The changes of metabolic profile and weight during Ramadan fasting

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ABSTRACT

Introduction: Ramadan is the holiest month in the Islamic calendar and Muslims fast during this month. We designed this study to evaluate the effect of Ramadan fasting on plasma lipids and lipoproteins.

Methods: This cohort study was performed during Ramadan in December 2002 (Islamic year 1423). The subjects were 81 students of Tehran University of Medical Sciences. We evaluated weight, body mass index (BMI), glucose, triglyceride (TG), cholesterol, low density lipoprotein (LDL), high density lipoprotein (HDL), and very low density lipoprotein (VLDL), before and after Ramadan.

Results: Body weight and BMI both decreased during Ramadan fasting in both genders. Glucose and HDL decreased and LDL increased significantly during fasting in Ramadan, but there was no significant change in total cholesterol, TG and VLDL. We did not find any association between TG, cholesterol, LDL, VLDL, HDL and the following variables: sex, body weight changes, and two or three instances of meals before Ramadan. Triglyceride level also increased in students with normal BMI while it decreased in overweight subjects.

Conclusion: This study indicated that Ramadan fasting led to a decrease in glucose and weight. Although there was a significant reduction in meal frequency, a significant increase in LDL and decrease in HDL was noted during Ramadan. It seems that the effect of Ramadan fasting on serum lipid levels may be closely related to the nutritional diet or biochemical response to starvation.

Keywords: cholesterol, fasting, high density lipoprotein, low density lipoprotein, Ramadan

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INTRODUCTION

Ramadan is the holiest month in the Islamic calendar and Muslims fast during this month[1]. Ramadan fasting is one of the five pillars of Islam, and is observed by millions of Muslims all over the world. Believers are commanded to abstain from food, drink and conjugal relationships from sunrise to sunset as a sign of restraint and introspection. Food and fluid intake are mainly nocturnal and usually, food frequency and quantity, sleep duration at night and daily physical activity are reduced. The food habits are not similar outside and during Ramadan in that the proportion of fat, protein and carbohydrate intake can differ during Ramadan. There is a tendency to consume foods and drinks that are richer in carbohydrates than those consumed during other months of the year. The quality of ingested nutrients can also differ during Ramadan compared with the rest of the year. The period in which the person fasts may vary depending on the geographical location of the country and the season of the year, and can be as long as 18 hours/day in the summer of temperate regions.

It has been established that a given nutrient ingested at an unusual time can induce different metabolic effects[2]. Lipid profile is affected by dietary habit, percentage of fat in the daily diet and its saturation, percentage of simple sugar, and exercise[3,4]. Another habit that may affect lipid profile is gorging and nibbling. It is believed that gorging may cause some impairment in lipid profile but this is still controversial. Today, the physiological changes in Ramadan are not well known. In fact, studies on the effects of Ramadan fasting on blood lipids, lipoproteins and apolipoproteins are scarce, and have given variable results and remain incomplete.

The basis for the potential effects of Ramadan fasting on different biochemical parameters have been found in investigations which reported various metabolic effects that have been produced either by a decrease in meal frequency or by different types of intermediate fasting. Conflicting results have been reported on the effect of Ramadan fasting on

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changes in lipid profile within healthy subjects[5-15]. It is therefore of interest to compare pre- and post-Ramadan lipid and lipoprotein profiles in fasting of Ramadan. We therefore designed this study to evaluate the effects of Ramadan fasting on plasma lipids and lipoproteins

METHODS

This cohort study was performed during Ramadan of December 2002 (Islamic year 1423). The subjects were students of Tehran University of Medical Sciences (TUMS).

Inclusion criteria included: healthy students who resided in dormitories of TUMS (for easy accessibility) and who indicated that they were going to fast during Ramadan, and aged 20-35 years. We excluded students with any acute or chronic disease or medication during the study, fasting less than 15 days, and any addiction except cigarette smoking. Furthermore, none of the female subjects were pregnant or using contraceptives. All subjects followed the same dietary regimen before and during Ramadan and were encouraged to continue their usual lifestyle and activities. This study was approved by the ethical committee from the research office of TUMS and volunteers gave informed consent for participation in the study.

We visited all subjects twice: three days before Ramadan and on the 26th day of Ramadan. Data gathering was performed by a questionnaire (by the same observer and same equipment on all occasions). Variables included general condition and review of different systems, past medical history, changes in habits during Ramadan such as smoking, illnesses, changes in food intake, height, body weight and body mass index (BMI). Blood samples were taken after a night fast at 10:00 hours before Ramadan and 12 hours after last meal (17:00 hours) on the 26th day of Ramadan in all subjects.

