

# The effect of Ramadan fasting on maternal serum lipids, cortisol levels and fetal development

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## Abstract

**Objective** To determine the effects of fasting during the month of Ramadan on fetal development and maternal serum cortisol and lipid profile.

**Methods** This study was performed in Obstetrics and Gynecology Department of Gaziantep University Hospital, between 23 September 2006 and 23 October 2006 (during the month of Ramadan). Thirty-six consecutive healthy women with uncomplicated pregnancies of 20 weeks or more, who were fasting during Ramadan, were included in the study group (group 1). The control group (group 2) consisted of 29 healthy pregnant women, who were not fasting during the study period. For evaluating Ramadan's effect on fetus, Doppler ultrasonography was performed on all subjects in the beginning and then once a week until the end of Ramadan for the following measurements: increase of fetal biparietal diameter (BPD), increase of fetal femur length (FL), increase of estimated fetal body weight (EFBW), fetal biophysical profile (BPP), amniotic fluid index (AFI), and umbilical artery systole/diastole (S/D) ratio.

Maternal serum cortisol, triglyceride, total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), very low density lipoprotein (VLDL), and LDL/HDL ratio were also evaluated before and after Ramadan.

**Results** No significant difference was found between the two groups for the fetal age, maternal weight gain (kilogram), estimated fetal weight gain (EFWG), fetal BPP, AFI, and umbilical artery S/D ratio. In the fasting group, the maternal serum cortisol levels on day 20 were significantly higher than the initial levels obtained 1 week prior to Ramadan ( $p < 0.05$ ). Although no significant increases were observed in total cholesterol and triglyceride levels in the fasting group, these increases were significantly higher than those in the control group ( $p < 0.05$ ). LDL and VLDL levels showed a non-significant decrease at the end of the Ramadan. HDL levels showed a slight increase, but LDL/HDL ratios were significantly decreased in fasting group ( $p < 0.05$ ).

**Conclusion** The results of this study showed that maternal serum cortisol level was elevated while LDL/HDL ratio were decreased in healthy women with uncomplicated pregnancies of 20 weeks or more, who were fasting during Ramadan. No untoward effect of Ramadan was observed on intrauterine fetal development.

**Keywords** Ramadan · Fasting · Cortisol · Maternal lipids · Fetal development

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## Introduction

Ramadan is the holy month for Islamic World. In Ramadan, food and fluid ingestion is restricted to the pre-sunrise and post-sunset hours for 1 month every year. It is obligatory for the healthy adult Muslims to abstain from eating, drinking, and smoking each day from dawn to sunset during the month of Ramadan [1].

Each year, the Ramadan falls almost 10 days earlier than previous year due to fact that Islamic calendar is shorter

than the solar calendar [2]. Therefore, the total period of fasting can range from less than 12 h to as much as 19 h each day depending on the season [2]. There are certain conditions that Muslims are allowed not to fast including pregnancy. If pregnant woman feels that herself or the baby might be harmed due to fasting she is allowed not to fast [2]. However, fasting during pregnancy is a very common practice among Muslim women [2, 3].

The effects of fasting on health during pregnancy have been the subject of many previously published articles [2–13], because there are some concerns that the metabolic consequences of fasting might have some adverse effects on both mother and fetus. The most of earlier reports suggested that fasting during Ramadan has no effect on Apgar scores, birth weight, gestational age at delivery, or infant's health [4–6]. However, these data are insufficient to assure that fasting is completely safe during pregnancy. For instance, little is known about the effects of fasting on the amniotic fluid index in addition to some other parameters of fetal health [2].

Fasting for less than 15 h is suggested not to be metabolically different from a physiological overnight fast for the healthy pregnant woman [2]. Ketonemia and hypoglycemia frequently occur with more prolonged fasting; however, there is no evidence that this affects the infant [2, 12, 13].

The aim of the present study was to evaluate whether fasting during Ramadan causes any significant effect on maternal cortisol and lipid profile, and fetal health in healthy pregnant women with a singleton uncomplicated pregnancies of  $\geq 20$  weeks.

