Effects of Ramadan fasting on body composition and arterial stiffness

Yusuf Sezen, Ibrahim Halli Altiparmak, Muslihittin Emre Erkus, Aydemir Kocarslan, Zekeriya Kaya, Ozgur Günebakmaz, Recep Demirbag

Abstract

Objective: To examine the effects of Ramadan fasting on body composition, arterial stiffness and resting heart rate.

Methods: This prospective study was conducted at the Department of Cardiology, Harran University, Sanliurfa, Turkey, during Ramadan 2015, and comprised overweight and obese males. Body composition, arterial stiffness and echocardiography were assessed before and after Ramadan. Body composition was assessed by bioelectrical impedance analysis using segmental body composition analyser. Arterial stiffness and haemodynamic parameters were also measured. SPSS 20 was used for data analysis.

Results: Of the 100 subjects enrolled, 70(70%) were included. The overall mean age was 37±7 years. No significant changes were observed in blood pressures, resting heart rate, aortic pulse wave velocity, aortic augmentation index-75, aortic pulse pressure, brachial pulse pressure, basal metabolic rate, total body water, fat-free mass, and echocardiographic parameters (p>0.05 each). Although aortic pulse wave velocity (m/s) and augmentation index-75 (%) decreased after fasting period compared to that of before Ramadan, these reductions did not reach statistically significant levels (8.6±1.8 vs. 8.9±1.9, and 13.6±6.6 vs. 14.7±9.3, respectively; p>0.05 each). Body mass index, waist-hip ratio, body water rate, percentage of body fat mass, body fat mass, and visceral fat mass percentage were significantly reduced (p<0.05 each) after Ramadan.

Conclusion: Ramadan fasting had beneficial effects on body composition, but did not have any significant effect on arterial stiffness and resting heart rate.

Keywords: Ramadan fasting, Body composition, Arterial stiffness, Overweight, Obese. (JPMA 66: 1522; 2016)

Introduction

Ramadan is the most important lunar month for Islamic faith. Muslims avoid eating, drinking and smoking from dawn to sunset in this blessed month. The duration of Ramadan fasting (RF) on a certain day varies from region to region. This period may last up to 18 hours or more in countries close to the equator, especially in the summer. That is why, people living in these countries are exposed to long-term hunger and thirst for approximately 30 days during Ramadan. 1-3

Arterial stiffness (AS) results from functional and structural disorders of the vessel wall, and reflects the end-organ damage. Further, the more AS is raised, the more cardiovascular disease (CVD) risk is increased. 4,5 The AS thus is a strong predictor of the cardiovascular events. 6 The parameters of AS primarily include aortic pulse wave velocity (PWV) and augmentation index. 7 The PWV is measured by calculating the travel time of the pulse wave between two reference points. The higher values prove anatomical or functional arterial disorders. On the other hand, the augmentation index displaying compliance of the arteries is defined as a percentage of the height of a reflected wave relative to the incident wave. Its percentage is inversely correlated to arterial compliance. In other words, decreased augmentation index indicates the deterioration of compliance of the arterial system. 8 The resting heart rate (RHR) is also an independent predictor of cardiovascular disease like AS. The raised RHR is correlated with both atherosclerosis and cardiovascular events. 9 Previous studies have investigated the relationship between RHR and RF, and pointed out conflicting changes in RHR before, during and after RF. 10-12

In Turkey, the daytime is long during the summer (nearly up to 18 hours or more). In some studies, it was shown that the reduction of food and fluid intake would lead to changes in body composition (BC) especially during the long summer days. 3,13-15 On the other hand, other studies demonstrated no significant change in BC. 16-18

To our knowledge, there is no data about the effects of RF on AS, including PWV, and augmentation index. The current study was planned to simultaneously investigate the effects of RF on BC, AS and RHR in overweight and obese individuals.

Subjects and Methods

This prospective study was conducted at the Department
of Cardiology, Harran University, Sanliurfa, Turkey, during Ramadan 2015, and comprised healthy-appearing overweight and obese Muslim males. The subjects were enrolled within one week before the fasting month and were followed up a week after the month was over (Figure). Healthy-appearing, non-smoking overweight and obese Muslim males, who intended to fast, were included. The demographic data and medical history were taken, and detailed physical examination, echocardiographic assessment and the measurement of AS and BC were performed in all participants. All measurements were performed twice, i.e. within seven days before and seven days after Ramadan. The time of Ramadan was twenty-nine days. Physical examinations, medical histories and echocardiographic assessments in all participants were completely normal (except body mass indexes [BMI]) and they also did not use any medication.

Subjects who had overt clinical disorders (e.g. diabetes mellitus, cardiovascular disorders, renal or hepatic insufficiency and thyroid dysfunction), advanced age, smoking or alcohol consumption, using any medication, and those who did not complete the follow-up period due to any reason were excluded.

