Original Article

Fasting during Ramadan and Associated Changes in Glycaemia, Caloric Intake and Body Composition with Gender Differences in Singapore

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Abstract

Introduction: Millions of Muslim patients with diabetes mellitus (DM) fast during Ramadan. However, little is known about the metabolic impact of Ramadan fasting. We aimed to study the changes in body composition and metabolic profile in this group of patients. Materials and Methods: We studied 29 Southeast Asian Muslim patients with type 2 diabetes; all underwent pre-Ramadan education. Study variables were weight change, body composition (using multifrequency bioimpedance method, InBody S20®, Biospace, South Korea), blood pressure (BP), glycated haemoglobin (HbA1c), fasting lipid profile, and caloric intake assessment using FoodWorks® nutrient analysis software. Results: Twenty-three subjects fasted ≥15 days; mean ± SD: 57 ± 11 years; 52% were males. HbA1c improved significantly (8.6 ± 2.4% pre-Ramadan vs 8.0 ± 2.3% end-Ramadan, *P* = 0.017). Despite similar body weight, there was reduction in body fat mass (BFM) (30.9 ± 11 kg vs 29.2 ± 12.2 kg, *P* = 0.013). Multivariate analysis suggested that the reduction in HbA1c was attributed by reduction in BFM (β = -0.196, *P* = 0.034). There was no change in visceral adiposity (visceral fat area (VFA)) but stratification by gender showed a reduction amongst females (137.6 ± 24.5 cm^2 to 132.5 ± 25.7 cm^2, *P* = 0.017). These changes occurred despite similar total caloric intake (1473.9 ± 565.4 kcal vs 1473.1 ± 460.4 kcal, *P* = 0.995), and proportion of carbohydrate (55.4 ± 6.3% vs 53.3 ± 7.5%, *P* = 0.25) and protein intake (17.6 ± 4.1% vs 17.3 ± 5.4%, *P* = 0.792), before and during Ramadan respectively, but with increased proportion of fat intake (11.9 ± 2.4% vs 13 ± 11.7%, *P* = 0.04). Seven out of 23 patients had medications adjusted to avert symptomatic hypoglycaemia but none of the patients developed severe hypoglycaemia. Conclusion: Ramadan fasting can be practiced safely with prior patient education and medication adjustment. It also confers modest benefits on metabolic profile and body composition, especially among females.

Ann Acad Med Singapore 2015;44:202-6

Key words: Diabetes, Education, Muslims

Introduction

Muslim individuals worldwide participate in obligatory abstinence from oral consumption of medications, food and liquid during the fasting month of Ramadan. Fasting during Ramadan is one of the 5 pillars of Islam. However, Islam exempts individuals whose health may be significantly affected from fasting. Despite this, up to 80%[1] of Muslim individuals with diabetes mellitus (DM) choose to fast during Ramadan and it is estimated that this figure is approximately 50 million Muslims globally. Singapore, a multi-ethnic country, has diverse religious beliefs and practices, and Muslims account for ~15% of the resident population.[2]

The Epidemiology of Diabetes and Ramadan (EPIDIAR) study, a large epidemiological study of Muslims with diabetes in 13 Muslim countries with over 12,000 participants, showed that severe hypoglycaemic episodes were significantly more frequent during Ramadan compared with other months, and less than half of the population changed their treatment dose when fasting.[1] Although having no overtly harmful effects, fasting during Ramadan has been observed to be associated with changes in lipid profile and body composition even in healthy individuals, which has been postulated to be due to either a change in nutritional habits during Ramadan or a response to

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starvation.[3,4] Notwithstanding its worldwide practice, the effect of fasting during Ramadan on metabolic profile and body composition in individuals with diabetes remains understudied with conflicting evidence in the literature.