## Materials and methods

This study was performed at the Obstetrics and Gynecology Department of Gaziantep University, hospital in Turkey between 23 September 2006 and 23 October 2006 (during the month of Ramadan). The study protocol was approved by the institutional ethics committee. All subjects included in the study signed an informed consent. All the consecutive healthy women with singleton uncomplicated pregnancies of  $\geq 20$  weeks' gestation were enrolled in to study group (group 1) if they were fasting during the study period. The control group (group 2) was selected from a group of healthy pregnant women, with singleton uncomplicated pregnancies of  $\geq 20$  weeks' gestation, who were not fasting during the study period.

Ultrasonography was performed on all subjects in the beginning and then once a week until the end of Ramadan for the following measurements: increase of fetal biparietal diameter (BPD), increase of fetal femur length (FL), increase of estimated fetal body weight (EFBW), fetal biophysical profile (BPP), amniotic fluid index (AFI), and

umbilical artery systole/diastole (S/D) ratio. Fetal body weight was measured using Hadlock's formula [14].

The modified biophysical profile (cardiotocography was not included) was scored according to Manning criteria [15].

Amniotic fluid index was also calculated by the sum of deepest vertical pocket in four uterine quadrants measured in sonography. Oligohydramnios is defined as amniotic fluid index of  $\leq 5$  cm. To remove the effect of other factors causing oligohydramnios and polyhydramnios, all cases with urinary or skeletal anomalies, intrauterine growth retardation, multiple pregnancy, diaphragmatic hernia, diabetes, fetal hydrops, and premature rupture of membrane, were excluded from the study.

Flow velocimetry waveforms were obtained by Doppler ultrasonography as described previously [16].

Abnormal umbilical artery Doppler velocimetry was defined as  $S/D \geq 3.0$ , or presence or absence or reversed of end diastolic flow, whereas abnormal uterine artery Doppler velocimetry was defined as  $S/D \geq 2.6$  or presence of early diastolic notch in either side of the uterus [16]. Abnormal Doppler velocimetry per se was not considered as an indication for cesarean section.

High definition image (HDI; A 3.5 MHz convex transducer, Applio-Toshiba, Otomara, Japan) was used to obtain AFI and Doppler waveforms.

Maternal blood samples were obtained 1 week prior to Ramadan and on 20th days of fasting for the measurement of followings: maternal serum cortisol, triglyceride, total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), and very low density lipoprotein (VLDL), and LDL/HDL ratio. Plasma cortisol levels were determined on Immulite 2000 autoanalyser (Diagnostic Products Corporation, Los Angeles, ABD) system by using Immunchemiluminescent method at the Central Laboratory of Gaziantep University Hospital. Total cholesterol, HDL, LDL, VLDL and triglyceride levels were measured on Roche Hitachi Modular DP Systems (Mannheim, Germany) autoanalyzer with spectrophotometer.

Subjects with the following conditions were excluded: diabetes, thyroid dysfunctions, Cushing syndrome, adrenal disease, preeclampsia, multiple pregnancies.

Multivitamin, calcium (1 g/day) and iron (100 mg/day) supplementations were given to all subjects. All the subjects were advised to drink at least 2 l water every night to prevent hypo-hydration.

## Statistical analysis

All comparisons between the groups were done by a paired *t* test or Mann–Whitney Rank Sum test where it was appropriate. Sigma Stat 3.0 was used for statistical analysis. *P* value  $< 0.05$  was accepted as significant.

## Results

A total of 65 pregnant women were studied: 36 women were in the fasting group (group 1) and 29 women were in the non-fasting group (Control group). The mean ( $\pm$ SD) number of consecutive fasting days was  $18 \pm 2.3$  days. Maternal and fetal gestational ages were similar in both groups.

The mean time course since the last oral intake was significantly longer ( $p = 0.001$ ), and the maternal glucose level was significantly lower in the study group than that in the control group ( $p = 0.002$ ). There was no statistically significant difference between the two groups for maternal weight gain (Table 1).

