ORIGINAL ARTICLE

Effect of Ramadan fasting on metabolic markers, dietary intake and abdominal fat distribution in pregnancy

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Abstract

Background: The aim of this study is to evaluate the effect of Ramadan intermittent fasting on metabolic markers, dietary intake, anthropometric measurements, and abdominal visceral fat thickness (VFT) in pregnancy.

Methods: Seventy-eight healthy pregnant subjects who had fasted for at least 15 days during the month of Ramadan in 2012 and 2013 and 78 controls were included in this study. Metabolic markers, dietary intake, anthropometric measurements, and ultrasonographic VFT were calculated for each subject before and after Ramadan fasting.

Results: When before and after Ramadan values in the fasting group were compared, we found that daily protein intake was increased ($p < 0.001$), but fat and carbohydrate intake remained unchanged. A significant reduction was observed in liquid consumption while the frequency of asymptomatic bacteriuria was increased. High-density lipoprotein significantly increased, and glycated hemoglobin, insulin, and homeostasis model index significantly decreased ($p = 0.005$, $p = 0.01$, $p < 0.001$, and $p = 0.03$, respectively). A significant increase in ferritin was found ($p = 0.02$). No change was observed in subcutaneous fat thickness, while VFT significantly decreased ($p = 0.08$, $p = 0.005$). However, in the control group, only ferritin level increased.

Conclusion: A combined change in the number and timing of meals and the portioning of the entire daily intake into only two meals per day may have beneficial metabolic effects and reduction in VFT during pregnancy. Hippokratia 2015; 19 (4): 298-303.

Keywords: Ramadan fasting, pregnancy, metabolic markers, abdominal visceral fat thickness

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Introduction

Ramadan is the holiest month in the Islamic calendar, and, during this month, millions of Muslims abstain from eating, drinking, conjugal relationships, and smoking during the day from dawn to sunset. Physiological changes induced by Ramadan fasting are not well known. However, some studies carried out in recent years have revealed that Ramadan fasting corrected metabolic parameters, helped provide glucose regulation and reduced the need for insulin without causing hypoglycemic attacks in patients with metabolic syndrome[1-6].

In the determination of metabolic risks, it is thought that body fat distribution is more important than fatty mass. Fat storage in the abdominal zone, especially in the visceral compartment, is riskier in metabolic terms[7]. It has been asserted that the positive metabolic effects of diet change specific to Ramadan occur by reducing the amount of visceral fat[8]. There are studies showing that Ramadan fasting reduced visceral fat thickness (VFT), especially in female volunteers[8,9].

In a few recent studies, it was shown that central fat storage showed better correlation with bad gestational results such as preeclampsia, gestational diabetes mellitus, and preterm birth when compared to peripheral lipoidosis[10-12]. However, we have no information on how to reduce visceral fat during pregnancy. Volunteer pregnant subjects fasting during Ramadan seem to be a good opportunity for researching the possible effects of this type of diet. We hypothesized that the change in the number and timing of meals and portioning the entire daily intake into two meals (instead of the usual four or five) could have a beneficial effect on metabolism and could reduce visceral adiposity in pregnant subjects.

Material and methods

This prospective observational study was carried out between June 2012 and July 2013, and was approved by the local Ethical Committee at Sifa University (no: B.30.2.ŞFÜ.00.50.500/45). Participants provided written informed consent to participate. The procedures were in agreement with the Helsinki Declaration of 1975 (revised in 2008).

During Ramadan, the climate in the region was hot, and the average minimum and maximum temperatures were 30.1°C and 37.7°C respectively. The duration of fasting was approximately 16 hours, from sunrise to sunset throughout the month.

Volunteer pregnant individuals with a single gestation of 12-28 weeks between the ages of 18-40 were included in the study. Pregnant individuals with diagnosis of Type 1 or Type 2 diabetes mellitus, hypertension, additional metabolic disease, history of renal stones, history of preterm delivery and poor obstetrics outcome, peptic ulcer disease, and malnutrition, as well as pregnant individuals with chronic drug utilization, tobacco use, and alcohol use, were not included in the study. Women who had become pregnant via in vitro fertilization were also excluded.