The aim of our study was to assess the impact of Ramadan-associated fasting on glycaemic control, caloric intake, and body composition in people with diabetes in Singapore. In addition, we aim to evaluate the safety of fasting in this group of people with the provision of physician and dietician-guided advice on safe practices in fasting based on the recommendations by the American Diabetes Association.[5]

Materials and Methods

This prospective cohort study was conducted at a single-centre outpatient clinic. The protocol for the research project was approved by the ethics committee of our local Institutional Review Board and conforms to the provisions of the Declaration of Helsinki. All adult subjects (age ≥18 years) with type 2 diabetes by accepted criteria,[6] who expressed intention to fast for at least 15 days during the month of Ramadan, in addition to being deemed eligible for fasting during Ramadan based on the recommendations of their primary physician, were eligible for recruitment. Subjects with end-stage kidney disease, acute illness during Ramadan, and pregnancy were excluded from the study.

All subjects underwent educational sessions with a physician and a dietician according to the recommendations of the American Diabetes Association on management of diabetes during Ramadan.[5] These education sessions included advice on frequent monitoring of blood glucose levels and acute management of hypoglycaemia and hyperglycaemia. Adjustment in dosage and timing of medications was individualised to the patient and at the discretion of the physician. Nutritional advice and methods of estimation of portion sizes were taught by the dietician in order to have an estimation of daily caloric intake.

Subjects were provided with glucometers and blood glucose strips and instructed to chart their blood glucose readings 5 times per day: before pre-dawn meal (suhoor); 2 hours post suhoor; between 12 pm to 2 pm; before breaking fast (iftar); and 2 hours post-iftar to guide diabetes management. Hypoglycaemia was assessed via review of symptoms and these readings. Severe hypoglycaemia was defined as hypoglycaemia requiring third-party assistance or hospitalisation.[7]

Study variables included weight change, body composition as analysed by multifrequency tetrapolar bioelectrical impedance method (InBody S20®, Biospace, Seoul, South Korea), blood pressure (BP), glycated haemoglobin (HbA1c), and fasting lipid profile. Daily meal and snack intake was determined via a 3-day food diary with information on portion sizes, frequency of eating, and food preparation. Caloric assessment was performed using FoodWorks® nutrient analysis software (Xyris Software, professional version 6.0.2539, Brisbane, Australia). These study variables were obtained pre- (within 1 month) and at the end (final week) of Ramadan.

Biochemical analyses on blood investigations were carried out at our institution's referral laboratory, which is accredited by the College of American Pathologists. Plasma glucose was obtained by enzymatic methods using blood collected in fluoride oxalate tubes. Serum total cholesterol (TC), triglyceride (TG), high-density lipoprotein cholesterol (HDL-C) and low-density lipoprotein cholesterol (LDL-C) levels were measured using an automated analyser (Roche COBAS INTEGRA 700).

Statistical analyses with SPSS version 19.0 software (SPSS, Chicago IL, USA) were conducted using paired t-test (pre- and end-Ramadan parameters) and multiple-linear regression (dependent variable: end-Ramadan parameters e.g. HbA1c; independent variables: corresponding pre-Ramadan parameters and predictor of interest e.g. change in body fat mass). When subjects were stratified by gender, non-parametric Wilcoxon signed-rank test was used. A P value <0.05 was considered statistically significant.

Results

A total of 29 subjects were recruited. Twenty-three subjects (80%) fasted for at least 15 days and had complete follow-up data. Four subjects were lost to follow-up and the remaining 2 subjects did not complete Ramadan-fasting due to acute illness. Table 1 shows the baseline demographics of the study population.

Mean age of the subjects was 57 ± 11 years. Fifty-two percent were men and 87% were of Malay ethnicity. The majority (58.6%) of subjects were treated with oral anti-diabetic agents alone, whilst the remainder was on insulin therapy with or without combination oral antidiabetic agents. A significant proportion of our study population had long diabetes duration; duration of diabetes was less than 10 years in 37.9%, between 10 to 20 years in 31%, and longer than 20 years in 27.6% of subjects.

There was no severe hypoglycaemia or complications of hyperglycaemia in our study group. Medications were adjusted in 7 subjects during Ramadan, primarily to avert symptomatic hypoglycaemia, which was self-treated in all. In the 2 subjects who fasted for <15 days, one was hospitalised for urinary tract infection and the other had an upper respiratory tract infection that did not require hospitalisation.

