

## The Effects of Islamic Fasting on Blood Hematological-Biochemical Parameters

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### ABSTRACT

**Introduction:** Fasting during the month of Ramadan is obligatory for healthy Muslims after the age of puberty. This paper was aimed to compare the changes in hematological and biochemical parameters before and after Ramadan.

**Methods:** This prospective study was performed one week before and one week after the month of Ramadan in 2015. Eighty-nine subjects (51 males and 38 females) with a mean age of 34.52±9.05 were enrolled in this study. Patients with systemic disorder, special drug using, and/or a history of previous surgery were excluded. Blood samples were taken from all participants before and after Ramadan to evaluate the effects of fasting on hematological-biochemical factors. Hematological and biochemical measurements were performed on the blood samples using a KX-21N cell counter (Kobe, Japan) and Hitachi 717 analyzer (Roche, Japan), respectively.

**Results:** Hematocrit, red blood cell (RBC) and Mean Red Cell Volume (MCV) decreased after Ramadan fasting (P= 0.002, P= 0.030 and P= 0.005, respectively), however mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC) increased (P=0.004, P=0.002, respectively). On the other hand, no changes were seen in hemoglobin, platelets and white blood cell (WBC) after Ramadan (P=0.900, P=0.923, P=0.282, P=0.300, respectively).

In this study, fasting led to decrease in uric acid, creatinine, selenium, sodium and potassium (P=0.00, P=0.015, P=0.021, 0.007 and 0.028, respectively), however, phosphor serum increased after fasting period (P=0.032). Moreover, no changes were seen in other biochemical parameters including fast blood sugar (FBS), urea, calcium, iron, zinc, and albumin (P= 0.54, P=0.300, P=0.054, P=0.372, P=0.170, and P=0.400, respectively).

**Conclusion:** This study on healthy subjects suggests that fasting could affect some hematological-biochemical parameters but not all of them. Also, these changes in hematological-biochemical parameters were within the normal range and Ramadan fasting seems to be safe for healthy subjects.

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### Introduction

Fasting is recommended in almost all religions, (1). Islam is also a religion practiced by about 2 billion individuals (approximately 23% of the world population), which requires its followers to fast for one month of a year, called Ramadan (2). In this month, Muslims should refrain from eating, drinking, smoking, taking medications, and injections from dawn to

sunset; however, children, menstruating women, patients suffering from severe illnesses, and passengers are exempt from fasting (3, 4). The Islamic calendar is lunar-based, so the duration of fasting can change from 12 to 18 hours depending on the season and latitude (5, 6). Since Ramadan fasting limits frequency of meals per day to two, it may cause several

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metabolic, biochemical, and hematological changes in people who fasts (7- 10).

In hematology, blood factors are measured, which may be helpful in identification of early signs of some diseases. Any difference in the size, shape, and number of blood cells can be early signs of blood dysfunction (11). Some studies showed that nutritional deficiency is one of the causes affecting hematological parameters (12). Anemia, the condition when hemoglobin level is less than 13.0 g/dL in males and 12.0 g/dL in females, is an indication of dietary deficiency in the world health (13, 14). In addition, biochemical tests that measure the blood's chemical components can be used to evaluate the various physiological state of body that may be affected by food and fluid intake (15, 16).

To our knowledge, this is the first study to examine the effects of Ramadan fasting on hematological-biochemical parameters in healthy subjects, simultaneously. Although Nasiri et al, investigated the effect of Ramadan on hematological parameters (17), their study design was different in methodology and they only evaluated hematological parameters. Hosseini et al. compared the effects of fasting on blood hematological-biochemical parameters between physically active and non-active groups (18). It is worth mentioning that their study concentrate on comparison between two groups with small sample population.

The aim of this research was to investigate the effects of Ramadan fasting on body mass index (BMI), hematological factors, and biochemical parameters in healthy subjects to help physicians offer appropriate medical advices to their patients.

## Material and methods

This prospective case-controlled study was conducted in Mashhad, Iran. The measurements were performed from June to July 2015, which covered one week before and one week after the month of Ramadan.

The ethical approval was obtained from the Ethics Committee of Mashhad University of Medical Sciences (Code Number: 940149). Before the study was started, we explained the objectives of the study to individuals and obtained their informed consent.

Healthy subjects (aged 20-50 years) who intended to practice fasting for at least 20 days

during Ramadan were included in this study.

