting periods.

It is interesting to note that this group had similar sociodemographics to our previous study,[17] with a high literacy level of at least secondary-school education and the majority had monthly household income below the national median monthly household income.[29] Their baseline diabetes characteristics were also similar to previous studies with the majority having type 2 diabetes.[3] The similarities in these populations might suggest better self-identification within such groups, which promoted better learning of self-management skills in a focused group education setting, as suggested by studies on peer education.[30]

In addition, our study population consisted of participants on a variety of diabetes therapies. Although the majority needed medication adjustment of

Table 3. Metabolic parameters for pre- and post-Ramadan.

Parameter	Pre-Ramadan (Mean ± SD)	Post-Ramadan (Mean ± SD)	*p* value	*r*‡
BMI (kg/m^2)	31.1 ± 8.0	29.3 ± 10.2	<0.01*	0.9959
Weight (kg)	76.6 ± 20.3	75.9 ± 21.3	<0.01*	0.9965
HbA1c, % (mmol/mol)	8.8 ± 1.8 (72.7)	8.5 ± 1.7 (69.4)	<0.01*	0.8389
LDL-C (mmol/l)	2.56 ± 0.99	2.61 ± 1.32	<0.01*	0.5071
TG (mmol/l)	1.78 ± 1.09	2.13 ± 1.09	<0.01*	0.5990
HDL-C (mmol/l)	1.32 ± 0.95	1.23 ± 0.46	0.5360	0.1245
Diabetes complications	Pre-Ramadan	During Ramadan		
Hypoglycemia (<4 mmol/l)	4 (13.8)	3 (10.3)	NA	NA
Hyperglycemia (⩾10 mmol/l)	9 (31.0)	1 (3.5)	NA	NA

*p value < 0.01 was considered statistically significant.
‡a correlation coefficient value of $r = 0.3$–0.5 was considered fair; 0.6–0.8 moderately strong and ⩾0.8 very strong.
SD, standard deviation; BMI, body mass index; LDL-C, low-density lipoprotein cholesterol; TG, triglycerides; HDL-C, high-density lipoprotein cholesterol; HbA1c, glycated hemoglobin.

dosage or regimen, most could fast for at least 14 days without complications, similar to that observed in the CREED study,[12] suggesting that medication dosage adjustment was adequate for preparation before fasting in most people without the need for changing the medication type. This may suggest that pharmacists could be involved in such programs on a larger scale, for those with lower risk during fasting and better glycemic control, as similarly suggested by Pinelli and colleagues[31] for pre-Ramadan advice on medication dosage changes and titration with tele-monitoring, based on glycemic control and diabetes complication encountered. It is noted that medication changes alone without risk assessment, focused diabetes education and monitoring, in comparison with an all-inclusive program, has not been performed as separate arms in such a varied population of people with poorly controlled diabetes and multiple treatment regimens.

There needs to be further prospective randomized studies to verify the suggested findings that that improvement in glycemic control, weight, BMI and lipid values on this program could potentially be predicted based on their pre-existing pre-Ramadan control. In addition, the suggested varied trend of HbA1c based on ethnic differences needs to be further verified in prospective studies to determine if ethnic-adapted culturally adapted focused programs could be designed to encourage maintenance of glycemic control, weight and lipid control.[5]

Even more importantly, our small study showed several-fold improvement in self-reported diabetes complications during Ramadan compared with pre-Ramadan, when patients were prepared adequately for the fasting period, which is similar to other studies.[5,13] The patients who fasted for less than 14 days were unwell due to conditions unrelated to diabetes; this aspect of sick-day management was also included in the program to ensure that the participants treated their acute illness and did not persist in fasting. Hence, the importance of the various components in focused pre-Ramadan diabetes education could not be overemphasized.

Limitations

Our study had several limitations.

Our sample size was small in this pilot study and lacked a control group as the first run of the program stretching from pre-Ramadan assessment, optimization and tele-monitoring, to post-Ramadan review. There was difficulty in having a control group, as performing obligatory fasting for this high-risk population without any

preparation or support is not recommended. Hence, the results of this exploratory study need to be evaluated in future studies of larger sample size for evaluation of cost effectiveness and clinical significance, in view of the public health implications.

It is evident that the majority of our participants were females. Hence, there could be sex bias due to self-selection for such a program.

We did not assess if the participants previously received any such focused education. However, as this was the first run of this program for Ramadan fasting, these participants had not undergone a similar program. However, a detailed assessment of knowledge level would have determined their knowledge in relation to their metabolic profile.