At the end of Ramadan, HbA1c improved significantly (8.6 ± 2.4 to 8 ± 2.3%, P = 0.017). Despite not having

Table 1. Baseline Characteristics of Study Participants

Parameter	Whole Cohort	Men	Women	*P* Value
Population (n, %)	29 (100)	15 (52)	14 (48)	NA
Age (years)	57 ± 11*	61 ± 11*	54 ± 10*	0.095
Diabetes duration (%)				
Less than 10 years	39.2	26.7	53.9	0.499
10 to 20 years	32.1	40.0	23.1	
More than 20 years	28.6	33.3	23.1	
HbA1c (%)	8.6 ± 2.4*	8.6 ± 2.7*	8.6 ± 2.0*	0.988
BMI (kg/m^2)	30.3 ± 5.6*	30.7 ± 6.7*	29.9 ± 4.7*	0.734
Treatment (%)				
Oral agents	58.6	60.0	57.2	0.442
Insulin therapy	41.4	40.0	42.8	

BMI: Body mass index; NA: Not available
*Data are expressed as mean ± SD.

significant change in body weight ($P = 0.837$), we observed a modest but significant reduction in body fat mass (BFM) (30.9 ± 11 to 29.2 ± 12.2 kg, $P = 0.013$). Multivariate analysis suggested that the reduction in HbA1c was partly attributable to reduction in BFM (β = -0.196, $P = 0.034$). Table 2 shows the biochemical and body composition variables pre- and post-Ramadan.

As a group, visceral adiposity (visceral fat area (VFA)) did not change throughout Ramadan ($P = 0.273$). However, when stratified by gender, a significant reduction in VFA was seen amongst women ($P = 0.017$). There was no appreciable change in caloric intake between the fasting (1473.1 ± 460.4 kcal) and non-fasting (1473.9 ± 565.4 kcal) period ($P = 0.995$) although when stratified by gender, total caloric intake was ~20% lower in women compared to men during Ramadan (1599.2 ± 492.5 in men vs 1277 ± 342.9 kcal in women, $P = 0.102$) and women consumed ~9% less calories during Ramadan as compared to pre-Ramadan (1408.5 ± 529.2 pre-Ramadan vs 1277 ± 342.9 during Ramadan, $P = 0.441$), although these were not statistically significant. There was no significant change in proportion of carbohydrate and protein intake before and

Table 2. Biochemical and Body Composition Variables of Study Participants Pre- and End-Ramadan Fasting

Parameter	Men			Women					
	Pre-Ramadan (mean ± SD)	End-Ramadan (mean ± SD)	*P* Value†	Pre-Ramadan (mean ± SD)	End-Ramadan (mean ± SD)	*P* Value‡	*P* Value§	*P* Value‖	*P* Value¶
BMI (kg/m^2)	30.7 ± 6.7	30.4 ± 6.7	0.332	29.9 ± 4.7	29.8 ± 4.5	0.028*	0.734	0.814	0.023*
BFM (kg)	30.7 ± 12.9	28.6 ± 14.5	0.092	30.4 ± 8.6	30.0 ± 9.0	0.058	0.946	0.807	0.013*
VFA (cm^2)	148.0 ± 33.3	148.0 ± 38.5	0.534	137.6 ± 24.5	132.5 ± 25.7	0.017*	0.388	0.337	0.273
SBP (mmHg)	150.2 ± 18.9	148.3 ± 16.4	0.100	158.6 ± 26.5	147.6 ± 18.7	0.721	0.337	0.925	0.174
DBP (mmHg)	84.2 ± 9.3	87.2 ± 6.3	0.833	87.0 ± 10.8	81.8 ± 6.3	0.313	0.462	0.066	0.500
HbA1c (%)	8.6 ± 2.7	8.0 ± 2.8	0.059	8.6 ± 2.0	8.0 ± 1.6	0.066	0.988	0.976	0.017*
LDL-c (mmol/L)	2.62 ± 0.80	2.65 ± 0.78	0.299	2.98 ± 0.74	2.94 ± 0.84	0.678	0.215	0.399	0.741
TG (mmol/L)	2.09 ± 1.03	2.04 ± 1.33	0.826	2.00 ± 1.19	1.67 ± 0.95	0.050	0.831	0.471	0.361
HDL-c (mmol/L)	1.15 ± 0.30	1.19 ± 0.26	0.530	1.22 ± 0.33	1.26 ± 0.36	0.677	0.567	0.598	0.475