This study was carried out in accordance with the suggestions asserted by the Declaration of Helsinki. All of the measures were performed twice, i.e. within seven days before and seven days after Ramadan. The time of Ramadan was twenty-nine days. Physical examinations, medical histories and echocardiographic assessments in all participants were completely normal (except body mass indexes [BMT]) and they also did not use any medication.

All of the measurements were carried out at a similar time point by the investigators, and the average of at least three measurements was enrolled for each parameter.

All echocardiographic assessments were performed based on the recommendations of the American Society of Echocardiography (ASE) guidelines. It was implemented in the left lateral decubitus position by an ultrasound machine GE-Vingmed Vivid S6 system (GE-Vingmed Ultrasound AS, Horten, Norway) and M4S-RS (1.5-3.6 MHz) cardiac transducer. Left ventricle diameters and wall thickness were measured according to established standards. Left ventricle ejection fractions (LVEF) were calculated using modified Simpson's rule.

Categorical variables were expressed as percentages and continuous variables were expressed as mean ± standard deviation (SD). The distribution of data (the differences of
variables before and after RF) was established by Kolmogorov-Smirnov test. Statistical analysis was done using paired t-test for normal distributed data, and Wilcoxon signed-rank test was performed for abnormal distributed data. Bivariate correlation analysis was used to determine correlation between the differences of variable. P<0.05 was considered statistically significant. All analyses were conducted using SPSS 20.

Results

Of the 100 subjects enrolled, 70(70%) were included and 30(30%) were excluded. Of those who were excluded,

Table 1: Clinical parameters, anthropometric parameters, body composition and arterial stiffness measurements of before and after Ramadan fasting in all participants (n=70).

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Before RF (mean ± SD)</th>
<th>After RF (mean ± SD)</th>
<th>Ranges (minimum-maximum)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resting Heart rate (beats/min)</td>
<td>69.9 ± 8.9</td>
<td>72.4 ± 7.8</td>
<td>Before RF: 50-90</td>
<td>0.092</td>
</tr>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>120.2 ± 11.6</td>
<td>121.2 ± 10.2</td>
<td>Before RF: 93-140</td>
<td>0.397</td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>73 ± 11</td>
<td>73 ± 9</td>
<td>Before RF: 53-90</td>
<td>0.883</td>
</tr>
<tr>
<td>LV end diastolic diameter (mm)</td>
<td>46.2 ± 2.1</td>
<td>46.1 ± 2.0</td>
<td>Before RF: 42-51</td>
<td>0.26</td>
</tr>
<tr>
<td>LV end systolic diameter (mm)</td>
<td>32.1 ± 1.9</td>
<td>32.0 ± 1.7</td>
<td>Before RF: 28-36</td>
<td>0.219</td>
</tr>
<tr>
<td>LV septal wall diameter (mm)</td>
<td>8.9 ± 1.1</td>
<td>8.9 ± 1.0</td>
<td>Before RF: 7-11</td>
<td>0.894</td>
</tr>
<tr>
<td>LV posterior wall diameter (mm)</td>
<td>7.8 ± 0.9</td>
<td>7.6 ± 0.8</td>
<td>Before RF: 6-9</td>
<td>0.054</td>
</tr>
<tr>
<td>LV ejection fraction (%)</td>
<td>63.3 ± 2.2</td>
<td>63.6 ± 1.9</td>
<td>Before RF: 60-68</td>
<td>0.081</td>
</tr>
<tr>
<td>Body mass index (kg/m2)</td>
<td>27.9 ± 2.6</td>
<td>27.5 ± 2.5</td>
<td>Before RF: 25.0-33.1</td>
<td>0.000*</td>
</tr>
<tr>
<td>Waist/hip rate</td>
<td>0.99 ± 0.09</td>
<td>0.92 ± 0.04</td>
<td>Before RF: 0.88-1.24</td>
<td>0.000*</td>
</tr>
<tr>
<td>Body composition parameters</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basal metabolic rate (kcal)</td>
<td>1849 ± 202</td>
<td>1838 ± 197</td>
<td>Before RF: 1472-2407</td>
<td>0.08</td>
</tr>
<tr>
<td>Body fat mass (%)</td>
<td>22.5 ± 5.0</td>
<td>21.7 ± 4.6</td>
<td>Before RF: 12.1-38.1</td>
<td>0.009*</td>
</tr>
<tr>
<td>Body fat mass (kg)</td>
<td>18.5 ± 5.2</td>
<td>17.6 ± 4.7</td>
<td>Before RF: 14.8-35.8</td>
<td>0.002*</td>
</tr>
<tr>
<td>Visceral fat mass (%)</td>
<td>8.4 ± 3.1</td>
<td>7.9 ± 2.9</td>
<td>Before RF: 1.0-14.0</td>
<td>0.000*</td>
</tr>
<tr>
<td>Fat-free mass (kg)</td>
<td>63.0 ± 6.9</td>
<td>62.7 ± 6.7</td>
<td>Before RF: 48.5-81.2</td>
<td>0.026</td>
</tr>
<tr>
<td>Body water rate (%)</td>
<td>56.7 ± 3.6</td>
<td>57.4 ± 3.3</td>
<td>Before RF: 47.0-62.3</td>
<td>0.003*</td>
</tr>
<tr>
<td>Total body water (kg)</td>
<td>46.1 ± 5.1</td>
<td>46.0 ± 5.0</td>
<td>Before RF: 35.5-59.4</td>
<td>0.447</td>
</tr>
<tr>
<td>Arterial stiffness parameters</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Pulse wave velocity aortic (m/s)</td>
<td>8.9 ± 1.9</td>
<td>8.6 ± 1.8</td>
<td>Before RF: 4.5-13.1</td>
<td>0.187</td>
</tr>
<tr>
<td>Augmentation index aortic 75 (%)</td>
<td>14.7 ± 9.3</td>
<td>13.6 ± 6.6</td>
<td>Before RF: 2.3-37.9</td>
<td>0.199</td>
</tr>
<tr>
<td>Pulse pressure aortic (mmHg)</td>
<td>38.6 ± 8.7</td>
<td>38.0 ± 7.4</td>
<td>Before RF: 26.4-65.6</td>
<td>0.564</td>
</tr>
<tr>
<td>Pulse pressure brachial (mmHg)</td>
<td>46.9 ± 7.8</td>
<td>47.8 ± 7.8</td>
<td>Before RF: 34.0-69.0</td>
<td>0.401</td>
</tr>
</tbody>
</table>