The increase in fetal BPD, FL, and EFBW was not statistically different between two groups. Fetal BPP, AFI, and umbilical artery S/D ratio were normal as control group in the fasting group (Table 2).

In the fasting group, the maternal serum cortisol levels on day 20 were significantly higher than the initial levels obtained 1 week prior to Ramadan ( $p < 0.05$ ).

No significant increase was observed in total cholesterol and triglyceride levels. However, the increases in both parameters were significantly higher compared to those in

**Table 1** Comparison of the maternal data between fasting and non-fasting groups

	Group 1 (fasting) ( $n = 36$ )	Group 2 (control) ( $n = 29$ )
Age (years)	23.4 (22.6–25.9)	24.4 (22.5–26.0)
Parity	2.3 (1.8–2.7)	2.6 (2.5–3.0)
Gestational age (week)	29 (6–38)	30 (8–37)
Oral intake (hours)*	9.3 (8.0–9.7)	2.1 (2.0–2.6)
Maternal weight gain (kg)	1.0 (0.8–1.9)	1.2 (0.7–1.8)

\* The difference between the variables was significant,  $p = 0.001$

**Table 2** Comparison of the fetal data between fasting and non-fasting groups

	Group 1 (fasting) $n = 42$	Group 2 (control) $n = 31$
Increase of Fetal BPD (mm)	4.5 (3.7–5.8)	4.0 (3.1–5.2)
Increase of Fetal FL (mm)	3.2 (2.6–3.8)	3.0 (2.7–3.4)
Increase of EFBW (g)	221(200–357)	214 (229–340)
Umbilical artery S/D ratio	2.7 (2.0–3.1)	2.5 (2.3–3.4)
AFI (mm)	12.9 (12.1–14.0)	13.3 (12.5–14.6)
BPP	7.8 (6.7–8.0)	7.0 (6.5–8.0)

BPD fetal biparietal diameter, FL fetal femur length, EFBW estimated fetal body weight, BPP fetal biophysical profile, AFI amniotic fluid index, S/D systole/diastole ratio

No significant difference was observed

control group. LDL and VLDL levels showed a non-significant decrease at the end of the Ramadan. HDL levels showed a slight increase, but LDL/HDL ratios were significantly decreased in fasting group ( $p < 0.05$ ) (Table 3).

## Discussion

The results of this study showed that fasting during Ramadan increases the serum cortisol levels while a significant decrease occurs in the LDL/HDL ratio of healthy women with uncomplicated pregnancies of 20 weeks or more.

In the present study, no significant difference was found between the fasting and control groups in terms of increase of EFBW, fetal BPP, AFI, and umbilical artery S/D ratio. These findings showed that fasting during Ramadan has no untoward effects on the fetal development. These findings were consistent with the results of previous studies [2–13].

Although there are some animal studies [17] and human studies that investigated the effects of fasting on cortisol levels [18] and the lipid profile [19], this is the first study that performed all these measurements together on a population of pregnant women.

Conflicting results have been reported on the effect of Ramadan fasting on changes in lipid profile within healthy subjects [19]. The food habits may differ during Ramadan [19]. Foods rich in carbohydrate are more likely to be consumed by people who are fasting [19]. It has been suggested that lipid profile is affected by dietary habit, percentage of fat in the daily diet and its saturation, percentage of simple sugar, and exercise [20, 21]. Kiziltan et al. [22]. reported a significant increase ( $p < 0.05$ ) in the HDL concentrations of 12 healthy fasting women with pregnancy of the first trimester [22]. They also reported a decrease in the levels of plasma LDL in 37 fasting healthy

**Table 3** The mean changes in maternal serum cortisol and plasma lipid levels on the 20th day of Ramadan compared to baseline levels

