

Impact of Pre-Ramadan Intervention Program on Diabetic Patients (PRINTED 1): A Randomised Controlled Trial in a Family Medicine Clinic - Abu Dhabi

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Abstract

Fasting during the month of Ramadan carries risk for some diabetic patients. Many Guidelines recommend providing pre-Ramadan structured education to all diabetic patients who intend to fast during Ramadan.

The aim of this study was to evaluate the effectiveness of a Pre-Ramadan structured educational program for diabetic patients. Before Ramadan, patients were risk stratified into low, moderate, high and very high risk for fasting in Ramadan. The content of the program was adapted from DAR/IDF guidelines and was delivered during patient-physician clinical encounters. This included: a medication review, categorization of patients individual fasting risk, as well as advice on risk of fasting for high risk groups, nutrition plan, monitoring of blood glucose and when to break the fast.

Methods: A Randomized single blinded control trial was conducted in Al Bateen Primary Healthcare clinic in Abu Dhabi, Ambulatory Health Services (AHS). Patients were allocated randomly to either an intervention or control group; 60 diabetic patients were chosen using simple randomization. The intervention group received a pre-Ramadan structured educational program by a trained family physician. The control group received standard/usual diabetic care. Pre/Post-Ramadan data was collected for both groups. Comparison between both groups was done using Chi-square test and independent samples Student's t-test; $p \leq 0.05$ was considered statistically significant.

Results: A total of 60 diabetic patients were included in the study: 30 patients in the intervention group and 30 patients in the control group. The duration of diabetes was 14.28 (SD±11.44) years in the study group and 10.52 (SD±6.94) years in the control group; mean years of age was 55.83 (SD±13.71) in the study group and 56.76 (SD±14.98) years in the control group. Approximately 90% of patients in each of the groups intended to fast during the forthcoming month of Ramadan. Approximately 33% of patients in each group intended to modify their medication during Ramadan. In terms of patient risk stratification for fasting amongst the two groups, there was no statistically significant difference: each group contained approximately one third low risk, one third high risk and one third very high-risk patients. The frequency of pre-study hypoglycemia was approximately similar, 40% intervention v 33% control in both groups. Medications were physician reviewed and modified when necessary

in all patients (100%) in the intervention group. In the control group 11 patients (36.6%) had their medications modified, either self-modification or by their health care providers. ($P < 0.5$).

The pre-study frequency of hypoglycemia was 12 (40%) in the intervention group and 15 (33%) in the control group ($p > 0.05$). In the intervention group, the frequency of hypoglycemia decreased significantly from 40% before the study to 16.7% during the study period (50.15% reduction) (P was 0.003). In the control group, the incidence of hypoglycemia remained the same (33.3%) before and during the study period. There was more than 50% reduction of post intervention hypoglycemia in the study group ($p < 0.003$).

In terms of dietary food intake and exercise practices during Ramadan, there was no significant difference between the intervention and control groups. There was also no significant difference in the mean score of knowledge of hypo/hyper-glycaemia symptom awareness, or when the fast should be broken. Pre-/post-Ramadan biomedical parameters changes including lipids, eGFR, BMI, HbA1c and blood pressure BP were statistically insignificant in both groups. The Mean number of days fasted during this Ramadan was 27(±7.1) in the study group and 28 (±6.3) in the control group.

Conclusions: A pre-Ramadan structured educational program as per IDF/DAR guidelines for diabetic patients who intend to fast in Ramadan, significantly reduces their risk of hypoglycemia by up to 50%. The physician review and modification of medications, in accordance with guidelines is one of the most important factors in reducing the frequency of hypoglycemia.

