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Effects of Islamic Fasting on Glucose and Lipid Profiles, Body Mass Index, Adiponectin and Leptin Levels in Obese Individuals

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ABSTRACT

Introduction Fasting is an Islamic practice, which causes various metabolic changes in fasting individuals. Numerous studies have examined different aspects of fasting, but its effect on individuals with different characteristics such as obesity has remained unknown. The impact of fasting on adipose tissue hormones such as leptin and adiponectin is still controversial. In this study, we aimed to examine the effect of Islamic fasting on glucose and lipid profiles, as well as plasma adiponectin and leptin concentrations in fasting obese and normal-weight individuals.

Methods: Obese and normal-weight individuals from Yazd, Iran, who fasted during Ramadan were divided into two groups (n=24). Blood samples were taken from all the participants after 10-12 fasting hours two days before and one day after Ramadan to assess glucose and lipid profiles and plasma adiponectin and leptin concentrations. The individuals who were not able to fast for at least 21 days due to inflammatory or infectious diseases and those who received oral medications or supplements during Ramadan were excluded from the study.

Results: Variations in weight, body mass index (BMI), total cholesterol, high-density lipoprotein cholesterol (HDL-c), the ratio of total cholesterol to HDL-c were significant in the obese group ($P<0.05$). There were no significant changes in leptin and adiponectin levels in obese cases. Variables such as weight, BMI, and triglycerides and leptin levels decreased significantly, while adiponectin level did not change significantly in normal-weight cases.

Conclusion: Islamic fasting can prevent cardiovascular diseases in obese and normal-weight individuals through reducing weight, BMI, and some blood lipids, elevating HDL-c level, and changing the concentration of some adipokines.

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Introduction

High-caloric intake and subsequent obesity increase incidence of diabetes, metabolic syndrome, and insulin resistance and elevate plasma lipid and inflammatory mediators' levels (1, 2), which significantly enhances the risk of cardiovascular diseases. If individuals are not able to resolve risk factors of cardiovascular diseases, they can at least modify their lifestyle to prevent these complications (3). Fasting can be referred to as transformation of lifestyle and dietary habits among Muslims.

Individuals are mainly encouraged to fast due to Islamic reasons; this ritual practice significantly affects well-being. There are more than one and a half billion Muslims around the globe, most of whom are living in Asia (69%) and Africa (27%) (4).

Assuming that millions of Muslims fast during

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Ramadan, Islamic fasting is a unique physiological model (5). During Ramadan, Muslims abstain from eating, drinking, and smoking from dawn (sunrise) to sunset (Iftar (The time when fasted individuals are allowed to break fasting and begin eating is called Iftar)). Fasting individuals are only allowed to eat from Iftar to dawn (6). Fasting, as an obligation in Islam, has various physiological effects on the body through changing sleep-wake cycle and eating and drinking habits (7).

Normally, every individual fasts for 29 or 30 days from 13 to 18 hours per day depending on seasonal conditions or geographical location. There are confounding factors on the relationship between fasting and health; different possible reasons for the confounding factors are as follows: heterogeneity of findings in fasting hours, smoking times, drug or intravenous fluids intake, eating habits, and changes in lifestyle (8).

Adipose tissue is known as an endocrine organ rather than an inactive energy reservoir. Adipocytes produce macrophages and mesenchymal cells, which penetrate each other. Adipocytes also produce cytokines and adipocytokines with essential regulatory effects on inflammation, insulin sensitivity, coagulation, vascular homeostasis, appetite, energy, etc. Disturbance in these regulatory effects leads to insulin resistance and cardiovascular diseases. Adipocytes produce important proinflammatory adipocytokines such as leptin, tumor necrosis factor (TNF) alpha, resistin, angiotensinogen, interleukin 6, and plasminogen activator inhibitor-1, which are atherogenic as C-reactive protein (CRP) and non-ester fatty acids (2). Adipose tissue mainly secretes leptin hormone, which increases body fat mass (9). Leptin is described as a factor instigating feeling of fullness and stimulating energy consumption. Serum leptin concentration varies due to hunger or overeating, either of which requires different energy levels (10).

Adiponectin is a protein hormone enhancing insulin function and causing anti-atherogenic and anti-inflammatory effects (11); this hormone regulates blood glucose level (9). Plasma adiponectin level diminishes in obese and diabetic patients as well as in those with metabolic syndrome and cardiovascular diseases (11). In fact, plasma adiponectin level is an independent risk factor for cardiovascular diseases (12). The inverse relationship between plasma adiponectin level and incidence of diabetes and cardiovascular events (11) and visceral fat mass (13) was shown in epidemiological studies.

