

The Impact of Fasting in Ramadan on Metabolic and Anthropometric Indices in Trained Type II Diabetic Patients: A Prospective Observational Study

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Abstract

Background: Fasting has certain effects on metabolic and anthropometric parameters in diabetic patients. It is, therefore, necessary for patients to receive proper education related to their physical activities, eating habits, blood glucose monitoring, and medications. The aim of this study was to investigate the effects of Ramadan fasting on metabolic and anthropometric indices in type II diabetic patients.

Methods: This prospective observational study was performed during Ramadan 2018. The study population consisted of diabetic patients who desired to fast and received information on physical activity, eating habits, blood glucose monitoring, and taking their medications before Ramadan. Fasting blood sugar (FBS), blood sugar 2-hour postprandial (BS2hpp), glycosylated hemoglobin (HbA1C), and the lipids profile were assessed before and after Ramadan month. FBS and BS2hpp were also evaluated on the fifteenth day of Ramadan. The significance level for data analysis was considered $p < 0.05$.

Results: Out of 40 diabetic cases who completed the study, 6 (15%) were male and 34 (75%) were female. The mean age of participants was 55.2 ± 9.3 years. The anthropometric variables, including weight, BMI, waist, and blood pressure, decreased significantly after Ramadan fasting ($p < 0.05$). FBS decreased significantly (125.1 ± 27.4 vs 105.2 ± 21.4 , $p < 0.0001$) and serum triglyceride increased significantly (127.5 ± 45.5 vs 166.5 ± 53.5 mg/dl, $p < 0.001$) after fasting compared to pre-Ramadan measurement. Other variables remained unchanged.

Conclusion: The results of this study indicate that type II diabetic patients who have controlled blood sugar and received information based on clinical guidelines about their lifestyle and medications can fast safely during the holy month of Ramadan.

Background

The majority of Iran's population is comprised of Muslims who fast during the holy month of Ramadan. Fasting during Ramadan is one of the obligatory duties of healthy people. Eating, drinking, and using oral medications is not allowed during fasting from dawn to sunset (when the fast is broken, also known as iftar) (1, 2). The religion of Islam has exempted people with chronic and morbid diseases from this duty as well as when fasting may make their health condition worse. However, most diabetic patients tend not to accept their illness (3) and it is not clear whether fasting is harmful for well-controlled diabetic patients or if it has positive effects on their health. Large sample studies (12914 people) in 13 Muslim countries have shown that approximately 43% of type I and 79% of type II diabetic patients fast for at least 15 days during Ramadan (4).

Fasting has a direct impact on diabetes control by effecting a change in lifestyle, meals, type of food, and medication timing. Insufficient metabolic control increases the risk of complications in diabetic patients and fasting in high-risk diabetics may lead to hypoglycemia, hyperglycemia, dehydration, or diabetic ketoacidosis. New eating patterns, due to fasting, increases the hypoglycemia risk 4.7 and 7.5 times in

type I and type II diabetic patients respectively. It also increases the risk of hyperglycemia in type II diabetes by up to five times (4–6). On the other hand, many studies have revealed that diabetic patients with good glycemic control before Ramadan had uncomplicated fasting (7). Diabetic subjects who desire to fast must be trained for physical activity, eating patterns, regular blood glucose monitoring, dose and timing of medications.

Primary care practitioners have an important role in diabetic care and family physicians could play for providing information, implementing guidelines and enhancing diabetic patients' care. This study aimed to investigate the effect of Ramadan fasting on metabolic and anthropometric indices in type II diabetic patients who were consulted by family physicians and had good control blood glucose before Ramadan.

Methods

This prospective observational study was conducted during Ramadan 2018. The study population was comprised of diabetic patients who were referred to academic outpatient diabetes clinics of Mazandaran University of Medical Sciences in Sari, Iran.

The patients were included in this study consecutively if they had been diagnosed with diabetes for at least one year, have $HbA1c \leq 8\%$ and desired to fast during Ramadan. Exclusion criteria were severe chronic diseases (kidney, liver, and heart failure based on patients' medical records), recent history of hypoglycemia, pregnancy, uncontrolled hypertension (up to 160 mmHg systolic or up to 100 mmHg diastolic blood pressure), smoking, use of medications that affect blood glucose or lipid profile (such as corticosteroids, oral contraceptive pills (OCP)), and fasting less than 15 days during Ramadan.