Key Words: Diabetes, Ramadan, randomized controlled trial, Focused Education, hypoglycemia

Introduction

Fasting in the holy month of Ramadan is one of the five pillars of Islam. All healthy Muslims are obliged to fast during Ramadan each year once they reach puberty. Individuals must refrain from eating, drinking, and using oral medication between dawn and sunset. Depending on the season and geographic setting, the duration of the daily fast may range from 12 to 20 hours, around 15 hours in Abu Dhabi in 2017. Ramadan fasting has several potential benefits particularly to healthy individuals but may adversely affect sick patients including those with Diabetes Mellitus (DM). Adverse effects which may affect patients with DM during Ramadan fasting include hypoglycemia, hyperglycemia, diabetic ketoacidosis, dehydration, and increased risk of thrombosis, resulting in stroke and retinal artery occlusion.(1) Patients with DM are classified as low risk/moderate risk, high risk, and very high risk for the development of such complications. Those in the categories of high risk and very high risk are usually advised not to fast.(2) In general, the Quran exempts an individual from fasting if the health of that individual can be adversely affected by fasting (3).

All patients with diabetes wishing to fast during Ramadan should receive proper counseling 1-2 months before the onset of Ramadan. Asking the patients not to fast, even though it may be based on scientific evidence, may not only lead to the patient fasting without telling his doctor but may also offend the patient's cultural values. The physicians should work with their patients to prepare an appropriate and individualized life-style, diet and drug plan (4).

The EPIDAR study showed that fasting during Ramadan increased the risk of severe hypoglycemia (defined as hospitalization due to hypoglycemia) some 4.7-fold in patients with type 1 diabetes and 7.5-fold in patients with type 2 diabetes. Severe hypoglycemia was more frequent in patients in whom the dosage of oral hypoglycemic agents or insulin was changed and in those who reported a significant change in their life style.(5)

The READ study demonstrated that Ramadan-focused education in diabetes can empower patients to change their lifestyle during Ramadan. It minimizes the risk of hypoglycemic events There was a significant decrease in the total number of hypoglycemic events in group A (those who attended a structured education program about physical activity, meal planning, glucose monitoring, hypoglycemia, dosage and timing of medications), from nine to five, compared with an increase in group B (who did not attend the program) from nine to 36 ($P < 0.001$) (6).

A prospective nonrandomized interventional controlled design was run in three phases: before, during, and after Ramadan on 262 type 2 diabetes patients and demonstrated that Ramadan educational program had a positive impact with reduction of hypoglycemic risk, HbA1c, and low-density lipoprotein cholesterol (7).

Another prospective interventional controlled design was carried out on patients with type 2 diabetes. There was a significant impact of pre-Ramadan educational program on reduction of hypoglycemic risk and other acute complications, reduction of low-density lipoprotein cholesterol and improvement of high-density lipoprotein cholesterol (8).

The results of a systematic review which included Randomized Controlled Trials (19 trials)(9,378 participants) showed that structured diabetes education has a positive impact on biomedical and quality of life on diabetic patients especially with some degree of reinforcement at additional points of contact (9).

The randomized controlled trial (RCT) is considered to provide the most reliable evidence on the effectiveness of interventions because the processes used during the conduct of an RCT minimize the risk of confounding factors influencing the results. Because of this, the findings generated by RCTs are likely to be closer to the true effect than the findings generated by other research methods (10).

Effectiveness of such educational programs has not been well studied in a randomized controlled study. The aim of this study was to evaluate the effectiveness of RCT of pre-Ramadan educational program to patients attending one of the Family Medicine clinics, Ambulatory Health Care Abu Dhabi Health Services Company - SEHA.

Objectives

1. To assess the risks of fasting during Ramadan among diabetic patients
2. To assess fasting pattern among diabetic patients.
3. To evaluate patients with diabetes knowledge, attitude and practices during Ramadan fasting regarding safe fasting.
4. To educate diabetic patients regarding adjusting medications, risk of fasting, indications to break fasting, meal plans, and exercise.
5. To assess impact of pre-Ramadan intervention program on improving Diabetic patients' knowledge on safe fasting reducing hypoglycemia, and biomarkers namely: lipids, eGFR, blood pressure, BMI, HbA1c level.

Methods

1. **Study Design:** A Randomized controlled study was conducted in a primary care clinic, Ambulatory Health Care.
2. **Study Population:** Patients who presented to Al Bateen Family Medicine Clinic with physician-diagnosed Diabetes based on the A1C above or equal 6.5% and met the inclusion and exclusion criteria were included in the study.
Inclusion Criteria were: Adult (above 18) diabetic patients and willing to fast during Ramadan.
Exclusion criteria were: Patients who were not willing to fast during Ramadan.