Data were collected one week before and one week after the month of Ramadan. All subjects were advised to recognize the warning symptoms of dehydration and hypoglycemia, including irritability, headache, weakness, fatigue, dizziness, excessive hunger or thirst, nausea/vomiting, dysuria, fever, flank pain, decreased fetal movement at night, and preterm contractions. For each fasting pregnant woman, a non-fasting healthy pregnant woman matched for age, parity, and gestational age at ultrasound (± one week) was recruited as a control. Multivitamin [Elevit Pronatal®, Bayer (Schweiz) AG, Zürich] and iron (100 mg/day) supplementations were given to all subjects.

All pregnant subjects were controlled between the 14th-18th days of the month of Ramadan, and fetal biometry and amniotic fluid index (AFI) measurements were made. All pregnant women were followed until birth. Birth weight, gestational age at delivery, and neonates' Apgar scores at 5 minutes were recorded.

Anthropometric and metabolic measurements

Body mass index (BMI) was calculated [weight (kg)/height (m)²] .

Blood samples were collected after 8–10 hours of fasting, one week before and one week after the month of Ramadan. They were processed for fasting plasma glucose (FBG) using Enzymatic Hexokinase, glycated hemoglobin (HA1c) using Turbidimetric Inhibition Immunoassay, plasma insulin and ferritin using electrochemiluminescence, plasma lipids: total cholesterol (TC), low-density lipoprotein (LDL-C), high-density lipoprotein (HDL-C), and triglyceride (TG) and iron (Fe) using an enzymatic colorimetric method. All above mentioned tests were performed in a COBAS 6000 analyzer (Roche Diagnostics, Rotkreuz, Switzerland). Homeostasis model index (HOMA-IR) was used for evaluating insulin resistance {[Fasting plasma glucose (nmol/L) x fasting serum insulin (UI/mL)]/22.5}. The cell counter SYSMEX Analyzer (Roche CA1500/CA7000 Automatic Blood Coagulation Analyzer, Japan) was used for the hemogram.

Urine specimens were tested with URS-10 multi-reagent strips (Teco Diagnostics, Anaheim, CA, USA) for the presence of nitrite and leukocyte esterase activity. For white blood cell count, uncentrifuged urine was drawn into a Neubauer (Reichert, Buffalo, NY, USA) hemocytometer by capillary action. Leukocytes were counted on one side of the chamber and multiplied by 1.1 to obtain a total cell count/mm^3. Urine specimens were examined by Gram stain method. Pyuria was defined as ≥ ten white blood cells/mm^3, and bacteriuria as any bacteria on any of ten oil immersion fields in a Gram-stained smear. One of pyuria, bacteriuria, or (+) results for nitrite or leukocyte esterase was accepted for asymptomatic bacteriuria (ASB).

Ultrasonographic assessment

All the subjects were examined by ultrasonography in the beginning, in the middle, and at the end of Ramadan for the evaluation of any changes in the following measurements: fetal biparietal diameter (BPD) percentile; fetal femur length (FL) percentile; fetal abdominal circumference (FAC) percentile and AFI. A high-resolution ultrasonographic system (Siemens, Acuson Anteres, Mountain View, CA, USA) and a 3.5 MHz convex transducer were used.

Ultrasonographic measurements of VFT and subcutaneous fat thickness (SFT) were carried out by one radiology specialist through the abdominal pathway by means of a high-resolution ultrasonographic system (Siemens, Acuson Anteres, Mountain View, CA, USA) and a VFX 9-4 MHz linear transducer. All measurements were carried out when the patient was in a supine position and after respiration in order to exclude respiration-based abdominal wall tension. Maximum preperitoneal visceral fat (Vmax) and minimum subcutaneous fat (Smin) were measured from the point where subcutaneous fatty tissue is minimal by making a longitudinal scan along the linea alba from the xiphoid apophysis to the umbilicus by means of a linear probe. The VFT was defined as the fat thickness between the liver surface and the linea alba, and the SFT was defined as the fat thickness between the skin and the linea alba (Figure 1)[13]. The ultrasonographic measurements were performed by a single investigator (O.I.). Forty out of 156 scans were examined by two blinded observers, by obstetrician (E.B.G.) and radiologist (O.I.), so that study reliability could be determined. The intra-observer reproducibility (O.I.) of the ultrasonographic measurements was 1.5–2.0% for Vmax and 1.8–3.2% for Smin. The reproducibility between the two operators was 1.8–2.2% for Vmax and 2.5–2.7% for Smin.