Plasma total cholesterol (TC) and high density lipoprotein (HDL) were measured by an enzymatic colorimetric method using cholesterol esterase, cholesterol oxidase, peroxidase and the chromagen 4-aminophenazone/phenol[16]. Plasma triglyceride (TG) levels were determined by an enzymatic colorimetric method using lipoprotein lipase glycerokinase, glycerophosphate oxidase and the chromagen 4-aminophenazone/N-ethyl-N-(3-sulphopropyl)-nramisidine[17]. Very low density lipoprotein cholesterol (VLDL) was calculated as TG/2.21. Low density lipoprotein (LDL) was calculated using the Friedewald et al equation[18].

In this study, we divided the subjects into two groups according to the sequence of meals before Ramadan; one group had two meals and another had three meals daily. We analysed our findings in these two groups separately. We analysed our findings in the female group, according to the number of days of fasting during Ramadan (they may be exempt from fasting during their menstrual period). Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) version 10.0 (Chicago, IL, USA). Results were expressed as mean and standard deviations (SD). ANOVA and student's paired t-test were used for data analysis. A p-value of less than 0.05 was considered to be statistically significant.

RESULTS

81 healthy volunteers (male/female ratio of 41:39) were included in the study (unknown sex in one subject). The mean age of subjects was 22.7 years (range: 18-29 years, SD 2.3). Table I shows that the body weight and BMI both decreased during Ramadan fasting in both genders. There were no significant relation and correlation between weight and BMI changes and the number of days of fasting during Ramadan.

Glucose levels decreased significantly during fasting in Ramadan and this effect was similar in both genders. In our study, glucose changes during Ramadan fasting did not have any association with BMI, decreased frequency of meals, and number of days of fasting during Ramadan. However, there was a significant association between glucose levels and weight changes (p=0.311, sig=0.005, n=80).

Table I. Changes of body weight and BMI during Ramadan fasting.

	Mean before Ramadan	Mean after Ramadan	Mean difference	Mean standard error	T	p-value
Weight:						
Male	68.7 +/- 12.1	67.5 +/- 10.8	4.2 +/- 15.9	0.4	3.5	0.001
Female	55.7 +/- 5.8	54.6 +/- 5.9	1.1 +/- 2.0	0.3	3.4	0.002
Total	62.4 +/- 11.6	61.2 +/- 10.8	2.7 +/- 11.5	0.2	4.9	0.000
BMI:						
Male	23.1 +/- 6.0	22.0 +/- 3.0	-0.6 +/- 1.2	0.7	1.5	0.136
Female	21.3 +/- 1.8	20.9 +/- 2.0	-0.4 +/- 0.8	0.1	3.3	0.002
Total	21.2 +/- 4.5	21.4 +/- 2.6	-0.5 +/- 1.0	0.4	2.0	0.048

Table II. Changes of glucose and lipid profile during Ramadan fasting.