3. Sample size: Based on patients' inclusion and exclusion criteria and 21.7% anticipated frequency of hypoglycemia in fasting patients at 95% confidence interval (11). Sample size was estimated to be 60 diabetic patients, 30 in each group.

4. Randomization: First 30 eligible patients with diabetes who attended the clinic were included in the intervention group and the second 30 eligible patients with diabetes who attended the clinic were included in the control group.

5. Patient Informed consent was obtained before study; AHS research and ethical committee approval was obtained.

6. Socio demographic characteristics including age, gender, education, diabetes duration, smoking, attended structured Ramadan management program, planning to fast this Ramadan, were included in the interview questionnaire.

7. Pre-Ramadan diabetes education included the following 6 Key areas (Face to Face education during consultation) according to IDF/DAR recommendations(4).

- 1 -Risk quantification
- 2 -Blood glucose monitoring
- 3 -Fluids and dietary advice
- 4- Exercise
- 5- Medication adjustments during fasting
- 6 -When to break the fast

8. Risk Quantification: Patients were categorized into three categories based on DAR IDF classification of Fasting risk(4):

- Category 1 (very high risk),
- Category 2 (high risk)
- Category 3 (moderate/low risk)

Patients in categories 1 and 2 were advised not to fast while patients in category 3 were allowed to fast if they wish. Doctors were aware that fasting during Ramadan is a personal decision and many patients, in spite of their awareness of the risk, chose to fast against medical advice. This decision was respected, and the patient was given advice and support that allowed them to fast as safely as possible.

9. Medical nutrition education during fasting in Ramadan: was adapted from DAR SAFA medical nutritional therapy, Diabetes and Ramadan (DAR) Alliance (12).

Patients were advised to:

- Distribute the carbohydrate intake between Iftar and Suhoor meals
- Avoid drinks and deserts containing excess sugars. Fruits should be consumed instead.
- Drink plenty of water/fluids from Iftar to Suhoor
- Delay Suhoor to as late as possible
- Take regular light to moderate exercise such as brisk walking for 30 minutes
- Taraweeh prayers can be considered as part of the daily exercise plan.

The educational intervention included material and written brochures focused on Safe fasting in Ramadan, including signs and symptoms of hyper- and hypoglycemia, self-

monitoring of blood glucose, physical activity, nutritional advice when to break the fast.

10. Knowledge of hypo and hyperglycemia: The intervention group was educated regarding symptoms of hypoglycemia in terms of Trembling Sweating/chills, Palpitations, Hunger Altered mental status. Confusion, Headache and the symptoms of Hyperglycemia as well as Extreme thirst, Hunger, Frequent urination, Fatigue, Confusion, Nausea/vomiting, Abdominal pain. Each symptom scored one if answered right or zero if wrong; total score of hypoglycemia or hyper glycaemia ranged from 0 to maximum 7 out of 7.

11. Hypoglycemia assessment: All patients were evaluated regarding hypoglycemia by Hypoglycemic Health Association Hypoglycemia Questionnaire(13) introduced by the Hypoglycemic Health Association of Australia. The questionnaire was translated into Arabic; it included 10 questions to check hypoglycemia symptoms, including:

1. Become tired or exhausted.
2. Forget things easily.
3. Feel sleepy during the day.
4. Get down or depressed.
5. Get down over nothing.
6. Have trouble concentrating.
7. Get nervous or shaky.
8. Easily get angry.
9. Eat or crave sweets, or once used to.
10. Awaken during the night.

Total the number of ticks in each column for RARELY, OCCASIONALLY and USUALLY, calculated as follows:-

RARELY (Total) x 1 = _____
 OCCASIONALLY: (Total) x 2 = _____
 USUALLY: (Total) x 3 = _____
 Add together for TOTAL SCORE _____

If TOTAL SCORE IS:

Less than 8: Hypoglycemic disease is unlikely.

Between 8 to 15: Hypoglycemic disease is possible.