Assessment of dietary intake

Dietary compliance was measured using a visual analog scale, and the nutrient intake was evaluated by means of a three-day food record. The nutrient calculations were carried out using the United States department of Agriculture's food composition table. Total liquid consumption of the participants was calculated by converting into milliliters (ml).

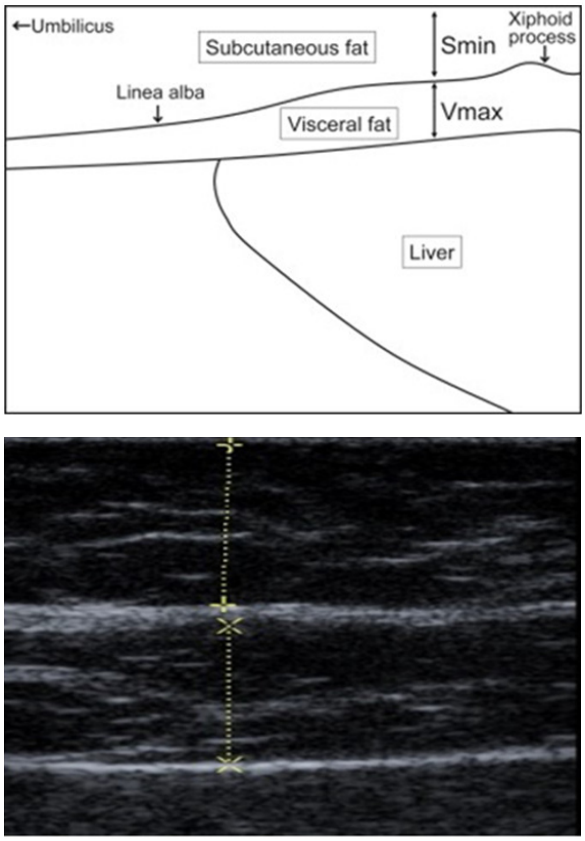

Figure 1: Measurement of ultrasonographic subcutaneous (SFT) and visceral fat thickness (VFT). The VFT was defined as the maximal fat thickness between the liver surface and the linea alba, and the SFT was defined as the minimal fat thickness between the skin and the linea alba.
Smin: minimal subcutaneous fat thickness, Vmax: maximal visceral fat thickness.

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 15.0, for Windows (SPSS Inc., Chicago, IL, USA). The results are reported as mean values and standard deviations. Group means before and after Ramadan were compared using paired *t*-test. Wilcoxon Signed Ranks Test was used to compare the non-parametric variables ASB and ketonuria. Kruskal Wallis non-parametric variance analysis was performed in order to examine the difference between physical performance, mental performance, level of attention, daily sleep time, and daily physical activity before and after Ramadan. Variance analysis was used to examine changes in fetal parameters. A p-value less than 0.05 was considered to be statistically significant.

Results

Thirteen of 94 volunteer participants accepted to the study were excluded since they fasted for less than 15 days, and three participants were excluded due to missing data. No pregnancies in the study group experienced warning symptoms or reduction in fetal movement. Mean fasting duration was 20.1 days in the study group. Mean birth weight, mean gestational age at delivery and the number of newborns whose five-minute Apgar score was less than seven points did not differ between the groups (Table 1).