The patients who expressed their consent to participate in the study signed the consent form.

The thyroid, liver, and renal function status (TSH, LFT, Bun, and Cr) were extracted from the patients' latest medical records. For all the participants the basal state of blood glucose profiles consisted of fasting blood glucose (FBS), 2-hour postprandial glucose (BS2hpp), glycosylated hemoglobin (HbA1C), and lipids profile (cholesterol, HDL-C, LDL-C, TG), all of which were evaluated during one month before Ramadan (using Pars Azmoon Kit, Iran, and 24i Auto Analyzer, Japan). Fasting venous blood samples were collected from all the patients before the iftar on the 15th and the last day of Ramadan and blood glucose profiles were tested. The fasting lipids profiles were evaluated on the last day of Ramadan. The patients were requested to test their BS2hpp (two hours after the iftar) at home using a glucometer (Contour Plus glucometer from Bayer, Germany, Damoun Tajhiz Teb Company).

Before fasting, the patients were given nutrition counselling to improve their diet and physical activity for fasting by a nutritionist. In order to accurately record the number of the days the participants fasted, a timetable was given to all patients.

Height, weight, waist circumference, and hip circumference were determined before and after the intervention. Clara 803 cluster digital balance scale, with a precision of 0.01 g, was used to weigh the

patients. Height was measured using a Seca stadiometer without shoes with a sensitivity of 0.1 cm (Seca, Germany). Waist and hip circumference were measured using Seca strip model 201. All anthropometric measurements were performed according to the methodology provided by the World Health Organization (WHO) standards. During the study, the anthropometric indices were measured twice and the mean of the two measurements was entered. Body mass index (BMI) of the individuals was also obtained using the relevant formula ($BMI = \frac{\text{weight (kg)}}{[\text{height (m)}^2]$). The waist-to-hip ratio (WHR) was calculated by dividing the waist circumference into the hip.

Blood pressure (using Riester blood pressure device, Germany) was measured twice for each patient by a qualified nurse practitioner in the clinic (8).

The type and dosage of anti-diabetic drugs were adjusted and the instructions for using the medications were explained to each patient according to the Ramadan fasting guideline (3).

The participants were free to attend to one of the 4 sessions of training programs which were held prior to the Ramadan month. The duration of each session was 3 hours and the duration of consultation for each patient lasted an average of 40 minutes. A nutritionist explained the proper nutrition and physical activity during fasting. The internal medicine specialist instructed the patients about using their medications during the fasting period. The research fellow family physician explained to each patient individually about self-monitoring their blood glucose (SMBG), hypo and hyperglycemia symptoms, and home management of hypoglycemia in addition to the conditions where fasting should be stopped. All the patients were trained to SMBG and recommended to perform SMBG 4 times a day (before and 2 hours after iftar and dawn and any time there were signs of hypoglycemia). The patients were advised to break their fast if blood sugar was less than 70 or higher than 250 mg/dl during fasting. The family physician contacted all patients on the 15th and 29th of Ramadan for any questions or problems while fasting and also to remind and advise them to perform the laboratory and SMBG tests. To facilitate contact with the family physician, a full-time telephone line was available for the patients.

Descriptive statistics including percentages and frequencies were reported using demographic data. Paired t-test and repeated measure analysis of variance were used for normally distributed variables and Friedman and Wilcoxon tests for non-parametric variables. All statistical analyses were performed using SPSS software (version 24, IBM SPSS Statistics, Chicago, IL). The significance level was considered $p < 0.05$.

Results

At the beginning, 46 diabetic patients participated in the study, including 7 men and 39 women. Five patients were excluded from the study including four female patients (one suffering from lymphoma, one for severe hypertension, one for use of OCP, and one for serious fluctuations in blood glucose) and one male patient (suffering from coronary artery disease and angioplasty). Finally, a total of 40 people remained in the study, who included 34 (75%) females and 6 (15%) males.

Patient demographics and attributes are presented in Table 1. A large majority (n = 29; 72.5%) of the study subjects fasted for 30 days. The results of patients' anthropometric data before and after fasting are shown in Table 2.