Subjects with underlying systemic disease or previous internal surgery were excluded from the study. Also, we excluded individuals with certain medication and who did not participate in the second phase of this study. Healthy subjects who did not do physically active exercises in their routine life were selected.

A total number of 89 healthy cases underwent the tests sequences including BMI and blood hematological-biochemical analysis.

To determine BMI, height (m) and weight (kg) were measured using a measuring tape and scale, respectively. BMI was calculated using the standard formula (19).

Blood was collected from the brachial vein after a few minutes of rest (18). Fresh blood samples were immediately centrifuged and analyzed using the KX-21N cell counter (Kobe, Japan). Serum biochemical concentrations were determined using the Hitachi 717 analyzer (Roche, Japan).

The first blood sample was obtained one week before and the second samples were collected one week after Ramadan. The blood sample collections were performed by a single experienced physician in the morning between 8-o'clock and 10-o'clock (AM) and the instruments in this study were calibrated by the manufacturer's representative before the study.

A complete blood count includes the following information: hemoglobin, hematocrit, platelets, white blood cell (WBC), red blood cell (RBC) and RBC indices [mean red cell volume (MCV), mean corpuscular hemoglobin (MCH) and mean corpuscular hemoglobin concentration (MCHC)]. RBC indices calculated using formulas below:

$$MCV = (Ht/RBC) \times 100$$

$$MCH = (Hb/RBC) \times 10$$

$$MCHC = (Hb/Ht) \times 100$$

Statistical analyses were performed using SPSS software (SPSS version 23 for Windows; SPSS Inc., Chicago, IL, USA). The Kolmogorov-Smirnov test was used to assess the normality of the data. For parameters with a normal distribution, Paired sample t-test was employed to compare means between the groups, whereas Wilcoxon signed-rank test was used to compare the non-parametric parameters before and after Ramadan. The P-value less than 0.05 was

considered statistically significant.

## Results

One hundred people participated in the study, 11 individuals decided not to undergo the second phase and the result of 89 subjects [51 male (57.3%) and 38 female (42.7%)] were analyzed.

The mean age of the participants was 34.98±9.10 years (males: 35.51±8.93 and females: 34.26±9.40 years).

The mean height of subjects was 1.68±0.90 meter (1.74±0.06 m, for male subjects and

1.60± 0.05 m, for female subjects).

The demographic data for the participants are presented in Table 1. Our findings showed a 0.97 kg reduction in weight (1.06 kg in males and 0.87 kg in females) and a 0.33 kg/m<sup>2</sup> reduction in BMI after fasting period.

CBC is the most common blood test, which includes hemoglobin, hematocrit, platelets, WBC, RBC, MCV, MCH and MCHC. Mean ±SD and p-values of CBC parameters for both Genders, one week before and one week after Ramadan, are presented in Table 2.

**Table 1.** The demographic data

	Before Ramadan (Mean±SD)	after Ramadan (Mean±SD)	P- value
Weight (kg)			
Participants	77.59±16.28	76.62±15.84	<0.001 <sup>†</sup>
Male	84.68±14.40	83.62±13.95	0.005 <sup>†</sup>
Female	68.07±13.71	67.22±13.23	0.012 <sup>†</sup>
BMI (kg/m <sup>2</sup> )			
Participants	27.12±48.83	26.79±47.34	<0.001 <sup>†</sup>
Male	27.71±4.57	27.37±4.45	0.005 <sup>†</sup>
Female	26.34±5.22	26.01±5.04	0.013 <sup>†</sup>

BMI: Body mass index, <sup>†</sup>Paired-samples T test. \*Wilcoxon signed ranks test. P<0.05 is statistically significant. Bold values are significant.