We did not perform continuous glucose monitoring to trend the pattern of glucose levels, nor serum fructosamine to account for the changes in HbA1c and the observed difference between the ethnic groups. Although HbA1c for Ramadan fasting is not the best measure, we were concerned about costs incurred by fructosamine measuring during clinic visits as additional tests, in view of the lack of recommendations in risk categorization. Further funded studies may be needed for a cost-effective evaluation.

Similarly, we were unable to collect adequate dietary and physical activity records for the interpretation of the caloric intake and metabolic rate to account for the observed differences. Hence, we did not consider subanalysis based on diet and physical activity.

Importance of our study

This study explored the need for a focused program to support Muslims with diabetes planning to fast through optimization and tele-monitoring support, with ongoing intervention starting from before Ramadan up to after Ramadan during the risky festive period. We sought to optimize the glycemic control not just during Ramadan, but maximized on the opportunity to improve control before Ramadan through our culturally adapted program despite a varied and high-risk poorly controlled population.

We noted that such a pre-Ramadan optimization supported by tele-monitoring feedback and intervention is essential for support in a Muslim-minority country with less resources for culturally adapted support.

It was interesting to note that in our study, despite a short duration, there was definite improvement in diabetes complications. The incidence of hyperglycemia during Ramadan decreased several folds to one ninth of that before Ramadan, more than the incidence of hypoglycemia, which decreased by a third.

Furthermore, our tele-monitoring support lasted till post-Ramadan throughout the festive period when the glucose surges were expected. We continued monitoring till post-Ramadan visit to close the loop for the care plan. Hence, we ensured that the participants revert to their treatment regimen for nonfasting periods, and reviewed their self-management experience during fasting to encourage self-empowerment throughout the nonfasting months and maintenance of improved glycemic control. In addition, we reiterated knowledge gained and experience for nonobligatory fasting practiced outside of Ramadan.

An important aspect of this program is that we ensured that our dedicated team members could overcome the concerning barriers of language, religion and culture in a Muslim-minority country where such resources are scarce.

Conclusion

In our program with focused risk assessment, diabetes education, individualized medication adjustment, tele-monitoring support and intervention from pre-Ramadan to post-Ramadan, there was improved glycemic control, with reduced diabetes complications when comparing pre-Ramadan and post-Ramadan in a varied high-risk population in a Muslim-minority country.

Further studies are needed to evaluate the cost effectiveness of culturally adapted programs with tele-monitoring to support a large population of Muslims with diabetes fasting during Ramadan. In addition, further prospective studies are needed to evaluate the impact of focused peer support groups for reducing the use of healthcare resources, and the impact of these learned culturally adapted self-management skills and tele-monitoring on maintaining glycemic control for improved long-term outcomes, especially in this population with higher diabetes prevalence and complications.

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Conflict of interest statement

The authors declare that there is no conflict of interest.