Table 1: Patient demographics and attributes		
Patient characteristics		All (n=40)
Gender		
	male	7 (17.5%)
	female	33 (82.5%)
Age (year)		55.23 ± 9.29
Job		
	freelance	2 (5%)
	employed	4 (10%)
	housekeeper	30 (75%)
	retired	4 (10%)
Education		
	illiterate	9 (22.5%)
	under diploma	19 (47.5%)
	diploma and higher	12 (30.0%)
Laboratory data		
	AST(IU/L)	19.68 ± 9.22
	ALT(IU/L)	22 ± 14.43
	ALP(IU/L)	173.95 ± 52.12
	BUN(mg/dl)	23.6 ± 9.29
	Cr(mg/dl)	0.92 ± 0.18
	TSH(mIu/ml)	2.13 ± 1.1
Duration of diabetes (years)		7.5 ± 6.35
Medication		
	Metformin	38 (95%)
	Gliclazide	22 (55%)
	Repaglinide	3 (7.5%)
	Acarbose	10 (25%)
	Insulin	1 (2.5%)
	losartan	12 (30%)
	Metoral	7 (17.5%)

	Atorvastatin	26 (65%)
	ASA	17 (42.5%)

Table2: Anthropometric data of 40 type II diabetic patients before and after fasting.

Variable	Baseline	Day 30	p-value
	mean \pm SD	mean \pm SD	
Body mass index (BMI)	29.9 \pm 5.2	29.0 \pm 5.1	0.042
Weight (kg)	74.9 \pm 12.7	73.0 \pm 13.1	<0.001
Systolic blood pressure (mmHg)	118.5 \pm 10.6	113.8 \pm 9.4	0.018
Diastolic blood pressure (mmHg)	72.0 \pm 7.9	68.3 \pm 7.0	0.020
Waist to hip ratio	0.98 \pm 0.05	0.97 \pm 0.04	<0.001
Waist circumference (cm)	106.2 \pm 11.8	105.3 \pm 11.6	<0.001

Table3: Glycemic profile before fasting, on the fifteenth day, and after fasting for 30 days in 40 type II diabetic patients.

	Baseline mean \pm SD	Day 15 mean \pm SD	Day 30 mean \pm SD
FBS (mg/dl)	125.1 \pm 27.4	117.3 \pm 28.8*	105.2 \pm 21.4**
BS 2hpp (mg/dl)	180.8 \pm 51.7	176.1 \pm 62.0	178.6 \pm 60.5
HbA1C	6.3 \pm 0.7	-	6.5 \pm 0.7
* Pvalue=0.014 between day 15 and 30			
** p value <0.0001 between baseline and day 30			

As shown in Fig.1, the FBS trend decreased during the three time points, which was statistically significant (p<0.0001, one-way repeated measure ANOVA)

Table 4: Lipid profile before and after fasting for 40 type II diabetic patients.

	Baseline	Day 30	p-value
	mean ± SD	mean ± SD	
TG mg/dl	127.5 ± 45.5	166.5 ± 53.5	<0.001
Cholesterol mg/dl	154.8 ± 29.0	157.9 ± 39.6	0.601
HDL-c mg/dl	41.8 ± 7.0	40.0 ± 6.2	0.085
LDL-c mg/dl	81.9 ± 21.5	88.2 ± 29.2	0.141

Discussion

In this study, most participants had continuous 30-day fasting in Ramadan. No episode of hypoglycemia was reported. Every participant was being visited by the research team to adjust their medication dosage and were given counseling about lifestyle changes. Medical consultation before starting to fast has a protective effect against hypoglycemia. Therefore, it was essential to inform the patients about the importance of medical counseling (9, 10). Kalantari evaluated the impact of Islamic fasting on blood sugar level of type II diabetic subjects in Gilan province, Iran, 2007. Seventeen patients with type II diabetes (5 males, 12 females) who had oral medication or diet enrolled in the study. Their results elucidate that patients taking oral pills did not develop hypoglycemia (11).