LV: Left ventricle. RF: Ramadan fasting. SD: Standard deviation. 
* P<0.05.
14 (46.67%) could not continue Ramadan fasting, 12 (40%) failed to come to the second evaluation on time and 4 (13.33%) were out of the province during the second assessment. The overall mean age of the subjects was 37±7 years (range: 22-49 years) and the mean BMI was 27.9±0.6 kg/m² (range: 25-33.1). The mean daily fasting period was 16.68±0.11 hours. BMI, waist-hip ratio, percentage of BFM, BFM, and visceral fat mass were significantly lower after Ramadan compared with before Ramadan (p<0.001, p<0.001, p<0.002, p<0.001, respectively), while body water rate increased during this period (p=0.003). However, no significant changes were observed in other parameters, including RHR (p=0.092), the basal metabolic rate (p=0.080), the fat free mass (p=0.262) and the total body water (p=0.447). Additionally, a significant change in both systolic blood pressure and diastolic blood pressure was not observed (p>0.05 each). Also, echocardiographic parameters were similar between before Ramadan and after Ramadan (p>0.05 each).

Although PWV were lower after fasting period compared to those of before Ramadan, this did not reach statistically significant level (p=0.187). Similarly, other haemodynamic parameters including Alxao-75, and aortic and brachial pulse pressures slightly changed in this period, but did not reach statistical significance (p>0.05 each) (Table-1).

In addition, bivariate correlation analysis for changes before and after Ramadan showed a significant relationship between those parameters; PWV-RHR (p=0.023), visceral fat mass ratio-BFM, and waist-hip ratio (p<0.001, p<0.001, respectively), percentage of BFM-BMI and waist-hip ratio (p<0.001 each), and body water ratio-BMI and waist-hip ratio (p=0.003 and p=0.001, respectively). However, no significant changes were observed between other parameters in bivariate correlation analysis (p>0.05) (Table-2).

**Discussion**

In the current study, RF gave rise to significant decrease in BMI, waist-hip ratio, visceral fat mass (%), and BFM (kg), but not basal metabolic rate (kcal), fat-free mass (kg), and total body water (kg). Moreover, RF did not have any significant effect on RHR, and parameters of AS (mainly PWV, Alxao-75 and aortic and brachial pulse pressure).