Above 15: Hypoglycemic disease is present.

12 Medication Review: During Ramadan medications are adjusted according to IDF/DAR guidelines and included a 20–30% reduction in dose in patients on insulin and sulphonylurea (4).

13. Written educational Arabic or English version of educational program was given to diabetic patients in the intervention group.

14. Statistical Analysis: data was entered in Excel Spreadsheet and analyzed using SPSS14 for Windows. Analysis used simple frequency distribution of key variables in the study. Comparison was made with selected base line demographic variable age gender educational status and socioeconomic status. The level of significance was set at $p < 0.05$. Data collected by the investigators was checked for consistency.

Results

A total of 60 patients (30 intervention group and 30 control group) with type 2 diabetes (women 10 (33.3%), men 20 (66.7%) in the control group, 15 (50.0%) women and 15(50.0%) in the study group) participated in this study. The mean diabetes duration was 14.28 (± 11.44) year in study group and 10.52 (± 6.94) years in control group; the patient mean age was 55.83 (± 13.71) in the intervention group and 56.76 (± 14.98) years. Both groups did not differ in baseline characteristics in terms of education, smoking and employment (Table 1).

Table 1: Socio-demographic characteristics

Variable	Study group 30	Control Group 30	Test Value	P Value
Mean age in years (SD)	55.83(± 13.71)	56.76(± 14.98)	t- 0.247	0.80
Mean Diabetes duration	14.28(± 11.44)	10.52(± 6.94)	t- 1.512	0.13
Gender				
1.Male	15(50.0%)	10(33.3%)	χ^2 - 1.714	0.19
2.Female	15(50.0%)	20(66.7%)		
Education				
1. No school	3(10.0%)	4(13.3%)	χ^2 - 4.919	0.42
2. Literacy classes	0 (0%)	1(3.3%)		
3. Elementary	7(23.3%)	6(20.0%)		
4. High school	12(63.2%)	7(36.8%)		
5. College	5(16.7%)	4(13.3%)		
6. Higher education	5(16.7%)	4(13.3%)		
Employment				
Employed	11(36.7%)	8(26%)	χ^2 - 0.693	0.40
Tobacco use				
Smoker	3(10.3%)	3(10.3%)	χ^2 - 0.000	1.00

χ^2 = Chi square test, t = Student t test, SD Standard Deviation

There was no statistically significant difference between study and control group in their intention to fast during Ramadan or in intention to modify their treatments (Table 2); 90% of both groups said that they will fast during the coming Ramadan and only one third of each group said that they will modify their medication before the coming Ramadan. Patients in both groups fasted most of Ramadan; the main reason for breaking the fast was hypoglycemia (Table 2).

Table 2: Days fasted in previous Ramadan and this Ramadan, patients whose medications had been modified before Ramadan

Variable	Study Group	Control Group	Test Value	P Value
Patients who had their medications modified before Ramadan	30 (100%) y	11(36.6%)	χ^2 -17.60	0.0027*
Patients who intended to fast during Ramadan	27(90%)	27(90%)	χ^2 -1.71	0.19
Mean number of days fasted in this Ramadan	27(± 1.1)	28(± 0.3)	t -0.56	0.57
Reasons for Not Fasting during Ramadan				
1-Hypoglycemia	8/19 (42.1%)	11/19(57.9%)	χ^2 -0.04	1.00
2-Hyperglycemia	1/19(11.1%)	1/19(11.1%)		

χ^2 = X² t = Student t test * Significant difference

Both intervention and control groups were similar in baseline characteristics in terms of medications used for treatment of diabetes. Almost half of patient were using oral medications only and the other half were using insulin plus oral medications (Table 3).

Table 3: Diabetes treatment medications

Diabetes medications	Study group	Control Group	Chi square	P value
Oral medications	14(48.3%)	17(58.6%)	0.698	0.719
Insulin only	3(10.3%)	3(10.3%)		
Oral medications and Insulin	12(41.4%)	9(31.0%)		

There was no significant difference between intervention and control group in terms of dietary food intake and exercise practices as shown in (Table 4). Approximately one third of control group had not received hypoglycemia education and more than 50 % were doing exercise as Taraweh prayer. Most patients in both groups used to drink enough fluids.

