

# Effects of long-term fasting on female hormone levels: Ramadan model

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## Summary

**Background:** Ramadan fasting is a special model of hunger and particularly affects metabolic processes, including carbohydrate and lipid levels. Endocrine changes induced by Ramadan fasting are not well known. **Objective:** The aim of this article was to evaluate the changes in hormone levels in women before and after the special Muslim fasting period of Ramadan. **Materials and Methods:** This study was performed in 30 healthy women in Obstetrics and Gynecology department during the Ramadan month of 2011. Patients during and after the first menstrual period had menstrual cycles fasting blood samples taken on the same days. Luteinizing hormone (LH), follicle stimulating hormone (FSH), estradiol (E<sub>2</sub>), testosterone, and prolactin (PRL) levels were determined. **Results:** Before and during fasting LH, FSH, E<sub>2</sub>, testosterone and PRL levels were not statistically different. **Conclusion:** Despite the limited available studies on these subjects in women, effect of Ramadan fasting on hormone levels were found to be within the normal limits.

**Key words:** Ramadan; Female hormones; Fasting.

## Introduction

During Ramadan, the ninth month of the Islamic lunar calendar, healthy adult Muslims are obliged to refrain from taking any food, beverages, or oral drugs, as well as from sexual intercourse between dawn and sunset [1,2]. It is assumed that hundreds of millions of people observe the Ramadan fasting period each year [3]. Individuals typically consume only two main meals a day; the first meal is usually consumed prior to the beginning of the day's fasting, between 04:30 to 05:30 (i.e., Sahur meal), and the other at the break of the day's fasting, at 19:00 (i.e., Iftar meal). Hence Ramadan fasting is not complete and there is no restriction to the amount of food or fluid that can be consumed during the permissible period [4]. Fasting is not obligatory for menstruating women and the sick and the children are also exonerated [5]. Since this is a lunar calendar, the timing of this month of fast changes each year and the duration of restricted food and beverage intake can vary from between 12 to 16 hours [6]. In addition, a change in sleeping and waking patterns may cause changes in the physiology, metabolic responses, and functioning of the body's hormonal system [7,8]. Metabolic and physiological modifications induced by the spontaneous inversion of eating habits during a whole month of Ramadan, as well as its impacts on women's ovulatory hormones have been partially evaluated before [9-11]. Nutrient ingested in an equal quantity, but at an unusual time is known to induce different metabolic effects [10]. The aim of the present work was to investigate the effects of Ramadan on female hormone

levels: follicle stimulating hormone (FSH), luteinizing hormone (LH), estradiol (E<sub>2</sub>), progesterone, and testosterone around follicular phase in healthy women living in Yozgat province, Turkey.

## Materials and Methods

This randomized, prospective study was conducted in the Obstetrics and Gynecology Department of Bozok University Hospital between August 1<sup>st</sup> and September 11<sup>th</sup>, 2011, (during the month of Ramadan). Thirty healthy females (without any acute or chronic disease and with regular menstruation) Muslim participants who were fasting during Ramadan and were not taking any regular medications, cigarette or alcohol, participated in the study after giving their informed consent. The study was approved by local ethical committee of Bozok University. Women with irregular menstruation, who were pregnant, smokers, those with severe hirsutism and galactorrhea, hyperandrogenism, thyroidism, drug consumers (two month before study and within two months of study entry), severe psychological disorders, athletes, primary or secondary amenorrhea, and females who could not fast were excluded from the study. The average fasting period was 14.5 hours; the beginning and ending hours of the fasting were approximately from 5:30 a.m. and 8:00 p.m. The study protocol was approved by the local institutional ethics committee.

The study was performed in two stages: firstly one or two months before the Ramadan, blood was withdrawn from study participants on their 9<sup>th</sup> to 11<sup>th</sup> day of menstrual periods (LMP) and secondly, during Ramadan, the same patients' blood was withdrawn on the same LMP days which were around the 22-24<sup>th</sup> days of Ramadan during fasting. Thus, the total duration of fasting was 21-24 days with an interruption of at least six to nine days.

Since most of the fasting participants consumed food just before dawn, the authors withdrew their blood samples between 13:00 and 14:00 to make sure they were fasting for around eight hours. Venous blood (20 ml) was separated by centrifugation, and serums

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Table 1. — *Hormone levels*

Hormones	Fasting	Nonfasting	P
FSH (mIU/ml)	5.99±1.82	5.45±1.61	n.s.
LH (mIU/ml)	3.67±0.74	3.07±1.84	n.s.
ESTRADIOL (pg/ml)	87.0±60.0	91.7±64.2	n.s.
TESTOSTERONE (ng/ml)	0.51±0.20	0.47±0.19	n.s.
PROLACTIN (ng/ml)	9.18±3.45	9.18±2.55	n.s.

sera were stored at  $-80^{\circ}\text{C}$  for subsequent determinations in the laboratory of Clinical Biochemistry.