Variables	The mean changes on the 20th day of Ramadan	
	Group 1 (fasting)	Group 2 (non-fasting)
Serum cortisol ( $\mu$ g/dl)	$2 \pm 1.7$	$1 \pm 1.4$
TC (mg/dl)*	$3 \pm 21$	$1 \pm 18$
TG (mg/dl)*	$2 \pm 18$	$(-1) \pm 15$
LDL-C (mg/dl)	$(-2) \pm 56$	$(-1) \pm 16$
HDL-C (mg/dl)	$2 \pm 12$	$1 \pm 18$
VLDL (mg/dl)	$(-1) \pm 0.8$	$(-0.3) \pm 1.4$
LDL/HDL*	$0.2 \pm 1.2$	$0.1 \pm 1.9$

TG triglyceride, TC total cholesterol, LDL low density lipoprotein, HDL high density lipoprotein, VLDL very low density lipoprotein

\*  $p < 0.05$

women with pregnancy of the second or third trimester [22]. These findings were relatively consistent with the results of the present study. We found a non-significant increase in HDL levels; however, LDL/HDL ratio was significantly decreased in the fasting group. Maislos et al. [23] suggested that eating one large daily meal (gorging) leads to significant increase in serum HDL levels, while decreasing the LDL/HDL ratio in healthy subjects during Ramadan. They reported that there was no change in the physical activity level or smoking pattern of the subjects, nor did they consume alcohol (forbidden by religious command). Thus, none of the factors known to affect the plasma HDL-cholesterol levels, other than the change in meal pattern, were observed in these subjects [23]. They suggested that the increase in the HDL levels were due to post-prandial lipemia [23] and because the magnitude of the postprandial lipemia suggested to be important to the metabolism and plasma levels of HDL [24].

Previously, the elevated levels of serum triglyceride in fasting subjects have been reported [5, 12, 13]. The increase in the serum triglyceride levels in fasting subjects has been linked to several factors: consumption of high-carbohydrate diets accompanied by less exercise, tendency for higher sugar consumption [5, 12, 13]. On the other hand, Ziaee et al. [19], reported a negative correlation between primary triglyceride levels before Ramadan and during Ramadan, i.e., subjects with higher triglyceride level had a lesser increase in triglyceride levels during Ramadan. In the present study, non-significant increases on total cholesterol and triglyceride levels were observed in the fasting group on the 20th day of Ramadan. However, increases in both parameters were significantly higher compared to those in the control group. These findings were in line with the study by Kiziltan et al. [22]. Elevated serum triglyceride may be attributed to the lipolytic effect of prolonged fasting. It may also be due to the consumption of high-carbohydrate diets and less exercise during this month.

To the best of our knowledge, the effect of Ramadan fasting on the cortisol levels in pregnant women has not been studied previously. However, this has been the subject of several studies performed on healthy fasting subjects [25–27], because one can suggest that change in the eating and sleeping schedule may affect the circadian rhythm of cortisol secretion. The rhythm of cortisol normally displays a peak in the morning [27]. El Ati et al. [25] reported no significant effect of Ramadan on the circadian rhythm of cortisol secretion in healthy fasting adults during Ramadan. On the other hand, changes in eating and sleeping schedules were found to reduce cortisol levels in the morning, and raise these levels in the evening during Ramadan [27]. Data of the present study showed that maternal serum cortisol levels on day 20 were significantly higher than the initial levels obtained one week prior to Ramadan ( $p < 0.05$ )

suggesting that the changes in eating and sleeping schedules might affect the maternal cortisol levels in fasting pregnant women.

There were several limitations to this study. (1) The low number of the subjects might be responsible for the non-significant comparisons. (2) We were not able to measure the difference between the morning and evening levels of cortisol in the study population that might allow us to comment more on the effects of Ramadan fasting on the circadian rhythm of cortisol secretion in pregnant women. (3) The details of the eating and sleeping habits of the subjects were not recorded. This might allow us to comment more on the results concerning the changes in lipid profile.

In conclusion, the results of this study showed that maternal serum cortisol level was elevated while LDL/HDL ratio were decreased in healthy women with uncomplicated pregnancies of 20 weeks or more who were fasting during Ramadan. No untoward effect of Ramadan fasting was observed on intrauterine fetal development.

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