Patients' weight, BMI, waist to hip ratio, and waist circumference reduced after one month of fasting in the current study. These results are consistent with the findings from other studies. In a study conducted by Bravis et al. in 2010, an average weight loss of 0.7 kg occurred in the case group vs 0.6 kg in the control group after Ramadan (p value < 0.001) (12). McEwen's study also showed a significant decrease in BMI and weight in the intervention group (-1.1 ± 2.4 kg/m² vs -0.2 ± 1.7 kg/m², p < 0.0001) (10). Another study by Khaled on anthropometric parameters and food consumption in 276 type II diabetic obese women in Algeria shows a significant decrease in weight at the end of Ramadan (1).

Evaluating the patients' lipid profiles in the present study before and after fasting showed a significant increase in the patients' triglycerides level. However, cholesterol, HDL, and LDL did not change significantly. The study of Zare on the effect of fasting during Ramadan on lipid profile showed a significant decline in TG, Cholesterol, LDL level, and elevation of HDL (13). Nonetheless, in Laajam's study, cholesterol levels significantly increased, but triglyceride remained unchanged (14). Khaled et al.'s survey on Ramadan fasting showed modifications of certain serum components in 60 obese women with type II diabetes, suggesting that fasting reduced HDL and increased cholesterol, triglyceride, and LDL,

which is consistent with the results of this study (15, 16). The elevation in blood TG in Ramadan fasting may be the result of increased fat tissues' lipolytic effect during Ramadan (16). Other possible causes of triglyceride increase in the present study could be due to decreased physical activity or sampling in the evening due to the nature of diurnal triglyceride changes (17).

In our study, a significant reduction in fasting blood sugar was observed during Ramadan. In addition, 2hpp blood sugar level did not show any significant difference between the beginning and the end of the month. Glycosylated hemoglobin (HbA1C) also increased slightly after Ramadan, which was not statistically significant.

In Kalantari et al.'s study, the mean FBS level before and during Ramadan was 152.35 ± 56.25 mg/dl and 140.18 ± 25.29 mg/dl, which showed a slight decrease and was not statistically significant (11). In a study by Katibi on blood sugar control among fasting Muslims with type II diabetes mellitus in 33 diabetic patients, there was a significant difference between blood glucose before and after Ramadan, and 76% of patients had better blood sugar levels compared to before Ramadan (18). The differences observed in various studies can be due to differences in study populations, such as participants' nutritional habits and even different durations of fasting, which may vary from one geographical location to another.

Zainudin conducted a study on diabetes training and modifying medication for self-management during Ramadan fasting with 29 participants (75.9% female and 24.1% male). Patients' HbA1C and weight at the end of the fasting period revealed a significant decrease (19). In a study by Laajam, none of the patients' sugar profile indexes changed (14). The study of M'guil focused on the safety of Ramadan fasting and its effect on the clinical and biochemical parameters of type II diabetes patients. The results showed that the blood sugar index did not change significantly at the end of the fasting period (20). In a study by Celik on the effects of Ramadan fasting on daily life and metabolic conditions of type II diabetic patients, 26 patients did not develop any changes in blood sugar indexes (21).

Another study by Nachvak et al. (20) on the effects of Ramadan on food intake, body composition, glucose homeostasis, and lipid profiles showed a significant decrease in blood glucose, body mass index, and weight at the end of Ramadan. Evaluation of food intake elucidated that the consumption of different food groups, except carbohydrates, decreased during Ramadan. The results from this study are consistent with our findings, but lipid profile was incompatible (22).

Yarahmadi studied anthropometric and biochemical variables of 57 type II diabetic patients during Ramadan. Their results indicate that body mass index and waist to hip ratio reduced in men but body mass index increased in women. On the other hand, blood pressure, fasting blood sugar, and serum fructosamine concentrations did not change during the study, whereas total cholesterol, LDL concentrations were significantly increased in all patients (23). Although some of the results from Yarahmadi's study were consistent with our study, improvement in anthropometric variables was seen in both sexes and there was no significant difference in our study.

In this study, we found significant improvement in systolic and diastolic blood pressure during Ramadan (pvalue < 0.05). According to Azizi, fasting effects blood pressure and may lead to hypotension (24). According to Erdem's study, intermittent fasting resulted in a significant decrease in office BP values and ABPM (ambulatory blood pressure monitoring) measurements (25). In some studies, no significant changes in systolic and diastolic blood pressure during this month were reported (23, 26). This discrepancy may have occurred due to nutritional consultation in our study.