The serum levels of free  $\text{T}_3$ , free  $\text{T}_4$ , thyroid stimulating hormone (TSH), testosterone, PRL, FSH, LH, and  $\text{E}_2$  were measured on an analyzer, using an electrochemiluminescent immunoassay (ECLIA) kit.

All data are expressed as means  $\pm$  SDs. The statistical significance of changes in hormone levels was determined using a Wilcoxon signed rank test on values obtained before and during Ramadan. All values were defined to be statistically significant at  $p < 0.05$ . Data were analysed using the computer program SPSS for Windows (version 16.0).

## Results

Minimum and maximum ages of studied participants were between 21 and 41 years. The average duration of menstrual cycle days were  $28.2 \pm 1.27$  and average menstruation days were  $6.86 \pm 2.10$ . there was no correlation between the duration of fasting time and the levels of LH, FSH,  $\text{E}_2$ , TSH, testosterone and PRL. Serum LH, FSH,  $\text{E}_2$ , TSH, testosterone, and prolactin levels were not statistically different before and during Ramadan ( $p > 0.05$ , Table 1).

## Discussion

Ramadan provides a unique model to study the effects of altered eating circadian to a very large meal in a day. It has been previously shown in animals and in humans that time distribution of food intake alters metabolism [11]. Yet, there is limited knowledge about the effect of Ramadan fasting on many biochemical parameter changes [12].

It has been shown that Ramadan can result in a delayed bedtime and shortened sleep, with partial sleep deprivation [13]. The effects of altered sleep patterns and eating habits on female hormone levels have been assumed to be altered but Shahabi et al reported that FSH, LH and Estradiol levels were not altered around ovulation period due to fasting [10]. In this present time period, the authors also did not observe a difference in FSH, LH, and  $\text{E}_2$  levels during Ramadan. They therefore suggest that the level of these hormones is not altered in Ramadan and follicular period might not be related to the changes in sleeping hours or caloric intake.

Testosterone levels were not altered by Ramadan fasting in this study group. Although the authors could not find any study addressing the changes in female testosterone

levels during Ramadan, it was made clear that the levels of sex hormones and gonadotropins, as well as other hormones, vary in healthy single males during the Islamic fasting month of Ramadan [8]. Mesbahzadeh *et al.* [8] reported a significant decrease in testosterone on the 20<sup>th</sup> and 28<sup>th</sup> days of Ramadan (compared with before Ramadan) that occurs simultaneously with significant increases in FSH levels. The authors contributed this result to the negative feedback system that controls testosterone secretion: following a decrease in testosterone secretion from the testes, the secretion of gonadotropin-releasing hormone (GnRH) from the hypothalamus increases and this hormone enters the anterior pituitary through the blood of the hypothalamus–pituitary portal system, thus stimulating the secretion of FSH and LH from the anterior pituitary [8].

Various conflicting results are present regarding different age and sex groups who studied the FSH, LH, testosterone and  $\text{E}_2$  levels in different days of Ramadan [3,6,8]. Ramadan is based upon a lunar calendar, and therefore, the beginning of Ramadan may occur at any time in the year, and hence, the duration of the daily fasting span undergoes large variations in relation to the season and latitude [14]. The Ramadan fasting of 2011 was in summer and was longer than the Ramadans of winter. The differences in the present results might be related with seasonal variations in the studied variables: different data may be observed according to the year these studies are performed.

Chennaoui *et al.* [15] did not observe any difference in testosterone and PRL levels before, during, and one week after Ramadan in eight middle-distance athletes.

Fasting first induces estrogen receptor expression at the beginning of the fasting and estrogen binds to these receptors to activate the neural pathway mediating fasting effect on LH secretion [16]. After 48-hour fasting, depending on the action of  $\text{E}_2$  on the paraventricular nucleus of the hypothalamus, pulsatile LH is suppressed [17]. While a negative correlation was present between  $\text{E}_2$  and LH levels in the present study group, the authors did not observe difference in  $\text{E}_2$  levels. In monkeys, Chen *et al.* [18] observed reduced LH secretion which was associated with inhibition of GnRH pulse during hypoglycemic stress.

The present data confirms the results of Shahabi *et al.* [10] who reported that, Islamic fasting does not cause significant variation in the secretion of hormones around ovulation nor does it influence the occurrence of ovulation. Although this theory is plausible, the data of the present results belong to the follicular period.

In summary, the present study showed that Ramadan fasting did not affect female hormones during the third week of Ramadan; otherwise, there was no significant effect on folliculation, which kept the same circadian pattern during Ramadan.

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