Muslims are exposed to some changes with regard to eating, drinking and sleep pattern during the holy month of Ramadan. Although this condition can be well tolerated by healthy people on short and cool winter days, it might result in some metabolic changes on long and hot summer days. Since eating and drinking are allowed only for night time in Ramadan, not only the feeding time decreases but also sleep pattern is disrupted. On the other hand, fluid loss and decrease in energy intake may be observed during the summer days.1,2,3

Some studies showed the contradictory results about the effects of RF on RHR.10-12 A study demonstrated considerably decreased RHR after RF with the mean RHR
of 63.1 beats/min before RF and 58 beats/min after RF in the subjects engaged in regularly and intensive sport activities. However, the present study comprised only healthy individuals without regular sport activity. On the other hand, a study pointed out that the RHR showed no significant change after Ramadan compared with before Ramadan. The subjects of that study had the same characteristics as in our study (healthy-appearing non-sportive volunteers). Also, the study showed that prolonged fasting time and changes in sleep cycles gave rise to increase in parasympathetic activity. Our study did not show significantly changed RHR. A study by Guvenc et al. involving soccer players also showed no change in RHR in the same time periods. We believe that our study population reflects more accurately the general population than that of Guvenc et al.

Although traditional anthropometric measurements such as BMI and waist-hip ratio may be used, the assessment of BC gives the more valuable information for distribution of fat mass, fat-free mass, total body water and other parameters. Overview of literature demonstrated controversial results about the effects of RF on BC changes. In one group of studies, patients had a considerable change in their BC. However, in another group, patients had an insignificant change or no change in their BC. Karli et al. pointed out that there were no significant changes in body weight, BMI, fat-free mass, and percentage of body fat associated with RF in power athletes. Rohin et al. also reported no significant changes in BC in individuals with different weight. On the contrary, Sadiya et al. investigated the effect of RF on BC and metabolic parameters in participants with metabolic syndrome, and proved that the patients lost weight and reduced their waist circumference. A study done by Norouzy et al. showed considerable changes in BC and anthropometric measurements. When study results were evaluated according to age and sex, it showed that RF led to fat-free mass reductions and weight loss in all groups, but the percentage body fat was considerably lower after RF in males only. Yucel et al. reported that there were no significant differences between before and after Ramadan in terms of the visceral fat tissue area by computed tomography (CT) and other BC parameters in male subjects. However, in our study comprising only male volunteers, fat-free mass was not varied, whereas visceral fat mass, BFM, and BMI were substantially decreased. Additionally, there were significantly positive correlations between the reduction of BMI and the reduction of BFM and visceral fat mass, while there were inverse correlations between the reduction of waist-hip ratio and the above mentioned values. We believe that since participants may be fed abundant fluid and protein rather than carbohydrates and fat-rich diet from sunset to sunrise, the reductions of BFM, visceral fat mass and BMI were shown, and that the cause of inverse relation of them with waist-hip ratio may be due to earlier reduction of waist circumference fat mass than that of hip. Another interesting positive correlation was shown between visceral fat mass and systolic blood pressure, and this result supported previous studies indicating visceral fat mass played a significant role for development of hypertension. However, to say anything definite, diets of individuals may be required to be standardised in suitable proportions. This condition can be explained by other studies. In addition, the present study also revealed a significant reduction in BMI and waist-hip ratio. We consider that acquired dietary habits in Ramadan should be continued throughout the year to sustain these favourable effects.

To our knowledge, no previous study has investigated the relationship between RF and detailed parameters of AS. However, there is only one study addressing the effects of RF on arterial pulse pressure, lipid profile and oxidative stress in hypertensive patients. This study indicated that the RF improved arterial pulse pressure which is a parameter of AS. We evaluated detailed AS parameters including PWV, aortic pulse pressure, brachial pulse pressure and Alxao-75. The present study has showed no significant change in these parameters. In our study, although the aortic pulse pressure increased, it did not reach statistical significance. This result was contrary to the abovementioned study performed with 40 subjects. However, both our sample sizes were larger than that study, and our results were supported by PWV and Alxao-75 without significant changes. Despite both results, we think that there is need for more studies with larger sample sizes.

As a consequence, our results showed that Ramadan fasting significantly ameliorated BC including visceral fat mass, which is a predictor of cardiovascular risk, and that Ramadan fasting reduced PWV without statistically significant results. Taken together, we think that if Ramadan habits can be continued longer, it may have positive effects of RF on AS.

The current study has some limitations as well. First, the sample size was small because the inclusion of the participants was limited to only one week before the onset of Ramadan. Second, the participants were only male subjects because women did not fast during the menstrual periods. Third, dietary and sleep patterns and physical fitness status of the participants were not optimised from sunset to sunrise. Fourth, in terms of

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assessment of RHR, we did not take into account the exercise capacity and depression-anxiety-stress scales of individuals.

**Conclusion**

RF did have beneficial impacts on BC but it did not have any significant effect on the parameters of AS and RHR in overweight and obese individuals. However, the lifelong continuation of eating habits like Ramadan fasting may provide beneficial effects on cardiovascular system.

**Disclaimer:** None.

**Conflict of Interest:** None.

**Source of Funding:** None.

**References**