Although the effects of fasting on metabolism and function of adipose tissue have been studied, this issue was less investigated in terms of Islamic fasting. Herein, we aimed to determine the effects of Islamic fasting on glucose and lipid profiles and plasma adiponectin and leptin concentrations in fasting obese and normal individuals.

Material and methods

This quasi-experimental study was performed during Ramadan on healthy individuals aged above 25 years with normal weight or obesity, who are living in Yazd, Iran. The participants were divided into two groups of 24. The individuals voluntarily participated in the project with written consent. The participants fasted from dawn to sunset and avoided eating, drinking, smoking, and drug consumption for 16 hours per day. They were asked not be involved in any major physical activities while fasting.

The inclusion criteria were individuals with normal weight (body mass index [BMI]=18-24.9 kg/m2) and obesity (BMI>30), fasting at least 21 days of Ramadan, not receiving any medications, especially non-steroidal anti-inflammatory drugs, or vitamins immediately before or during the study, absence of any acute and chronic diseases such as respiratory diseases or diabetes, not smoking, and not participating in other research projects. Any individual who received medications or treatment during the study or did not fast for at least 21 days was excluded from the study.

Blood samples were drawn after 10-12 fasting hours two days before and one day after Ramadan. The samples were collected in two phases: prior to Ramadan from 7:30 to 9 am and before sunset at the end of Ramadan. At the end of Ramadan, all the participants were asked to visit the laboratory they had visited prior to Ramadan to re-perform all the tests.

For anthropometric assessment, the participants were weighed using the Seca digital scale made in Germany with 100 grams precision and a minimum coverage. Height was quantified using a tape measure with 0.5 cm precision while

four parts of the body touched the wall without shoes on. The tests relevant to lipid profile and blood glucose level were conducted in the laboratory under contract at the beginning and end of the project to measure adiponectin and leptin concentrations. Blood samples were placed at room temperature for one hour for complete blood coagulation. Afterwards, the samples were centrifuged for 15 minutes at 3000 rpm at 4°C. Then, the isolated serum was kept at -80°C until the required parameters were measured; only 5 ml of blood samples was needed.

The kits used to measure fasting blood glucose, triglycerides, total cholesterol, and high-density lipoprotein cholesterol (HDL-c) levels were prepared from Bio System Company (Spain). The collected data were evaluated using the Prestige 24i Automated Analyzer. The low-density lipoprotein (LDL) level was obtained according to Fried Wald equation as follows: TC-(HDLc + TG/5).

Adiponectin was measured using the ELISA method (Adiponectin E09 Kit, Mediagnost, Germany) with ELISA Reader (3200 State Fax, USA). Normal range is within 1-100 ng/ml with 0.2 ng/ml sensitivity based on the desired kit. Leptin is also measured by ELISA (Kit Leptin E09, Mediagnost, Germany) with an ELISA Reader (3200 State Fax, USA). Normal range is within 2-100 ng/ml with 0.6 ng/ml sensitivity based on the desired kit.

Results

In this study, 45 fasting individuals were included 26 (57.8%) of whom were male. A total of 22 individuals (48.9%) had a BMI over 30 kg/m2 (obese) and 23 as normal weight individuals (51.1%) had a BMI between 19 and 25 kg/m2. The mean age of the participants was 37.6±6.9 years (age range: 25-58 years).

In Table 1, the mean of the studied variables are compared within and between the groups. As shown in the table, weight significantly reduced in both groups at the end of Ramadan. The obese group lost almost 2 kg and the normal-weight group lost 1.5 kg. Similarly, the mean BMI significantly decreased in both groups. Although fasting blood glucose significantly diminished in the normal group, no significant difference was found between the two groups. No significant difference was observed between the two groups in terms of mean triglyceride levels before and after Ramadan.

A significant difference was observed in mean cholesterol level between the two groups at the beginning and end of Ramadan. Mean cholesterol level was significantly higher in the obese group compared to the normal-weight group. Mean cholesterol level significantly diminished at the end of Ramadan. No significant difference was noted between the two groups in terms of mean LDL, HDL, and TC/HDL.

As shown in Table 1, mean serum leptin level was significantly higher in the obese group before the fasting period and a significant difference was found between the two groups in terms of mean serum leptin level at the end of Ramadan. However, no significant difference was seen in mean serum leptin level before and after Ramadan fasting in the obese group.

