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The Effects of Aerobic Exercise during Ramadan on the Levels of Leptin and Adiponectin in Overweight Women

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ABSTRACT

Introduction: Several epidemiological studies have indicated factors such as Leptin level, Adiponectin and plasma leptin –to-adiponectin index to be the predicting biomarkers for cardiovascular diseases. Given the importance of healthy nutrition and adequate exercise in reducing the risk of Atherosclerosis, this study aimed to investigate the effects of fasting and aerobic exercise on the level of leptin and adiponectin in overweight women.

Materials and Methods: In this study, 27 overweight and obese women with the body mass index (BMI) of ≥25 kg/m^2 and the age range of 45-20 years were selected by targeted sampling and were divided into two groups of fasting accompanied with aerobic exercise (N=15), and fasting only (N=12). The active group had an exercise protocol including three 60-minute sessions of aerobic exercise per week, with a 50% to 65% of heart rate reserve. Anthropometric dimensions and blood levels of leptin and adiponectin were measured in all the subjects before, at the second week and the fourth week and one week after Ramadan. Data were analyzed using repeated measures and the significance level of P≤0.05 was considered.

Results: In this study, one month of fasting accompanied with aerobic exercise had a significant effect on the amount of leptin, adiponectin and leptin-to-adiponectin ratio (P<0.05). However, no significant differences were observed between the two study protocols in terms of changes in leptin, adiponectin and leptin-to-adiponectin ratio in the two study groups.

Conclusion: According to the results of this study, aerobic exercise during Ramadan could not result in any significant changes in the level of leptin, adiponectin and leptin–to-adiponectin index in comparison to fasting alone. The insignificant differences in the changes of leptin and adiponectin indices between the two study protocols could be due to the insufficient number of aerobic exercise sessions, as well as the low intensity and duration of the exercises.

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Introduction

Obesity is the most prevalent metabolic disorder in the world and the main cause of many other diseases, which are associated with reduced quality of life (1).

In modern medicine, fat tissues are known to play a pivotal role in inflammation, production of various cytokines, and causing metabolic changes; therefore, they are considered as endocrine tissues. Furthermore, the accumulation of these tissues in the central parts of the body, which causes abdominal obesity, increases the risk of cardiovascular mortality through mediating inflammation and production of hormones, which may alter the metabolism of glucose and lipids (2). Some of these hormones, which are generally referred to as Adipocytokines, have a key role in the development of inflammation during the process of Atherosclerosis (3).

Leptin is the most significant hormone secreted by fat tissues representing the principal proportion of stored fat in the body. By increasing the metabolism, leptin regulates the amount of required energy controlling the amount of body fat. The plasma levels of leptin are directly correlated with stored body fat and respond to the changes in the energy balance of the body (4).

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Physiological factors such as fasting, exercise and exposure to cold affect the serum levels of leptin and reduce the amount of this hormone in blood circulation (5). Serum leptin levels are directly associated with the proportion of stored body fat, and weight loss could decrease these levels. Moreover, short-term fasting is known to reduce leptin levels while overeating could increase this index (6).

Leptin serum concentrations could be considered as the environmental messengers regulating food intake and energy expenditure, and obesity could be associated with higher levels of leptin (7).

Adiponectin is another hormone secreted by the adipose tissue (8). Unlike other cytokines originating from this tissue, serum levels of adiponectin are inversely associated with obesity, body mass index (BMI), body adiposity index, cardiovascular diseases, insulin resistance and dyslipidemia (9).

The precise physiological role of adiponectin remains unclear; however, current information indicates that adiponectin has anti-atherogenic and anti-inflammatory properties, which explain the protective effects of this hormone at the onset and during the progression of atherosclerosis (10). Accordingly, decreased levels of adiponectin in men could independently increase the risk of cardiovascular diseases (11).