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References

1. Azizi F. Islamic fasting and health. *Ann Nutr Metab* 2010; 56: 273–282.
2. Padgett D, Mumford E, Hynes M, *et al.* Meta-analysis of the effects of educational and psychosocial interventions on management of diabetes mellitus. *J Clin Epidemiol* 1988; 41: 1007–1030.
3. Salti I, Bénard E, Detournay B, *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: 2306–2311.
4. Al-Arouj M, Bouquerra R, Buse J, *et al.* Recommendations for management of diabetes during Ramadan. *Diabetes Care* 2005; 28: 2305–2311.
5. Hassan A, Meo SA, Usmani AM, *et al.* Diabetes during Ramadan – pre-approach model: presentation, risk stratification, education. *Eur Rev Med Pharmacol Sci* 2014; 18: 1798–1805.
6. Bravis V, Hui E, Salih S, *et al.* Ramadan Education and Awareness in Diabetes (READ) programme for Muslims with type 2 diabetes who fast during Ramadan. 2010; 27: 327–331.
7. Ahmedani 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; 29: 709–515.
8. Yeoh ECK, Zainudin SB, Loh WN, *et al.* Fasting during Ramadan and associated changes in glycaemia, caloric intake and body composition with gender differences in Singapore. *Ann Acad Med Singapore* 2015; 44: 202–206.
9. Masood SN, Alvi SF, Ahmedani MY, *et al.* Comparison of Ramadan-specific education level in patients with diabetes seen at a primary and a tertiary care center of Karachi-Pakistan. *Diabetes Metab Syndr* 2014; 8: 225–229.
10. Ahmed MH and Abdu TAM. Diabetes and Ramadan: an update on use of glycemic therapies during fasting. *Ann Saudi Med* 2011; 31: 402–406.
11. Lee SWH, Lee JY, Tan CSS, *et al.* Strategies to make Ramadan fasting safer in type 2 diabetics. *Medicine (Baltimore)* 2016; 95: e2457.
12. Babineaux SM, Toaima D, Boye KS, *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: 819–828.
13. Hassanein M, Al-Arouj M, Hamdy O, *et al.* Diabetes and Ramadan: practical guidelines. *Diabetes Res Clin Pract* 2017; 126: 303–316.
14. Lee JY, Lee SW, Nasir NH, *et al.* Diabetes telemonitoring reduces the risk of hypoglycaemia during Ramadan: a pilot randomized controlled study. *Diabet Med* 2015; 32: 1658–1661.
15. Lee JY, Wong CP, Tan CSS, *et al.* Telemonitoring in fasting individuals with type 2 diabetes mellitus during Ramadan: a prospective, randomized controlled study. *Sci Rep* 2017; 7: 10119.
16. Zainudin SB, Ang DY and Soh AWE. Knowledge of diabetes and safe practices during Ramadan fasting among Muslim patients with diabetes in Singapore. *Singapore Med J* 2017; 58: 246–252.
17. Gaborit B, Dutour O, Ronsin O, *et al.* Ramadan fasting with diabetes: an interview study of inpatients' and general practitioners' attitudes in the South of France. *Diabetes Metab* 2011; 37: 395–402.
18. Ilkilic I and Ertin H. Ethical conflicts in the treatment of fasting Muslim patients with diabetes during Ramadan. *Med Health Care Philos* 2017; 20: 561–570.
19. Almansour HA, Chaar B and Saini B. Fasting, diabetes and optimizing health outcomes for Ramadan observers: a literature review. *Diabetes Ther* 2017; 8: 227–249.
20. Lee JY, Wong CP, Tan CSS, *et al.* Type 2 diabetes patient's perspective on Ramadan

fasting: a qualitative study. *BMJ Open Diabetes Res Care* 2017; 5: e000365.

21. Patel NR, Kennedy A, Blickem C, *et al*. Having diabetes and having to fast: a qualitative study of British Muslims with diabetes. *Health Expect* 2015; 18: 1698–1708.
22. Mygind A, Kristiansen M, Wittrup I, *et al*. Patient perspectives on type 2 diabetes and medicine use during Ramadan among Pakistanis in Denmark. *Int J Clin Pharm* 2013; 35: 281–288.
23. Zainudin SB and Hussain AB. The current state of knowledge, perception and practice in diabetes management during in Ramadan by healthcare professionals. *Diabetes Metab Syndr* 2018; 12(3): 337–342.
24. Ministry of Health, Singapore. National Health Survey 2010, Published November 2011. https://www.moh.gov.sg/content/moh_web/home/Publications/Reports/2011/national_health_survey2010.html (accessed 29 December 2017).
25. Loh PY, Toh MPHS, Molina JA, *et al*. Ethnic disparity in prevalence of diabetic kidney disease in an Asian primary healthcare cluster. *Nephrology* 2015; 20: 216–223.
26. Al-Arouj, Assaad-Khalil S, Buse J, *et al*. Recommendations for management of diabetes during Ramadan: update 2010. *Diabetes Care* 2010; 33: 1895–1902.
27. Sokol R and Fisher E. Peer support for the hardly reached: a systemic review. *Am J Public Health* 2016; 106(7): e1–e8.
28. Ibrahim M, Abu Al Magd M, Annabi FA, *et al*. Recommendations for management of diabetes during Ramadan: update 2015. *BMJ Open Diabetes Res Care* 2015; 3: e000108.
29. Department of Statistics, Singapore. Key Household Income Trends, http://www.singstat.gov.sg/publications/publications-and-papers/population#household_income (2016, accessed 24 November 2017).
30. Liu Y, Han Y, Shi J, *et al*. Effect of peer education on self-management and psychological status in type 2 diabetes patients with emotional disorders. *J Diabetes Investig* 2015; 6: 479–486.
31. Pinelli NR and Jaber L. Practices of Arab American patients with type 2 diabetes mellitus during Ramadan. *J Pharm Pract* 2011; 24: 211–215.