Mean serum leptin level significantly decreased in the normal-weight group. Nevertheless, no significant difference was found between the two groups in terms of serum leptin level. Mean adiponectin level was significantly higher in the normal-weight group compared to the obese group before and after Ramadan. Moreover, no significant variations were observed after fasting in either group in terms of mean adiponectin level, and mean adiponectin level showed no significant difference between the groups after fasting.

Discussion

In this study, weight and BMI significantly decreased among the participants, an mild dehydration due to fasting might be an underlying reason for weight loss (14). Undoubtedly, weight loss is more than 5% clinically important in health promotion (15). Previous studies have shown a significant reduction in body weight despite no significant variations in energy intake. It could be argued that weight loss is partly due to effective reduction of body fat mass during fasting period (4). The results of this study are in line with those obtained in former studies in terms of weight status (1, 16).

In other words, some believe that weight loss is due to reduced energy intake during fasting period since energy balance significantly regulates changes in body weight (1). Some inflammatory factors are diminished during fasting, which promotes activity of lipoprotein

Table 1. The mean weight, body mass index, and blood biochemical factors in the obese and normal-weight subjects before and after fasting

Variables	Before fasting	After fasting	Changes	P-value**
Weight (kg)				
Obese	94.5±12.1	92.3±11.2	-2.2±1.81	<0.001
Normal	69±11.05	67.5±10.8	-1.44±1.98	0.002
P-value*	<0.001	<0.001	0.17	
Body mass index (kg/m2)				
Obese	33.7±4.93	32.9±4.92	1.75±0.93	<0.001
Normal	23.9±2.8	23.4±2.9	0.53±0.11	0.003
P-value	<0.001	<0.001	0.16	
Fasting blood sugar (mg/dl)				
Obese	98.86±18.68	93.68±11.66	-5.18±15.23	0.12
Normal	94.6±11.17	85.69±7.32	-8.91±10.38	<0.001
P-value	0.35	0.009	0.34	
Triglyceride (mg/dl)				
Obese	263±193.6	255±177.4	-8.86±86.48	0.6
Normal	190±131.2	163±97	-26.22±72.39	0.1
P-value	0.13	0.04	0.47	
Total cholesterol (mg/dl)				
Obese	209±42.7	217±43.3	8.72±18.85	0.04
Normal	182±33.6	186±32.6	3.6±29.77	0.5
P-value	0.02	0.009	0.49	
Low-density lipoprotein cholesterol (LDLc) (mg/dl)				
Obese	122±35.8	129±33.9	6.95±16.74	0.04
Normal	101.8±27.4	111±28.1	9.18±27.12	0.1
P-value	0.06	0.06	0.74	
High-density lipoprotein cholesterol (HDLc) (mg/dl)				
Obese	37.2±8.8	41±6.1	3.81±6.81	0.01
Normal	39.1±8.7	40.1±7.9	1±6.31	0.4
P-value	0.46	0.68	0.15	
LDLc/HDLc				
Obese	3.28±0.76	3.07±0.65	-0.2±0.53	0.09
Normal	2.69±0.71	2.83±0.65	0.14±0.54	0.21
P-value	0.01	0.25	0.03	
Cholesterol/HDL				
Obese	5.77±1.2	5.35±1.04	-0.41±0.75	0.01
Normal	4.79±0.94	4.7±0.72	-0.09±0.65	0.5
P-value	0.005	0.01	0.12	
Leptin (ng/ml)				
Obese	26±20.1	26.1±25.3	0.12±10.62	0.95
Normal	11.7±1.16	8.7±10.8	-3.01±3.61	0.001
P-value	0.005	0.006	0.2	
Adiponectin (ng/ml)				
Obese	7.96±3.4	8.71±2.7	-0.75±1.98	0.09
Normal	10.9±9.1	12.8±5.6	-1.91±5.77	0.1
P-value	0.05	0.03	0.37	

*: Student t-test; **: Paired t-test

lipase (LPL) and production of free fatty acids.

On the other hand, there is low access to glucose while fasting and fat is used as an alternative for energy production; thereby, body fat and weight are reduced (17). Nevertheless, some studies have exhibited no changes in body weight after fasting period (18), while some others demonstrated an increase in body weight (19). It also has been confirmed that the nutrients digested at unusual times may have different metabolic effects. In addition, the hormones associated with energy metabolism and energy intake regulation significantly influence body weight (4).