	Mean before Ramadan	Mean after Ramadan	Mean difference	Mean standard error	T	p-value
Glucose:						
Male	75.0 +/- 8.2	68.8 +/- 6.0	6.2 +/- 8.6	1.3	4.7	.000
Female	78.2 +/- 6.4	69.7 +/- 5.4	8.5 +/- 6.7	1.1	7.9	.000
Total	76.6 +/- 7.5	69.2 +/- 5.7	7.3 +/- 7.8	0.9	8.4	.000
Triglyceride:						
Male	77.7 +/- 39.6	85.9 +/- 38.7	-8.2 +/- 31.4	4.8	-1.7	0.09
Female	54.7 +/- 26.7	52.3 +/- 14.7	2.4 +/- 18.5	3.0	0.8	0.42
Total	66.6 +/- 35.7	69.7 +/- 34.0	-3.1 +/- 26.4	2.9	-1.1	0.29
Total cholesterol:						
Male	166.1 +/- 30.5	168.7 +/- 32.2	-2.6 +/- 25.0	3.9	-0.7	0.51
Female	170.7 +/- 29.0	171.5 +/- 29.1	-0.8 +/- 18.3	2.9	-0.3	0.78
Total	168.3 +/- 29.7	170.0 +/- 30.6	-1.7 +/- 21.9	2.4	-0.7	0. 48
LDL:						
Male	114.9 +/- 26.4	119.6 +/- 28.3	-4.2 +/- 22.9	3.5	-1.2	0.237
Female	115.4 +/- 26.3	120.1 +/- 27.7	-4.7 +/- 19.1	2.6	-1.8	0.075
Total	115.2 +/- 26.2	119.6 +/- 27.9	-4.5 +/- 19.8	2.2	-2.0	0.045
HDL:						
Male	36.1 +/- 5.9	32.4 +/- 4.0	4.0 +/- 5.0	0.8	4.8	<0.001
Female	44.1 +/- 11.7	40.8 +/- 9.8	3.3 +/- 8.6	1.4	2.4	0.20
Total	40.0 +/- 9.9	36.4 +/- 8.4	3.5 +/- 6.9	0.8	4.6	<0.001
VLDL:						
Male	15.5 +/- 7.9	17.1 +/- 7.7	-1.5 +/- 6.3	1.0	-1.59	0.12
Female	11.0 +/- 5.4	10.4 +/- 2.9	0.6 +/- 3.9	0.6	1.0	0.33
Total	13.4 +/- 7.2	13.9 +/- 6.8	-0.5 +/- 5.4	0.6	-0.8	0.40
LDL/HDL:						
Male	3.3 +/- 1.0	3.7 +/- 0.9	-0.4 +/- 0.8	0.1	-3.3	0.002
Female	2.8 +/- 1.0	3.1 +/- 1.2	-0.3 +/- 0.7	0.1	-2.9	0.006
Total	3.0 +/- 1.0	3.4 +/- 1.1	-0.4 +/- 0.8	0.1	-4.4	0.000

There were no significant changes in total cholesterol and TG after Ramadan fasting. We did not find any association between these two tests and the following variables: sex, body weight changes, number of meals per day (two or three) before Ramadan, and numbers of days of women fasting. There was negative correlation between primary TG level before Ramadan and its change during Ramadan, i.e., subjects with higher TG level had a lesser increase in TG during Ramadan (Pearson correlation=-0.432, sig= 0.000, n=81). This negative correlation was stronger in women than men (male: Pearson correlation=-0.424, sig=0.005, n=42; female: Pearson correlation=-0.847, sig=0.000, n=39). Cholesterol also had this negative correlation. TG level increased in students with normal BMI, while it decreased in overweight subjects and this difference was significant.

There was a significant association between TG and cholesterol changes in this study (p=0.405, sig=0.000, n=81). HDL decreased (p=0.001) and LDL increased significantly (p=0.045), but there was no significant change in VLDL.

We did not find any association between these three tests and the following variables: sex, body weight changes, BMI and two or three meals per day before Ramadan.

There was a negative correlation between LDL changes and the number of days of fasting in women [Pearson correlation = -0.314, sig. (2-tailed) = 0.055, n=38]. Changes of glucose and lipid profile are shown in Table II.

DISCUSSION

During Ramadan, Muslims refrain from eating, drinking, smoking and sexual relations from sunrise (Sahur) until sunset (Iftar). They are otherwise allowed to eat during the remaining hours. Since Hijra is a lunar calendar, Ramadan occurs at different times in the seasonal year over a 33-year cycle. It has been established that a given nutrient ingested at an unusual time can induce different metabolic effects[2], and the Ramadan fasting provides an excellent opportunity to study the effects of the prolonged reduction of meal frequency on body metabolism.

Table III. Comparison of our findings with other studies.

Parameters	Present study	Bilto[34]	Hallak & Nomani[20]	Sliman & Khatib[35]	Temizhan et al[19]	Adlouni et al[8]
No. of subjects	81	74	16	68	52	32
Age (in years)	20-35	20-48	18-30	15-65	23-43	-
Weight	-	-	-	-	No change	-
BMI	-	-	-	-	-	-
Total cholesterol	No change	-	No change	-	-	-
HDL	-	-	-	-	No change	-
LDL	-	-	-	-	-	-
VLDL	No change	-	-	-	-	-
TG	No change	No change	-	-	-	-
Glucose	-	-	-	-	-	No change

The findings in this study are compared with similar studies in Table III. Our study showed significant weight reduction with Ramadan fasting that is in agreement with the findings in other studies[7,13]. With decreased weight during Ramadan, BMI has decreased in both genders. A decrease in BMI has been found by others[19]. Frost and Pirani showed the energy intake was significantly higher during Ramadan than post-Ramadan period (3,680 versus 2,425 kcal/day) and the mean body weight immediately after Ramadan was higher than that at the beginning of Ramadan (60.3 versus 58.9 kg)[5].