Furthermore, adiponectin is known to improve insulin sensitivity and prevent inflammation in blood vessels; several studies conducted on rodents have demonstrated that adiponectin is able to reduce blood glucose levels and prevent fat accumulation in skeletal muscles.

Adiponectin inhibits the synthesis of tumor necrosis factor alpha (TNF-α) and the function of interleukin 6 (IL-6), which reduce the production of C-reactive protein (CRP) resulting in the inhibition of inflammatory responses. The subsequent reduction in the ICAM-1 gene expression and improvement of the endothelial function slows down the progression of atherosclerosis.

Recent studies have indicated that the level of adiponectin could increase in individuals with long-term, caloric-restricted diets; in other words, low serum adiponectin levels, which are present in obese individuals, are likely to increase due to weight loss (9, 12). Nevertheless, in a study by Maestu et al. (2008), no changes were observed in the levels of adiponectin in a group of weight-training men after 10 weeks of interventional training despite the significant reduction in their weight and body fat percentage (6.5%) (13). Similarly, Madsen et al. claimed that such a significant increase in the levels of adiponectin was only possible through a relatively substantial weight loss (>10-11%) (14).

On the other hand, several researchers consider baseline leptin and adiponectin levels as potential atherogenic markers; they also presume that the leptin-to-adiponectin ratio could be a proper indicator for the assessment of insulin resistance (15, 16).

High levels of leptin are generally associated with high insulin levels, such that in obese individuals, high levels of leptin might reduce the response of pancreatic β-cell receptors causing an increase in insulin secretion. Furthermore, hyperinsulinemia could independently increase leptin levels and intensify obesity.

Recent studies have confirmed a significant association between the leptin-to-adiponectin ratio and increased levels of leptin with factors such as decreased insulin sensitivity, increased BMI, waist circumference, systolic and diastolic blood pressure, fasting blood glucose, insulin and insulin resistance index (17, 18).

According to several studies, changes in dietary patterns and lifestyle could result in decreased inflammation and changes in the production of adiponectins while reducing the risk of cardiovascular diseases (19).

Physical activity is one of the most beneficial interventions to modulate inflammatory mediators; many experts have reported a significant association between increased levels of inflammatory markers and lack of physical activity, regardless of the development of obesity.

Performing physical activity, especially aerobic exercises, is an effective approach to diminish the consequences of diseases induced by obesity. In addition to exercise, changes in the dietary patterns could remarkably decrease the risk of cardiovascular diseases.

On the other hand, fasting is an effectual method of changing eating habits among Muslims and is considered as an energy-restricted diet; however, it should be noted that Islamic fasting is distinct from other types of fasting (20, 21).

According to the regulations of Islam, fasting is mandatory for all healthy, adult Muslims in the month of Ramadan. During this month, Muslims should abstain from eating and drinking from dawn to sunset for 30 consecutive days. During Ramadan, the type and amount of the energy received by fasting individuals see a noticeable change; similarly, the patterns of sleeping and daily physical activities are different from other times of the year. Therefore, the evaluation of cytokine changes caused by starvation in Islamic Fasting has been a major concern in the field of medicine (22, 23).

Several studies have investigated the effects of regular physical activity on the levels of adiponectin and leptin in normal dietary patterns suggesting that regular physical activity could significantly increase adiponectin concentration, compared to baseline levels, in overweight women. However, only a few studies have evaluated the biological response of the body to physical activity during the fasting month of Ramadan.

Given the fact that over a billion Muslims live across the world and hundreds of millions of them are required to fast as to fulfill their religious duties, this study aimed to examine the effects of aerobic exercise during Ramadan on the levels of adiponectin and leptin in overweight women.

Materials and Method

In this quasi-experimental research, 27 overweight and obese women with a BMI of ≥25 kg/m^2 and age range of 20-45 years were selected by purposive sampling. All the participants were healthy with no history of respiratory, metabolic, cardiovascular, renal and hepatic diseases. In addition, the subjects had no smoking habits or history of participation in regular exercise programs.