Table 4: Patients' practices regarding Dietary and physical activities in Ramadan

Practice	Study group	Control group	Chi square	P Value
Received dietary advice for fasting before Ramadan	30(100%)	8(32.0%)	1.059	.0058*
Food intake during Ramadan			1.072	0.585
1-increased	4(13.8%)	3(10.3%)		
2-decreased	12(41.4%)	7(24.1%)		
3-unchanged	13(44.8%)	19(65.5%)		
Sweets intake in Ramadan			2.639	0.267
1-increased	7(24.1%)	9(32.1%)		
2-decreased	8(27.6%)	3(10.7%)		
3-unchanged	14(48.3%)	16(57.1%)		
Suhoor (pre-dawn meal) contained high sugary or oily food	4(14.8%)	6(21.4%)	0.404	0.525
Usually have a large meal for Iftar?	12(41.4%)	9(32.1%)	0.605	0.437
Included plenty of fruit, vegetables and salads in your food?	22(75.9%)	22(75.9%)	0.000	1.000
Usually drink enough fluids in between Iftar and Suhoor?	29(100.0%)	25(89.3%)	3.280a	.070
Exercise (walking, Tarweeh payer etc.)	18(62.1%)	17(58.6%)	0.072	0.788

* Significant difference

Patients' knowledge regarding hypoglycemia was similar in both groups where the mean score of hypoglycemia knowledge in pre and post intervention study and control group were statistically not significant even in the intervention group as shown in (Table 5).

Table 5: Hypoglycemia and hyperglycaemia knowledge

Variable	study	control	t test	P value	95% Confidence Interval
Pre intervention Mean Score (SD) of hyperglycemia knowledge	1.58(±0.90)	1.48(±1.03)	3.242	0.20	0.54-2.33
Post intervention Mean Score (SD) of hyperglycemia knowledge	3.04(±1.8)	1.60(±1.3)	.334	0.74	0.52-0.72
Pre intervention Mean Score(SD) of hypoglycemia knowledge	2.64(±1.17)	2.16(±.898)	1.570	0.12	-.135-1.08
Post intervention Mean Score (SD) of hypoglycemia knowledge	3.09(±1.27)	2.33(±1.11)	2.081	0.04*	.023-1.48
Mean score of knowledge when to break the fast	2.8(±.847)	1.63(±.850)	0.761	0.04*	-.272-.605

* Significant difference

Approximately two thirds of each group checked their blood glucose during fasting without statistically significant difference between intervention and control group. There were statistically significant more patients in intervention group checked their blood glucose during fasting compared to control group before pre-dawn meal (Suhoor), mid-afternoon, pre sunset meal and at any time when feeling unwell as shown in (Table 6).

Table 6: Self-monitoring blood Glucose

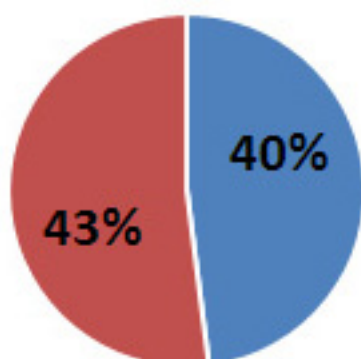
Variable	study	control	Test value	P value
Number of Patients who checked Blood Glucose During Fasting Hour	19/26(73.1%)	18/25(72.0%)	χ^2 0.699	0.12
Mean (SD) number of SMBG per day during Ramadan	2± (1.3)	1.3± (0.60)	t- test 0.57	0.02*
1. Pre-dawn meal (Suhoor)	17(56.7%)	8(26.7%)	χ^2 9.231	0.018*
2. Morning	6(20.0%)	5(16.7%)	χ^2 0.111	0.739
3. Midday	11(26.7%)	2(13.3%)	χ^2 1.667	0.197
4. Mid-afternoon	16(53.3%)	5(16.7%)	χ^2 8.864	0.003*
5. Pre-sunset meal (Iftar)	15(33.3%)	6(20.0%)	χ^2 1.364	0.043*
6. Two-hours after Iftar	3(10.3%)	1(3.4%)	χ^2 1.074	0.300
7. At any time when feeling unwell	16(53.3%)	8(27.6%)	χ^2 4.051	0.044*