BFM: Body fat mass; BMI: Body mass index; DBP: Diastolic blood pressure; HDL-c: High-density lipoprotein cholesterol; LDL-c: Low-density lipoprotein cholesterol; SBP: Systolic blood pressure; TG: Triglyceride; WHR: Waist-hip ratio; VFA: Visceral fat area
*Indicates statistical significance, *P* value <0.05.
†Pre- and end-Ramadan comparison within men.
‡Pre- and end-Ramadan comparison within women.
§Pre-Ramadan comparison between gender.
‖End-Ramadan comparison between gender.
¶Mean changes as a group (including both men and women) pre and end-Ramadan.

during Ramadan although there was a significant increase in proportion of fat intake overall, with women having a higher proportion as compared to men during Ramadan ($P = 0.018$). Table 3 shows the dietary variables pre- and post-Ramadan.

A decrease in serum triglycerides was observed in women at end-Ramadan (near statistical significance, $P = 0.05$), which was not present in men ($P = 0.826$). There were no significant changes in blood pressure and other lipid parameters.

Discussion

Our observation shows that daylight fasting during the month of Ramadan appears to confer benefits on glycaemia and body composition, especially among women with type 2 diabetes, with improvement in HbA1c and a reduction in VFA. In addition, fasting during Ramadan is safe in a group of individuals who have received prior education on dietary counselling, glucose monitoring, and adjustment of medication dosage and timing.

Improvement in glycaemic control with HbA1c reduction was observed in the presence of decreased meal frequency, despite no appreciable change in overall total caloric intake. Total caloric intake during Ramadan has been shown to be similar to non-fasting periods in some studies despite the reduction in meal frequency,[8] whilst other studies have shown a decrease[9] or increase[10] in total caloric intake. These differences can be attributed to distinctive dietary habits in different countries and customs during the month of Ramadan.[9] Similarly, variable changes in glycaemic control have been reported;[11] with some showing no significant changes,[12] while others had improved[9] or worsened glycaemic control. Similarly, the increase in fat intake found in our study is concordant to previous findings,[11] where the decrease in carbohydrate intake is compensated for with an increase in fat intake without any appreciable change in daily caloric intake. Despite the reduction in meal frequency due to fasting, it is a common observation that people often overeat during the breaking fast meal.

Interestingly, our study found a gender-specific difference in the associated changes; with a higher fat intake, decreased BFM, and a significant reduction in VFA in women. These differences may be hypothesised to be due to increased fat oxidation in women during the fasting period,[13] supported by decreased serum triglycerides[11,14] at the end of Ramadan.

None of the subjects required hospitalisation for any of the acute complications of diabetes, such as hyperglycaemic emergencies (diabetic ketoacidosis or hyperosmolar hyperglycaemic state), hypoglycaemia or dehydration. Symptomatic hypoglycaemia occurred in 30% (7/23) of the subjects, and these were self-managed by the subjects with subsequent adjustment of medication dose by the physician. It is possible that the provision of patient education, active glucose monitoring, dietary counselling, and the review and adjustment of medication dosage and timing before