The exclusion criteria of this study were as follows: 1) long-term use of medications; 2) orthopedic injuries; 3) absence from more than two consecutive sessions of the study and 4) interruption of fasting for more than 10 days. The subjects were allowed to leave the study for any reasons at any time.

Before providing informed consent from the participants, they were fully notified on the terms of cooperation in the research project including essential points about exercise, nutrition, use of medications, tobacco consumption and use of dietary supplements. Following that, the subjects completed self-report demographic and health status questionnaires.

The study samples were randomly divided into two groups of fasting only (N=12) and fasting accompanied with aerobic exercise (N=15). During the study, four members from each group were excluded due to non-compliance with the requirements of the study. Weight and height of the participants were measured one week before the beginning of Ramadan and during the last week of the month using Seca scales and height gauges.

In addition, hip and waist circumference were measured in centimeters using a tape meter, and body fat percentage was measured based on the percentage of body weight using InBody720 bioelectrical impedance (made in South Korea).

By the division of the body weight by the square of height, BMI (kg) was acquired, and by dividing the square meters of waist to hip circumference, the waist-to-hip ratio (WHR) was obtained.

In this study, blood samples were provided via serial sampling in four intervals; the first sampling was carried out three days before the start of Ramadan, and the second, third and fourth were respectively performed at the end of the second week, end of the fourth week and two weeks after the end of Ramadan through the same process.

Before the beginning of the study, all the participants, especially the subjects in the aerobic exercise-fasting group, were asked to avoid any physical activity prior to blood sampling. Blood samples were taken by a specialist from the right brachial vein of the subjects (10 ml) after 12 hours of fasting between 8:00-10:00 A.M. For measuring the leptin and serum levels of adiponectin, we used the ELISA Kit manufactured by Cosmo Bio Co. Ltd. (Tokyo, Japan).

In this study, the duration of fasting in the month of Ramadan (August) was about 16 hours per day, and the subjects in the fasting-only group had no regular physical activities during this period. On the other hand, the aerobic exercise-fasting group adhered to the physical activity protocol from the first week of Ramadan until the end of the fourth week.

The training programs were performed under the direct supervision of the researchers

in three 60-minute sessions per week. Each session was composed of the following: 10 minutes of warm-up, 45 minutes of interval walking/running on the treadmill with the intensity of 50-65% of the maximum heart rate, and 5 minutes of cool-down. Workout intensity was controlled by an Electronic Stethoscope Polar Model manufactured by Polar Team System, Finland.

Data analysis was carried out using SPSS V.16, and after checking the normal distribution of data and homogeneity of variance by the Levene's test, analysis of variance and repeated measures were performed in order to compare the means of inter- and intra-groups. A P value of ≤0.05 was considered as significant

Result

According to the information in Table 1, one month of fasting accompanied with aerobic exercise resulted in a significant reduction in the body weight, BMI and waist-to-hip circumference (P<0.05), and although the percentage of body fat reduced as well, this reduction was not considered significant.

On the other hand, one month of fasting alone caused a significant reduction in the body weight (P<0.05) while the reduction in the BMI, waist-to-hip circumference and body fat percentage was not significant. In general, the comparison of the two study protocols indicated that a month of fasting with and without aerobic exercise had no significant effects on the body weight, WHR, BMI and body fat percentage.

According to the information in Table 2, the changes within the aerobic exercise-fasting group were indicative of a significant difference in the variables of leptin, adiponectin and leptin-to-adiponectin ratio. However, the changes in these variables in the two groups showed no significant differences between the two study protocols.