**Table 2.** The Effects of Ramadan fasting on hematological parameters measurements using KX-21N cell counter

	Before Ramadan (Mean±SD)	after Ramadan (Mean±SD)	P- value
Hemoglobin (g/L)			
Participants	14.11±1.45	14.12±1.54	0.900*
Male	15.00±1.07	15.08±1.08	0.423
Female	12.91±0.94	12.83±1.06	0.481
Hematocrit (%)			
Participants	41.79±3.53	41.24±3.55	0.002*
Male	44.08±2.40	43.53±2.30	0.033
Female	38.72±2.22	38.18±2.46	0.026
Platelets (n/L)			
Participants	227.85±47.129	228.10±50.018	0.923*
Male	226.67±44.383	226.90±46.501	0.942
Female	229.45±51.148	229.71±54.985	0.950
WBC (10 <sup>9</sup> /L)			
Participants	1772.89±6.73	1617.65±6.58	0.282 <sup>†</sup>
Male	1770.61±26.63	1378.79±6.36	0.105
Female	1790.68±6.86	1871.32±6.87	0.974
RBC (10 <sup>12</sup> /L)			
Participants	4.85±0.44	4.79±0.46	0.030*
Male	5.11±0.32	5.08±0.32	0.243
Female	4.51±0.31	4.39±0.29	0.069
MCV (fL)			
Participants	86.48±3.19	86.22±3.27	0.005*
Male	86.20±3.22	85.71±3.24	<0.0001
Female	86.87±3.15	86.91±3.24	0.971
MCH (pg/cell)			
Participants	29.06±1.87	29.47±1.64	0.004 <sup>†</sup>
Male	29.34±1.65	29.67±1.54	0.002
Female	28.69±2.09	29.20±1.74	0.084
MCHC (g/dL)			
Participants	33.82±1.60	34.18±1.44	0.006*
Male	34.22±1.83	34.63±1.48	0.042
Female	33.29±1.049	33.58±1.15	0.049

CBC: complete blood count, WBC: white blood count, RBC: red blood count, MCV: mean cell volume, MCH: mean corpuscular hemoglobin, MCHC: mean corpuscular hemoglobin concentration. \*Paired-samples T test. <sup>†</sup>Wilcoxon signed-rank test. P<0.05 is statistically significant. Bold values are significant.

**Table 3.** The Effects of Ramadan fasting on biochemical parameters measurements by means of Hitachi 717 analyzer

	Before Ramadan (Mean±SD)	After Ramadan (Mean±SD)	P- value
<b>FBS</b>			
Participants	96.34±12.90	98.28±11.82	0.054 <sup>‡</sup>
Male	97.55±13.66	99.37±11.94	0.182
Female	94.71±11.77	96.82±11.65	0.169
<b>Urea (mg/dL)</b>			
Participants	32.54±9.82	31.60±6.84	0.300*
Male	36.02±9.39	33.75±6.84	0.085
Female	27.87±8.44	28.71±5.77	0.480
<b>Creatinine (mg/dL)</b>			
Participants	0.96±0.18	0.93±0.17	0.015 <sup>‡</sup>
Male	1.07±0.16	1.03±0.15	0.042
Female	0.83±0.11	0.80±0.09	0.182
<b>Uric acid (mg/dL)</b>			
Participants	4.73±1.30	4.34±1.46	<0.0001 <sup>‡</sup>
Male	5.4765±1.08399	5.1510±1.19421	<0.0001
Female	3.7426±0.82215	3.2605±1.05255	0.001
<b>Sodium (mg/dL)</b>			
Participants	2.74±1.39	2.21±1.38	0.007*
Male	2.40±1.40	2.26±1.38	0.003
Female	3.09±1.39	2.16±1.38	0.364
<b>Potassium (mg/dL)</b>			
Participants	4.19±0.24	4.11±0.24	0.028*
Male	4.16±0.24	4.11±0.25	0.238
Female	4.22±0.22	4.12±0.23	0.044
<b>Phosphor (mg/dL)</b>			
Participants	4.55±0.69	4.77±0.73	0.032 <sup>‡</sup>
Male	4.47±0.70	4.75±0.79	0.041
Female	4.65±0.66	4.79±0.65	0.369
<b>Calcium (mg/dL)</b>			
Participants	9.75±0.42	9.63±0.46	0.054 <sup>‡</sup>
Male	9.87±0.42	9.74±0.46	0.158
Female	9.59±0.37	9.47±0.43	0.190
<b>Iron (mg/dL)</b>			
Participants	78.34±29.17	81.93±35.017	0.372*
Male	84.89±25.45	87.40±34.27	0.642
Female	69.55±31.77	74.58±35.09	0.412
<b>Zinc (mg/dL)</b>			
Participants	76.29±8.37	74.61±7.21	0.170 <sup>‡</sup>
Male	77.61±8.79	76.60±6.63	0.548
Female	74.51±7.51	71.93±7.16	0.151
<b>Albumin (g/dL)</b>			
Participants	4.82±0.26	4.85±0.26	0.400 <sup>‡</sup>
Male	4.91±0.27	4.97±0.21	0.175
Female	4.70±0.20	4.68±0.22	0.644
<b>Selenium (mg/dL)</b>			
Participants	87.17±13.71	82.78±13.30	0.021 <sup>‡</sup>
Male	85.53±13.62	80.42±11.64	0.271
Female	89.38±13.69	85.96±14.81	0.016

FBS: fast blood sugar. \*Paired-samples T test. <sup>‡</sup> Wilcoxon signed-rank test. P<0.05 is statistically significant. Bold values are significant

A summary of the effects of Ramadan fasting on the biochemical parameters are shown in Table 3. Our results showed statistically significant reduction in some biochemical parameters.