χ^2 = chi square test, t = student t test, * significant difference

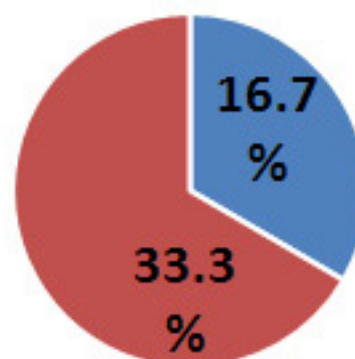
Table 7 and Figure 1: show the frequency of hypoglycemia symptoms. There was no significant difference in hypoglycemia symptoms in both groups before Ramadan and before the intervention program. The impact of the intervention program in reducing the frequency of hypoglycemia is presented in Table 8, and Figure 2; there was significantly less hypoglycemia in the study group compared to the control group.

Table 7: Pre-intervention frequency of hypoglycemia before fasting during Ramadan

Hypoglycemia	Number/percent	Group		Chi square	P Value
		Study30	Control028		
Unlikely	Number (%)	6(20.0%)	7(23.3%)	11.627	0.579
Possible	Number (%)	12(40.0%)	11(36.6%)		
Present	Number (%)	12(40.0%)	13(43.3%)		

Figure 1 : Hypoglycemia frequency before Ramadan

■ intervention group ■ control group

Figure 2 : Hypoglycemia frequency during Ramadan

■ intervention group ■ control group

Table 8: Frequency of hypoglycemia during fasting for Ramadan

Hypoglycemia	Number/percent	Group		Chi square	P Value
		Study	Control		
Unlikely	Number (%)	19(63.3%)	6(20.0%)	1.094	0.003
Possible	Number (%)	6(20.0%)	14 (46.7%)		
Present	Number (%)	5 (16.7%)	10 (33.3%)		

Patients were stratified according to IDF DAR recommendation by their physician as low, moderate and high risk and very high risk of fasting during Ramadan. There was no statistically significant difference between the two groups; for total population the risk was approximately one third low risk, one third high risk and another one third very high risk (Table 9).

Table 9: Risk quantification of Fasting during Ramadan in study and control groups

Risk quantification	Number/percent	Group		Total	Chi square	P Value
		Study	Control			
Very high	Number (%)	9(30.0%)	13(43.3%)	22(36.7%)	1.08	0.42
High	Number (%)	11(36.7%)	9 (30.0%)	20(33.3%)		
Moderate/low	Number (%)	10 (33.3%)	8 (26.7%)	18(30%)		

There was no statistically significant difference in HbA1c among intervention or control groups either before or after the intervention; mean HbA1c was above 7% in all patients (Table 10).

Table 10: HbA1c before and after Ramadan in intervention and control group

Group	N	Mean	SD	t test	P value	95% Confidence Interval	
A1Cpre study	30	7.893	1.58	-.167	.868	-1.02	.87
control	25	7.972	1.92	-.164	.870	-1.04	.89
A1CPost study	20	7.465	1.24	-.236	.815	-.96	.76
control	24	7.566	1.54	-.241	.811	-.95	.74

(Table 11) Biochemical marker showing no significant difference in blood pressure, lipids, BMI, A1c or eGFR could be demonstrated. Pre Ramadan mean A1c was 7.89 % in intervention group and was 7.97 % in control group, After intervention (post Ramadan) A1c was 7.46% in the intervention group and was 7.56% in the control group. Pre Ramadan BMI was 31.09 in the intervention group and was 32.88 in the control group. Post Ramadan BMI was 30.05 in the intervention group and was 33.00 in the control group.