Discussion

According to the results of this study, one month of fasting accompanied with aerobic exercises could significantly reduce the body weight, BMI and WHR while a month of fasting without exercise only caused a significant reduction in the BMI, and no significant

Table 1. Changes in Body Size and Body Composition of FE (N=15) and FNE (n=12) during Different Stages/ Changes in the Means of Inter- and Intra-groups

Variable	Group	Stage		Variation			
		Week Before Ramadan	Week After Ramadan	P Value [a]		P Value [b]	
				F	P	F	P
Weight, Kg	FE[c]	79.9±13.2	78.4±13.2	18.59	0.001*	0.42	0.52
	FNE	69.9±8.8	68.8±8.0				
BMI, Kg/m²	FE	31.5±5.2	31.0±5.5	18.43	0.001*	0.27	0.60
	FNE	27.9±2.8	27.5±2.4				
WHR	FE	0.93±0.06	0.92±0.06	7.16	0.016*	0.15	0.69
	FNE	0.89±0.05	0.88±0.05				
Body fat percent, %	FE	44.4±5.7	43.9±5.2	0.86	0.36	0.45	0.50
	FNE	41.2±4.7	41.1±4.6				

[a] P Value within group
[b] P Value between group
[c] Abbreviations: FE: fasting+exercise, FNE: fasting+non exercise

Table 2. Changes in Serum Hormone Values in FE (N=15) and FNE (N=12) during Different Stages/Changes in the Means of Inter- and Intra-groups

Variable	Group	Stage				Variation			
		Week Before Ramadan	Day 15 of Ramadan	Day 28 of Ramadan	Week after Ramadan	P Value [a]		P Value [b]	
						F	P	F	P
Leptin (ng/ml)	FE[c]	24.0±10.9	21.8±15.5	22.9±20.2	18.6±8.6	3.31	0.027*	0.79	0.50
	FNE	22.4±5.7	19.7±7.8	15.1±6.2	14.0±4.6				
Adiponectin (ng/ml)	FE	7.8±2.7	8.3±2.6	8.7±3.0	11.1±3.1	8.84	0.009*	2.06	0.11
	FNE	9.1±3.6	10.6±3.8	10.1±3.0	10.9±2.7				
Leptin/ Adiponectin	FE	3.27±1.6	2.69±1.4	2.66±1.7	1.70±0.7	8.69	0.001*	0.34	0.79
	FNE	2.97±1.6	2.30±1.8	1.79±1.4	1.36±0.6				

[a] P Value within group
[b] P Value between group
[c] Abbreviations: FE: fasting+exercise, FNE: fasting+non exercise

difference was observed in the body fat percentage between the two study groups.

In this regard, the studies conducted by Saleh Mansi (2007), Al-Hourani (2007), Haghdoost (2009) and Tayebi (2010) also reported weight loss in the subjects during the fasting month of Ramadan, which is consistent with the findings of the current study (24-27). On the other hand, Ramadan (2002) reported no significant changes in the body weight after Ramadan, and Yousef Boobes (2009) and Maislos (1993) observed weight gain in their subjects during Ramadan, which are incompatible with the findings of the current study (28-30). According to the results obtained in the present study, since no significant change was observed in the body fat percentage, the reduction in the body weight during Ramadan could be due to decreased fluid intake and glycogen reserves.Furthermore, our findings indicated that although the changes in leptin levels of the blood were not significant between the study groups, fasting alone or accompanied with aerobic exercise could lead to a decrease significant in leptin levels.

Fasting also causes alterations in the sleep-wake cycle and changes the serum levels of long-term regulators of energy intake and fat storage in the body, such as leptin (4). Leptin is associated with loss of appetite and increased fat oxidation in the body; leptin serum concentration is higher in obese individuals compared to those with normal body weight, and it is directly correlated with body fat mass (31).

The findings of the present study are consistent with the results of Hasani et al. (2012) and Dubuc et al. (1998) (32, 33), while they are incompatible with the findings of Ranjbar et al. (2013) and Kassab (2003), (34, 35). In their study, Ranjbar et al. reported an increase in leptin concentration in fasting-only and aerobic exercise-fasting groups, which was not considered statistically significant. According to their findings, this change was due to the insignificant increase in the leptin concentration and dietary fat percentage in the studied subjects by the end of Ramadan (34).