Table 3. Dietary Variables of Study Participants Pre- and End-Ramadan Fasting

Parameter	Men			Women					
	Pre-Ramadan (mean ± SD)	End-Ramadan (mean ± SD)	*P* Value†	Pre-Ramadan (mean ± SD)	End-Ramadan (mean ± SD)	*P* Value‡	*P* Value§	*P* Value‖	*P* Value¶
Daily energy intake (kcal)	1515.9 ± 603.1	1599.2 ± 492.5	0.510	1408.5 ± 529.2	1277.0 ± 342.9	0.441	0.667	0.102	0.995
Carbohydrates (gram)	222.0 ± 69.4	233.2 ± 86.6	0.636	189.6 ± 66.6	164.0 ± 48.3	0.260	0.281	0.041*	0.826
% of total energy intake	56.6 ± 5.2	55.3 ± 7.6	0.802	53.7 ± 7.6	50.3 ± 6.6	0.314	0.294	0.128	0.250
Protein (gram)	68.9 ± 28.0	66.0 ± 25.9	0.683	65.1 ± 27.2	56.7 ± 14.1	0.441	0.755	0.338	0.365
% of total energy intake	17.5 ± 4.6	16.9 ± 6.5	0.683	17.9 ± 3.5	17.9 ± 3.4	0.833	0.834	0.633	0.792
Fat (gram)	48.6 ± 26.8	51.5 ± 18.1	0.530	45.4 ± 17.6	46.0 ± 15.5	0.859	0.759	0.461	0.692
% of total energy intake	11.4 ± 2.5	12.3 ± 1.3	0.221	12.6 ± 2.1	14.0 ± 1.8	0.110	0.289	0.018*	0.040*

BFM: Body fat mass; BMI: Body mass index; DBP: Diastolic blood pressure; HDL-c: High-density lipoprotein cholesterol; LDL-c: Low-density lipoprotein cholesterol; SBP: Systolic blood pressure; TG: Triglyceride; WHR: Waist-hip ratio; VFA: Visceral fat area

*Indicates statistical significance, *P* value <0.05.

†Pre- and end-Ramadan comparison within men.

‡Pre- and end-Ramadan comparison within women.

§Pre-Ramadan comparison between gender.

‖End-Ramadan comparison between gender.

¶Mean changes as a group (including both men and women) pre and end-Ramadan.

and during the fasting month contributed to this positive outcome. The Ramadan Prospective Diabetes Study showed a similar observation that the majority of patients did not have any serious acute complications of diabetes during Ramadan with a reduction in frequency of hypoglycaemic episodes.[15] Similarly, the Ramadan Education and Awareness in Diabetes (READ) programme showed that a structured education programme about physical activity, meal planning, glucose monitoring, hypoglycaemia, dosage and timing of medications prevented weight gain in the group of patients who attended the programme as compared to a group that did not; along with a decrease in the total number of hypoglycaemic events.[16] Our study supports the findings of these studies that people with diabetes intending to fast during Ramadan should receive structured education. Healthcare professionals should also actively ask about the intention to fast among their Muslim patients with diabetes.

The limitations of our study include the small sample size, the absence of a control group, and the lack of physical activity quantification. The provision of diabetes education related to fasting may also contribute to the improvement in glycaemic control seen. Despite these limitations, this study presents important findings in view of a high prevalence of fasting in Ramadan among patients with DM.

Future studies involving larger sample sizes will be useful to confirm our findings and elucidate the determinants of these changes in body composition and metabolic profile as well as gender differences. It is tempting to speculate that these benefits may be attributable to changes in circadian rhythm[17] and physical activity with intensive prayer activity performed during the month of Ramadan.

Clinical practice indications of this study include promoting the provision of structured education for Muslims with diabetes in Singapore intending to fast during the month of Ramadan. Nutritional and dietary counselling is an essential component in the education package. Healthier alternatives to sugary fluids and sweet foods traditionally used to break fast should be advised to Muslims with diabetes along with avoidance of high saturated fat meals. In addition, it may be advisable to spread the daily caloric allowance over the non-fasting period to mitigate hyperglycaemic swings.

Conclusion

Ramadan fasting confers metabolic and glycaemic benefits (albeit modest) and can be practiced safely with appropriate patient education, blood glucose monitoring, adjustment of medication dose, and timing among Muslims with diabetes.

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