A statistically significant increase was observed in the weights of the participants in both the study and control groups ($p = 0.005$ and $p = 0.006$, respectively). When comparing before and after Ramadan values in the fasting group, we found that diastolic blood pressure was significantly lower after Ramadan ($p < 0.001$). A significant increase in HDL-C and significant reductions in HA_{1c}, insulin, and HOMA-IR were observed ($p = 0.005$, $p = 0.01$, $p < 0.001$, and $p = 0.03$, respectively). The increase in ferritin was found to be significant ($p = 0.02$). ASB was found at a significant level after Ramadan ($p = 0.02$) while fasting-related ketonuria was not observed in the pregnant subjects. On the other hand, it was found that only the ferritin level was increased in the control group ($p = 0.04$).

An increase in protein ratio and a decrease liquid intake in the Ramadan diet attracts attention ($p < 0.001$ for both) in the fasting group.

No change was noted in the SFT during Ramadan, but the values of VFT were significantly reduced in fasting group ($p < 0.005$). Neither SFT nor VFT significantly changed in the control group (Table 2).

No change was encountered in fetal biometry and AFI values of the fasting pregnant subjects at the start of, in the middle of, and after Ramadan (Table 3).

Discussion

The results of this present study demonstrate that Ramadan fasting can lead to some beneficial changes in HDL-C, HA_{1c}, insulin level, insulin resistance, blood pressure, and VFT during pregnancy. There are studies showing that fasting during Ramadan creates positive changes in metabolic parameters in non-pregnant individuals[2,3]. In a study carried out by Shariatpanahi et al, it was suggested that the improvement in metabolic parameters dependent on Ramadan fasting might be associated with the reduction in caloric intake and body weight[5]. On the other hand, despite no reduction in daily calorie consumption and an increase in the weights of the participants, a remarkable metabolic recovery in the fasting pregnant women was found in our study. It may be suggested that this situation is associated with hormonal changes, fetal growth, and reduction in the visceral fat in the pregnancy.

In our study, we observed that VFT was significantly reduced at the end of Ramadan. Visceral fat is metabolically different from subcutaneous fat: it contributes more to oxidative stress by producing more inflammatory cytokines and less leptin. Also, visceral fatty tissue may increase hepatic insulin resistance through direct drainage to the liver via the portal pathway[14]. It was shown that body fat distribution associated with Ramadan fasting changes depending on age and gender. In a study by Norouzy et al, it was shown that young women (age <35) lost a significant

Table1: Characteristics of the 78 healthy pregnant subjects who fasted for at least 15 days during the month of Ramadan in 2012 and 2013 and 78 controls that were included in this study.

	Fasting Group (n=78)	Control Group not fasting (n=78)	p
Mean age (years)	24.2 ± 4.2	25.1 ± 3.9	0.9
Mean BMI	24.5 ± 4.7	24.8 ± 5.2	0.4
Parity (±SD)	2.3 ± 0.1	2.5 ± 0.1	0.2
Mean gestational week (±SD)	20.4 (12-27)	19.7 (12-27)	0.7
Mean birth weight (g)	3248 ± 123	3292 ± 157	0.2
Mean gestational age (±SD) at delivery (weeks)	38.2 ± 1.2	39.0 ± 1.1	0.6
5 min Apgar ≤7 (n, %)	2 (2.5%)	1 (1.2%)	0.09

BMI: Body mass index, SD: standard deviation, n: number, p <0.05 was considered statistically significant.

Table 2: Clinical and laboratory characteristics, and ultrasonographic findings of the 78 pregnant fasting women and the 78 controls before and after, at least 15 days of fasting (Mean values and standard deviations).