Studies on the impact of fasting on blood lipids (20) and other biochemical factors (16) have reported conflicting results. It is well known that variations in sleep-wake cycle and eating habits during fasting changes metabolism (16). The difference in the results obtained from various studies may be due to several factors such as race or ethnicity, fasting hours, climatic

conditions, cultural influences, physical activity, and mostly dietary patterns (21, 22).

In the current study, concentrations of LDL and cholesterol increased in obese individuals, which is consistent with results of some other studies. Elevated LDL and cholesterol levels may be associated with reduced weight during fasting (22). Grundy et al. revealed that LDL level increases when higher levels of saturated fatty acids are consumed (23). Changes in blood lipids probably depend on quality and quantity of food intake and changes in body weight (3). Adipose tissue lipolysis in visceral fat cells is more than subcutaneous fat cells, which can enhance circulation of free fatty acids (FFAs) from their reserves. The FFAs from visceral tissue are collected by the portal vein and transferred to the liver. Fatty acids are highly accumulated in the liver rather than systemic circulation. FFAs boost production of triglycerides in the liver and promote very low-density lipoprotein (VLDL) secretion, as a result, LDLc level increases (20). However, studies on restriction of receivable calories have shown that FFA oxidation increases during the weight loss period while FFA synthesis diminishes (24).

A significant increase in HDL and cholesterol levels in obese individuals was observed, which could be attributed to both quality and quantity of dietary energy and fat to some extent. HDLc level and total cholesterol (TC)/HDLc ratio were recommended as the best predictors of coronary heart disease (CHD) (5). Even one unit increase in TC/HDLc increases the incidence rate of coronary heart disease by 68% (5, 25). Various studies reported an increase in HDLc level during fasting period, which was maintained even after fasting for one month (17, 26).

Additionally, an increase in concentration of HDLc was observed among fasting male athletes (27). Although the exact mechanism of increase in HDLc level is not fully understood yet, high HDLc level might be due to weight loss (27). Aksungr et al. conducted a study on healthy and fasting individuals in which no significant differences were observed in levels of total cholesterol, triglycerides, and LDLc. The TC/HDLc ratio, as a risk factor, decreased during and after Ramadan in both genders (5). Some studies also unmasked positive effects of fasting in reducing BMI, triglyceride, and cholesterol levels as well as increasing HDLc (28, 29).

Leptin is a protein produced by ob gene, which plays a key role in regulating body weight and energy homeostasis in the long term. The information on energy reserves and stimulation of hypothalamic response regulates both energy intake and consumption (6, 30). In the current study, leptin level significantly decreased in the normal weight group. Kassab et al. conducted a study on 44 fasting female volunteers in 2003 (26 normal and 18 obese individuals), where leptin level increased and was positively correlated with body fat indices. Previous studies have exhibited that chronic restriction on caloric intake declines leptin level up to 30-66% from the baseline (31).

On the other hand, chronic overeating is significantly associated with increased leptin, which is due to an increase in BMI and body fat percentage. For this reason, lifestyle, fasting hours, physical activity, the amount of food intake, the number of meals, and eating patterns vary for each individual in each season during Ramadan (4). Considering the relationship between leptin level and mealtime, many studies were conducted on the short-term and severe effects of fasting in human cases, but long-term effects of fasting on leptin level were not assessed in detail (30).

Adiponectin increases fatty acid oxidation, which ultimately lowers concentration of circulating fatty acids and triglyceride accumulation in the muscles and liver (2, 9). In this study, concentration of adiponectin in obese and normal-weight individuals increased, which was not significant. There are conflicting results on low levels of serum adiponectin and increased risk of CHD. The reasons behind this discrepancy might be biological markers such as glucose, HDL-c, and CRP and the effect of gender and confounding factors (12).

Bouhlel et al. conducted a study on male athletes in 2008, showing that fasting is associated with reduced BMI and body fat mass without significant changes in the adiponectin or leptin levels (32). Ajabnoor et al. performed a study on fasting individuals in 2014 and revealed that mean leptin concentration was significantly higher in the morning before Ramadan while adiponectin significantly decreased during fasting period (33). Hormonal changes are associated with an increase in insulin resistance in the morning and evening hours compared to before

Ramadan.

The limitations of this study include not accounting for previous medical history of the participants, absence of a control group, and lack of physical activity measurement. Considering the relationship between leptin, adiponectin, and insulin, future studies are recommended to take insulin level into account.

Conclusion

Islamic fasting can prevent cardiovascular diseases in obese and normal-weight individuals through reducing weight, BMI, and some blood lipids, elevating HDL-c, and changing the concentration of some adipokines.

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