This study had some limitations, including fewer male participants in the study in addition to the lack of control group. It was not feasible to select a control group due to specific time limitations of Ramadan in a year. Also, most of the diabetic patients did not agree not to fast during Ramadan.

Conclusion

The results of this study indicate that type II diabetic patients who had well controlled blood sugar before Ramadan and were given consultation by healthcare professionals (for their diet, physical activity, medications, blood glucose monitoring, and symptoms of hypoglycemia), can have safe fasting during the holy month of Ramadan.

Abbreviations

DM
diabetes mellitus
OCP
oral contraceptive pills
FBS
fasting blood glucose
BS2hpp
2-hour postprandial glucose
HbA1C
glycosylated hemoglobin
HDL-C
high density lipoprotein- cholesterol
LDL-C
low density lipoprotein- cholesterol
TG
triglyceride
WHO
World Health Organization
BMI
Body mass index
WHR

waist-to-hip ratio

SMBG

self-monitoring their blood glucose

Declarations

- Ethics approval and consent to participate: The study was approved by the Imam Hospital-Mazandaran University of Medical Sciences Ethics Committee (Approval ID: IR.MAZUMS.IMAMHOSPITAL.REC.1398.067). Written informed consent was obtained from all participants.
- Consent for publication: Not applicable
- Availability of data and materials: All the data is available with Dr. Mehrnoush Sohrab (corresponding author), reasonable request will be responded with supplementary raw-data.
- Competing interests: The authors declare that they have no competing interests in this study.
- Funding: This research was supported by Mazandaran University of Medical Science.
- Authors' contributions:
- Dr T. Yazdanyar and Dr M. Sohrab: Designer and project manager, data collection and analysis, writers of main manuscript
- Dr A. Ramezani: Nutritional consultant, co-author
- Dr Z. Kashi, Dr P. Karimi Aliabadi: Data collection, co-author
- Dr A. Bahar, Dr M. Shirzad, Dr E. Yousefi Abdolmaleki: Data collection
- Dr M. Aarabi: Designer, data analysis
- All authors reviewed the manuscript.
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Figures

FBS repeated measurements during a month of fasting

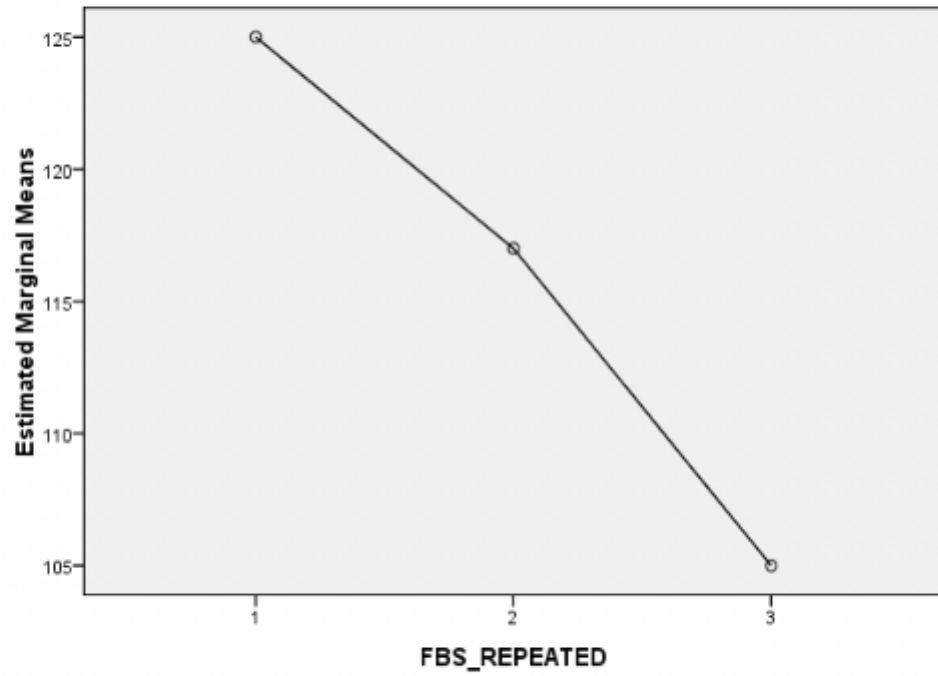


Figure 1

Fasting blood sugar changes during Ramadan