	Fasting Group (n=78)			Control Group not fasting (n=78)		
	First day of Ramadan fasting mean (SD)	after more than 15 days of fasting mean (SD)	p_1	First day of Ramadan fasting mean (SD)	after more than 15 days of fasting mean (SD)	p_2
Weight (kg)	67.3 (10.4)	68.1 (10.4)	**0.005**	66.3 (9.8)	67.7 (10.1)	**0.006**
Systolic blood pressure (mmHg)	115.5 (10.4)	113.0 (10.4)	0.1	112.7 (11.8)	111.9 (10.8)	0.2
Diastolic blood pressure (mmHg)	74.3 (8.1)	70.5 (6.3)	**<0.001**	72.8 (7.7)	73.1 (6.9)	0.6
Dietary Intake (daily consumption)						
Total energy (kJ)	2034.6 (391)	2012.8 (363)	0.7	2120.6 (382)	2234 (340)	0.6
Protein (g)	65.6 (18.7)	82.2 (22.9)	**<0.001**	70.8 (19.2)	69.5 (22)	0.7
Carbohydrate (g)	241.7 (127)	257.7 (115)	0.1	238 (134)	242 (128)	0.9
Fat (g)	55.3 (18.9)	50.4 (18.1)	0.07	59.1 (11.9)	62 (10.9)	0.1
Fluid (ml)	2241 (423)	1997.4 (231)	**<0.001**	2350 (383)	2450 (355)	0.2
Chemistry Analysis						
FPG (mg/dL)	88.4 (8.7)	88.0 (8.2)	0.8	91.4 (6.7)	92.4 (7.1)	0.9
TC (mg/dL)	177.4 (35.7)	183.4 (31.4)	0.08	167.4 (25.7)	162 (22)	0.08
TG (mg/dL)	109.2 (47.8)	110.5 (44.6)	0.7	103.2 (45)	109 (39)	0.07
HDL-C (mg/dL)	66.4 (16.5)	72.1 (14.5)	**0.005**	63.8 (19.5)	64.4 (12.3)	0.4
LDL-C (mg/dL)	111.4 (34.5)	107 (32.1)	0.07	110 (44.2)	108 (39.6)	0.4
Insulin (Uu/ML)	12.0 (13.5)	6.4 (3.8)	**<0.001**	10.8 (10.5)	11 (9.9)	0.4
HOMA-IR (%)	3.6 (4.1)	2.1 (1.5)	**0.03**	3.2 (4)	3.3 (2.2)	0.2
HbA_{1c} (%)	5.0 (0.4)	4.6 (0.4)	**0.01**	5.1 (0.1)	5.3 (0.3)	0.8
Hb (g/dL)	11.8 (0.8)	11.9 (0.8)	0.5	12.1 (0.9)	12.4 (0.2)	0.5
Ferritin (ng/ml)	20.3 (13.6)	21.9 (13.5)	**0.02**	22.4 (10.6)	24.3 (11)	**0.04**
Fe (ug/dL)	95.2 (44.8)	93 (34)	0.5	94.2 (40.8)	94.9 (35)	0.6
ketonuria	2.5*	5.0**	0.1	3.1*	3.7*	0.6
ASB	5.0*	40.0**	**0.02**	6.2*	6.5*	0.5
Ultrasonographic Findings						
SFT (mm)	11.6 (3.7)	11.9 (4.6)	0.08	11.0 (3.2)	11.1(1.1)	0.9
VFT(mm)	12.1 (4.6)	10.7 (3.5)	**0.005**	12.4 (3.6)	12.2(2.2)	0.6

SD: standard deviation, FBG: fasting plasma glucose, TC: total cholesterol, TG: triglyceride, HDL-C: High density lipoprotein, LDL-C: low density lipoprotein, HOMA-IR: Homeostasis model index, HbA1c: glycated hemoglobin, Hb: hemoglobin, Fe: iron, ASB: asymptomatic bacteriuria, SFT: subcutaneous fat thickness, VFT: visceral fat thickness, p <0.05 was considered statistically significant, *: mean rank, **: sum of ranks.

amount of body fat during Ramadan[15]. In another study, it was put forth that Ramadan fasting reduces the thickness of visceral fat in women[9]. In a study by Saedeghi et al, it was shown that body fat reduction was statistically faster in females, and women lost body fat especially from the abdominal visceral section during Ramadan fasting[8].

Table 3: Comparison of fetal data in first, seventh day and fifteenth day of fasting in the fasting group of the 78 pregnant women.