The secretion and injection of leptin from the adipose tissue reduces in response to hunger, whereas it enhances in response to a positive energy balance induced by overeating (36). Leptin serum concentration has been shown to have a direct association with the body fat percentage; in a study by Zarghami et al. (2010), serum levels of leptin were observed to be three times higher in obese women compared to women with normal body weight, and a direct correlation was also observed between leptin and BMI (37). Moreover, other studies have reported a correlation between leptin serum concentration and BMI, body fat percentage, fat deposits, and subcutaneous fat thickness (32).

This association is three times more prevalent in obese women compared to obese men (38). The results of the present study were indicative of a no significant decrease in the percentage of body fat between the two study groups during Ramadan compared to the beginning of the month. Therefore, lack of significant changes in leptin concentrations in this study could be due to the unchanged percentage of the body fat in the subjects.

Another studied variable in our research was blood adiponectin, which, according to the findings of this study, had a significant increase in the aerobic exercise-fasting group; however, this change was not considered to be statistically significant between the groups. The findings of this study in this regard are consistent with the results of Sharifi et al. (2010) and Ryan et al (2003) (2, 39), while they are incompatible with the findings of Hotta et al. (2000) (40). In the study conducted by Sharifi et al. (2010), 40 subjects with metabolic syndrome and 21 healthy individuals were evaluated, and adiponectin serum levels were measured in all the subjects one week before Ramadan as well as the end of the month.

In the current study, no significant changes were observed in the adiponectin levels during Ramadan in fasting individuals with and without metabolic syndrome. The researchers concluded that no adiponectin changes during the fasting month of Ramadan could be due to the lack of changes in the body weight, waist circumference and body fat percentage possibly caused by short-term fasting and inappropriate dietary pattern during Ramadan (2).

In adults, the levels of adiponectin are inversely associated with the body fat percentage; some studies have suggested that adiponectin might increase in patients with long-term calorie-restricted diets, and fasting could be considered as an energy-restricted diet (41). However, Ryan et al. (2003) reported no significant changes in

serum adiponectin levels after a six-month period of weight loss accompanied with training programs in postmenopausal women. Furthermore, they stated that if the weight loss is about one-quarter to one-tenth of the individual's body weight, it could lead to a significant increase in adiponectin concentrations (39).

In another study, Hotta et al. (2000) claimed that after a caloric-restricted diet for 2 months in non-diabetic patients, a 10% reduction was observed in the BMI, and the adiponectin levels increased by 42%. However, the results of the current study indicate that the reduction observed in the indices of body weight, BMI and WHR was probably an effective factor in the increase of adiponectin concentrations (40).

In addition, the results of the present study were indicative of a reduction in the leptin-to-adiponectin ratio, which could be due to the decreased amount of leptin and increased amount of adiponectin during Ramadan.

In another study, Mazzli et al. (2006) observed that a slight weight loss could lead to a significant reduction in plasma leptin levels whereas adiponectin concentrations remained unchanged; consequently, no significant change was observed in the leptin-to-adiponectin ratio (42). Recent findings have also revealed that the reduction of leptin and leptin-to-adiponectin ratio are associated with improved insulin sensitivity and decreased indices of BMI, fasting blood glucose, insulin and insulin resistance index. Therefore, the reduction of leptin-to-adiponectin ratio could be a testament to the improved health status of individuals (16).

Conclusion

According to the results of this study, aerobic exercise during Ramadan could not result in any significant changes in the level of leptin, adiponectin and leptin-to-adiponectin index in comparison to fasting alone. The lack of significant changes in leptin and adiponectin levels between the two study protocols could be due to the insufficient intensity, number of sessions and duration of aerobic exercises in this study.

Given the remarkable effects of nutrition and dietary patterns on the changes of body fat percentage and cardiovascular risk factors, it is recommended that the effects of exercise and controlled diet on these variables be investigated in future studies.

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