Table 11: Biochemical marker changes before and after Fasting during Ramadan

Variable		Mean	(SD)	T test	P - Value	95% Confidence Interval	
TC pre intervention	study	3.95	1.03	-1.360	.180	-0.983	0.189
	control	4.35	1.12				
TC Post intervention	study	4.62	2.61	.693	.492	-.77107	1.57503
	control	4.21	00.86				
HDL pre intervention	study	1.10	00.39	-1.075	.287	-.2978	.0900
	control	1.21	00.30				
HDL Post intervention	study	1.15	00.26	-.895	.376	-.24735	.09561
	control	1.23	00.27				
LDL pre intervention	study	2.16	00.87	.067	.946	-.466	.499
	control	2.14	00.73				
LDL Post intervention	study	2.20	00.95	-.144	.886	-.58255	.50522
	control	2.24	00.69				
TG pre intervention	study	1.84	1.11	-.403	.689	-.97382	.64876
	control	2.01	1.73				
TG Post intervention	study	1.54	00.56	-1.077	.289	-.92546	.28481
	control	1.86	1.09				
eGFR pre intervention	study	86.86	24.46	1.162	.251	-6.340	23.718
	control	78.17	28.88		.		
eGFR Post intervention	study	89.67	25.43	1.990	.054	-6.340	23.718
	control	73.40	20.00				
Wt pre intervention	study	79.95	14.03	-1.178	.244	-12.2661	3.1955
	control	84.48	13.70				
Wt Post intervention	study	78.49	15.93	-1.219	.230	-14.548	3.591
	control	83.97	13.82				
BMI pre intervention	study	31.09	5.44	-1.144	.258	-4.93117	1.34917
	control	32.88	6.03				
BMI Post intervention	study	30.05	4.64	-1.906	0.063	-.538	.496
	control	33.00	5.39				

TC: total cholesterol, HDL: High density Lipoprotein, LDL: Low density Lipoprotein, TG: Triglycerides, eGFR: estimated glomerular filtration rate, Wt : Weight, BMI : Body Mass Index

Discussion

This is the first randomized controlled trial to evaluate the impact of focus pre Ramadan education and reviewing medications for diabetic patients who were wishing to fast during Ramadan. There are many studies that have evaluated the effect of pre-Ramadan health education for safe fasting and medications adjustment (6,7,12,15,16,17,18), although these studies demonstrated positive effects on reducing acute complications i.e. hypoglycemia, hyperglycemia, diabetic ketoacidosis or dehydration, most of these studies were observational, case control or pre-post evaluation of the same group. These studies led to safer fasting during Ramadan, weight loss, and improved glycemic control among the intervention group. The care provided in some of the interventions, however, was not standardized; and some studies did not attempt to quantify the effect of interventions. None of these studies had a robust design and response rates were either low or not provided. Power calculations were not reported in many instances. None of the included interventions were large robust randomized control trials (RCTs); some were pre-post studies and others were parallel group quasi-experimental studies (19).

Intervention research in this area requires robustly designed and structured interventions that can be tested in different contexts. A literature review study revealed many gaps regarding diabetes management in Ramadan. Health professionals are willing to provide services for fasting diabetes patients but need upskilling. In our study we tried to evaluate the impact of a pre-Ramadan simple, face to face, concise and clear message for safe fasting and medication adjustment in a RCT that has shown less hypoglycemia episodes in intervention group compared to control group (20).

Ramadan-focused education was shown to be beneficial in reducing hypoglycemia in observational studies but not RCTs (0.25 versus 1.00). Ramadan-focused education shows to be a promising strategy but more rigorous examination from RCTs are required (19, 21, 22).

Our study demonstrated that most of the participants in each group fasted almost all Ramadan month days. Mean number of days fasted in this Ramadan was 27 (SD7.1) in the study group and was 28 (SD6.3) in the control group. These results are similar to those found in the CREED study (11), which demonstrated Fasting by ADA risk status during Ramadan. The average number of days fasted according to ADA risk status for the Type 2 cohort was 27.4 (low risk), 26.9 (moderate risk), 27.5 (high risk), and 25.3 (very high risk). The range for average number of days fasted per region was: Asia, 27.4 (low risk) to 25.7 (very high risk); Middle East, 29 (low risk) to 27 (very high risk); North Africa, 29.1 (low risk) to 25.4 (very high risk); and Europe, 24.3 (moderate risk) to 21 (very high risk) (23). Approximately 76% of participants reported fasting during Ramadan; moreover, the medication dosage and timing had changed for 71% of diabetic patients during this same period (24).