Fasting Group (n=78)	Firsth day of fasting mean (SD)	Seventh day of fasting mean (SD)	Fifteenth day of fasting mean (SD)	p
AFI(mm)	128.7 (13.5)	126.7 (11.4)	130.1 (17.2)	0.5
Fetal BPD percentile (%)	73.3 (8.2)	72.7 (8.2)	73.8 (8.2)	0.8
Fetal HC percentile (%)	71.7 (8.3)	71.9 (8.1)	71.7 (8.2)	0.9
Fetal FL percentile (%)	71.1 (14.3)	71.0 (12.9)	71.1 (14.3)	1
Fetal FAC percentile (%)	74.8 (9.8)	74.7 (9.7)	74.8 (10)	0.9

AFI: amniotic fluid index, BPD: biparietal diameter, HC: Head circumference, FL: femur length, FAC: fetal abdominal circumference. $p<0.05$ was considered statistically significant.

Different techniques are available for the measurement of VFT. Methods such as bioelectrical impedance, dual energy X-ray absorptiometry, and computerized tomography (CT) that are widely used in the general population for the measurement of the VFT cannot be used during gestation due to radiation exposure and differences in body water distribution during gestation[15,16]. However, ultrasonographic VFT measurement is a simple examination that can be performed with minimal cost. Moreover, it shows a good correlation with CT measurement, which is the gold standard in VFT measurement[8]. In our study, we used the method defined by Hamawada et al, which seemed technically easier compared to other methods[13].

There is a limited number of studies on the changes in daily calories and content of the diet during Ramadan, and the results are different from each other. Shariatpanahi et al determined a reduction in fat ratio and an increase in carbohydrate ratio and reduction in total calorie Ramadan diet while the protein content was found to be reduced in the diet in a study carried out by Norouzy et al[5,15]. In our study, it was observed that the number of calories and the amounts of fat and carbohydrate in the diet during Ramadan remained unchanged while the protein content was increased. Although the total number of calories in the diet did not change, we observed that some beneficial changes occurred in metabolic parameters in the study group. This situation increased our interest in the Ramadan diet. Islamic fasting is different from other types of fasting: as compared to other diet plans, in Ramadan fasting, there is no malnutrition or inadequate calorie intake. Additionally, in Islamic fasting, people are not subject to a diet of selected foods only (i.e. protein only, fruits only, etc.). In the hypothalamus part of the brain, there is a center called the "lipostat" that controls body mass. Ramadan is a month of self-regulation and self-training in terms of food intake, thereby causing, hopefully, a permanent change in the lipostatic reading[6]. It is recommended that the effects of this diet model be investigated in a more comprehensive study.

The results of our study have put forth that the liquid intake of the pregnant individuals during Ramadan fasting are significantly reduced. This is probably due to the fact that a long period of fasting reduces the time available for fluid intake. This situation seems to explain the increase in the ratio of ASB observed in urinalysis of the pregnant individuals.

In our study, we observed that hemoglobin (Hb) and Fe, levels remained unchanged. Likewise, in the study carried out by Dikensoy et al, it was shown that Ramadan fasting does not cause a change in the level of ferritin and Hb in pregnant individuals taking a sufficient amount of iron[17].

In our study, we observed that HbA1c levels were significantly reduced at the end of Ramadan in the study group. HbA1c provides information about the last three months of glycemic levels in non-pregnant individuals. However, the erythrocyte turnover is accelerated in pregnant women. Therefore, it is believed that the monthly change in HbA1c may be significant.

Research about Ramadan fasting during pregnancy has not demonstrated any effect on Apgar scores, fetal Doppler parameters, AFI, birth weight, gestational age at delivery, or infant well-being[18,19]. We also did not observe a reduction on fetal percentile or oligohydramnios in any of the pregnant individuals we followed in our study.

Different changes in physical activity and sleeping-wakefulness periods and durations during Ramadan have been reported[20,21]. Therefore, it is difficult to evaluate physical activity objectively. Lack of assessment of the physical activity and sleeping-wakefulness periods is a limitation of our study. Another limitation in our study is the small study group. Lastly, it would have been useful to include inflammatory markers in this study.

In conclusion, the present study shows for the first time that Ramadan intermittent fasting leads to a reduction in VFT without affecting fetal development and the level of amniotic fluid in healthy pregnant women. However, there is not sufficient evidence to recommend or discourage fasting for the pregnant woman.

Conflict of interest

Authors declare no conflict of interest.

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