The effect of Ramadan fasting on lipid profile is different in published articles and this may be due to a change in the dietary regimen during Ramadan, decreased activity and some cultural parameters. Although in this study, the serum level of triglycerides had no difference in pre- and post-Ramadan testing, in some studies, it increased significantly during Ramadan[14]. Elevated blood TG levels observed may be due to the consumption of high-carbohydrate diets accompanied by less exercise during this month. There is a tendency for higher sugar consumption during Ramadan[5, 12-14].

Hallak and Nomani reported that the TG level at the 14th day of Ramadan correlated positively with sugar intake (g/day) during this month[20]. The increase in blood TG with high sucrose intake was also observed by Albrink and Ullrich[21].

Gumaa et al observed an increase in blood TG level with Ramadan fasting in subjects on a high-carbohydrate diet[12]. In tvhis study, the total blood TG level and change in TG level during Ramadan was not related to the body weight and its change. Some studies reported that at the initial stages of weight loss there was an increase in blood TG level, which may have been due to mobilisation of body fat[22-24]. Increase in TG level declines with increasing weight loss, a finding that may be due to its use as a source of energy.

In this study, there was a negative correlation between primary TG level before Ramadan and during Ramadan, i.e. subjects with higher TG level had a lesser increase in TG during Ramadan. This finding is in agreement with the reports by many other investigators who had observed a greater decrease in TG levels among subjects with a higher baseline TG level during fasting and weight reduction[20,25-27]. Also, in our investigation, the level of total cholesterol did not increase significantly during Ramadan and we did not find any correlation between change in cholesterol and change in measured anthropometric factors.

Use of body reserve fat and newly-synthesised fat as a source of energy is greater under these circumstances than during normal energy intake conditions that increase circulating fat elements. Indeed, at a dietary energy intake close to the required level, dietary fat and blood cholesterol levels were positively correlated[28]. Furthermore, it seems that an increase in blood cholesterol level is more rational. Although we did not measure the level and type of fatty acid in the dietary regimen of the study population, the significant decrease in HDL-cholesterol and increase in LDL-cholesterol in our study may be a reflection of the total energy intake and type of dietary fat.

It has been shown by Grundy that plasma LDL-cholesterol was elevated when saturated fatty acids were in the diet[29]. The TC:HDL-cholesterol ratio at day 28 increased but was <4.5, the ratio above which the chances of coronary-problems are enhanced[30,31]. An increased TC:HDL-cholesterol ratio as a result of weight loss was also observed in many other studies[22,32,33] but in this study, we found no correlation between weight change and LDL-cholesterol level or

LDL:HDL. Hallak and Nomani reported that the TC: HDL-cholesterol ratio response to weight change was curvilinear and highly significant in regression models[20]. In several studies, a decrease in blood LDL-cholesterol was accompanied by a reduction in TC[8,19,34], but an increase in LDL-cholesterol without any change in TC has also been observed[20].

Although volunteers had their blood investigations done after 12 hours of fasting, the timing was different (10:00 hours versus 17:00 hours). There may be concerns that circadian rhythm of hormones like cortisol could account for differences in glucose levels. The circadian rhythms of nutrition-related biological variables change during Ramadan[36]. Bogdan et al observed that unlike non-fasting periods, the cortisol rhythm is overtly biphasic during Ramadan fasting. They reported an evident rise in the serum concentration starting at 12:00 hours, and a plateau between 16:00 hours and 20:00 hours, i.e. at the time of the first meal following the daytime fasting period[37]. However, circadian rhythm during Ramadan fasting is not similar to the normal circadian rhythm.

This study had some limitations. Physical activity may affect the lipid profile. Although physical activity usually decreases during Ramadan fasting, this item was not measured in this study. Furthermore, this study represents a healthy population and it is not representative for diabetic or hyperlipidaemic patients. According to Islamic rules, Ramadan fasting is not obligatory for patients. We did not evaluate the effect of counter-regulatory hormones on metabolic profiles. As it is noted in the discussion, subjects had their blood investigations done after 12-hour fasting but the timings were different (10:00 hours versus 17:00 hours).

In conclusion, this study indicated that Ramadan fasting led to a decrease in glucose levels and weight. There was a significant association between glucose levels and weight changes. Although there was a significant reduction in meal frequency, a significant increase in LDL and decrease in HDL were noted during Ramadan. It seems that the effect of Ramadan fasting on serum lipid levels may be closely related to the nutritional diet or biochemical response to starvation. Ramadan fasting probably decreases TG in women with a high TG level and in overweight subjects.

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