In this study the base line frequency of pre-Ramadan hypoglycemia was (40.0%) in the control group and was (33.3%) in the study group before the intervention; there was no significant difference in hypoglycemia symptoms in both groups before Ramadan and before the intervention program. Baseline rate of hypoglycemia in our study was similar to the incidence of hypoglycemia in many other studies (5,6,13,14). Hypoglycemia frequency was significantly reduced to 16.7% in the intervention group; after intervention, it was almost 50% reduction in hypoglycemia incidence in the intervention group which can be considered as a great improvement in fasting Ramadan safety, putting into consideration that fasting during Ramadan in diabetic patients without medical advice increases risk of hypoglycemia by 7.5-fold in patients with type 2 diabetes (5).

In our study incidence of symptomatic hypoglycemia before Ramadan and before the intervention was nearly similar (43.3% in the intervention group, 40.0% in the control group). After the intervention program the incidence of hypoglycemia was significantly reduced in the intervention group (16.7%) compared to the control group (33.3%); almost 50% reduction. Although hypoglycemia was evaluated by symptoms only and not by documentation of low blood glucose, this assessment was conducted using validated hypoglycemia questionnaire. Moreover the questionnaire was translated to Arabic language. Symptomatic hypoglycemia in fasting patients was evaluated in other studies (24) which showed higher rates of symptomatic hypoglycemia seen in 8.3% of patients with type 1 diabetes and in 60.3% of patients with type 2 diabetes. Hypoglycemia assessment in a later study was very subjective and based on one question (Did you experience the symptoms of hypoglycemia?) which could be interpreted in different ways by different patients which reduces result validity.

In our study, regarding diabetes treatment, 10.3% of patients in both groups were on insulin therapy; 14 (48.3%) study group and 17 (58.6%) in control group were on oral glucose-lowering agents (OHAs), and 12 (41.4%) in the study group and 9 (31.0%) in the control group were on combined oral medication (OHA) and insulin therapy. These results are consistent with results of a study conducted by Jabbar et al, they found that the proportion of participants on oral anti-diabetic medication alone ranged from 68.4% (Middle East) to 80.5% (Asia); the proportion on insulin alone ranged from 3.7% (Middle East) to 8.6% (Europe) (25).

In this study the most effective strategy to reduce hypoglycemia was focused pre Ramadan education and medication review which was adapted from DAR /IDF which reduced frequency of hypoglycemia from 33.3% to 16.7% (50.15% reduction). Ramadan-focused education was shown to be beneficial in reducing hypoglycemia in observational studies but not RCTs (0.25 versus 1.00) (26).

Our study demonstrated that there was no significance difference in anthropometric and biochemical parameters including lipid profile, weight, BMI eGFR and HbA1c in baseline and after the study. Our results were not consistent with results of a study(27) that found significant reduction after fasting during Ramadan among those who received individualized education, their body mass index (-1.1 ± 2.4 kg/m² vs -0.2 ± 1.7 kg/m², $p < 0.0001$) and glycated hemoglobin ($-0.7 \pm 1.1\%$ vs $-0.1 \pm 1.3\%$, $p < 0.0001$) after Ramadan. The explanation of discrepancy between our results and results in other studies regarding anthropometric parameters may be attributed to study design; we conducted RCT but others were observational studies or a short duration study which was conducted in 4 weeks (Ramadan month).

Study limitations: Symptomatic assessment of hypoglycemia was main tool to assess hypoglycemia during fasting; further studies are needed to assess hypoglycemia by monitoring and documenting blood glucose documenting. As sample size was small, further study is needed also in more patients to increase study power.

Conclusions: A pre-Ramadan structured educational program as per IDF/DAR guidelines for diabetic patients who intend to fast during Ramadan, significantly reduces their risk of hypoglycemia by up to 50%. The physician review and modification of medications, in accordance with guidelines is one of the most important factors in reducing the frequency of hypoglycemia.

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