## Discussion

A significant decrease was observed in weight and BMI in both genders. However, these changes were more remarkable in males than

females. Fakhzadeh et al. (20) and Noruzi et al. (21) reported similar findings.

No significant changes were observed in WBC and hemoglobin. A significant reduction in the hematocrit level was observed after Ramadan, which could result from incomplete dehydration augmented by stopping drinking and dietary changes in during Ramadan. Our findings are in agreement with those of Maughan et al. (12) study done on soccer

players. Also, Hosseini et al. (18) reported similar results for hematocrit but their study concentrate on comparison between two physically active and non-active groups with small sample size. Chaouachi et al. (22) noted an increase in hematocrit in elite judokas while Tayebi et al. (9) reported no change in this parameter in male weight-lifters. The disparity in the results may be due to sport and exercise regime. They focused on physically active people in their study but the present study concentrated on non-active subjects with routine life.

In the present study, fasting in the month of Ramadan had no effects on the platelet count, which is in contrast to the results reported by Ramadan et al. (16), who compared the effects of the fasting on hematological parameters of 13 male workers. This difference may be due to their small sample size.

Based on our findings, RBC declined after Ramadan in the total population but separate study of male and female participants for this parameter didn't show any reduction. This finding may indicate the effect of sample size. Tayebi et al. (9) failed to observe any significant changes in RBC but reported that MCV and MCHC were significantly decreased and increased in fasting group, respectively. These results were consistent with the present findings.

No significant change was observed in FBS, this is in accordance with finding of Saleh et al. (23). The mechanism that explain this outcome is physiological response. When a person refuses to eat for any reason, the blood glucose level reduces slightly but then increased gluconeogenesis and decreased glycolysis in the liver stabilize the blood glucose level (24). This process can be the reason for the constant blood sugar level during fasting. Also, Hosseini et al. (18), investigated FBS in two physically active and non-active fasting male groups and reported a significant decrease for FBS in physically active-fasting group, while there was no change for non-active group after Ramadan.

The current findings indicated a significant decline in creatinine and uric acid, which is contrary to the results of Trabelsi et al. (25) and Gumaa et al. (26). The increased serum creatinine levels and uric acid during Ramadan found in their studies can possibly be attributed

to the increased protein consumption in athletes.

Previous studies have reported different effects of Ramadan fasting on serum electrolytes (include sodium and potassium) (16, 27), which may be due to variations in the diet, activity level, and some cultural features (27). This study showed a significant decrease in sodium and potassium after Ramadan. The season of fasting also affects the extent of changes in the body water and electrolytes (16). This study was conducted during a period of time when Ramadan coincided with summer (June-July). Also, the time of second phase in this study was an influential factor on the outcomes of electrolytes because the second phase of measurements was performed one week after Ramadan. It was better to design the multi-phase study for monitoring serum electrolytes during fasting and non-fasting periods, which is considered as a limitation for our study.

In the current study, serum phosphorus increased and serum selenium decreased after fasting. No changes in other biochemical parameters including serum albumin, zinc, iron, and calcium were recorded at the end of the study.

Based on the previous literatures, the most common nutritional deficiency responsible for anemia is iron deficiency (28, 29). According to the values of the hemoglobin, red blood cell indices, and iron (Table 2), It can be concluded that Ramadan fasting does not lead to iron deficiency anemia. Since nutritional deficiencies of folic acid and/or vitamin B12 are other common types of nutritional anemia (28, 29), it is recommended to assess the effect of fasting on folic acid and vitamin B12 changes in subsequent studies. It is also suggested to evaluate the effects of Ramadan fasting on hematological-biochemical parameters in patients with anemia in future studies.

## Conclusion

The results of the present study showed that Ramadan fasting could affect some but not all hematological-biochemical parameters. Also, the changes in these parameters were within the normal limits; thus, Ramadan fasting seems to be safe for healthy subjects. These results can be used in clinical management.

## Conflicts of interest

The authors have no conflicts of interest.

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