ORIGINAL RESEARH

Anthropometric and Biochemical Effects of Ramadan Fasting on Overweight and Obese Male Adults in Rafah City-Gaza

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تأثير صيام شهر رمضان على القياسات الجسمية والتحاليل المخبرية عند البالغين الذين يعانون من زيادة الوزن والسمنة في مدينة رفح-غزة

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الملخص: تهدف هذه الدراسة الى اثبات ما اذا كان الصيام خلال شهر رمضان له تأثير على القياسات الجسمية والتحاليل المخبرية عند الأفراد الذين يعانون من زيادة الوزن والسمنة.

هذه الدراسة هي وصفية تحليلية أجريت خلال شهر رمضان (سبتمبر – أغسطس 2009) في مدينة رفح. 128 متطوع من البالغين الذكور الذين يعانون من زيادة الوزن والسمنة (مؤشر كتلة الجسم =31.18+4.48 كيلوجرام/متر مربع)، ليس لديهم تاريخ مرضي قد خضعوا للتقيم قبل اسبوع واحد من شهر رمضان وفي الاسبوع الأخير منه بعد متوسط 14 ساعة من الصيام.

عندما تم جمع العينات ومقارنتها احصائيا، كان هناك انخفاض ذو دلالة احصائية في مؤشر كتلة الجسم، محيط الخصر، ونسبة الخصر الى الأرداف في نهاية شهر رمضان. ووجدت الدراسة أيضا انخفاضا ملحوظا في نسبة جلوكوز الدم وعدد الصفائح الدموية خلال شهر رمضان. وأشارت النتائج الى ارتفاع ملحوظ في الكولسترول الكلي والكولسترول عالي الكثافة ومنخفض الكثافة و نسبة الكولسترول الكلي للكولسترول عالي الكثافة و عدد الخلايا اللمفاوية في نهاية الشهر. انخفاضا في مستويات الدهون الثلاثية أيضا قد لوحظ في نهاية شهر رمضان ولكن الفرق لم يكن ذو دلالة احصائية.

لذا فاننا نخلص الى أن التغير في عدد وجبات الطعام خلال شهر رمضان المبارك قد أثر ايجابيا وبشكل ملحوظ على الكولسترول عالي الكثافة وسكر الدم والقياسات الجسمية كمؤشر كتلة الجسم، محيط الخصر ونسبة الخصر الى الأرداف في هذه العينة من السكان الفلسطينيون الذين يعانون من زيادة الوزن والسمنة. كما أنه قد اشارت الدراسة الى أن التغير السلبي في مستويات الكولسترول الكلي والكولسترول منخفض الكثافة قد يكون نتيجة اتباع عادات غذائية غير صحية من قبل البعض خلال شهر رمضان.

مفتاح الكلمات: شهر رمضان، الصيام ، السمنة، استقلاب الدهون، سكر الدم ، مؤشر كتلة الجسم، محيط الخصر، نسبة الخصر للأرداف.

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ABSTRACT: This study aimed to ascertain whether fasting during Ramadan has any effect on anthropometric measurements and biochemical parameters among overweight and obese individuals; thus contributing to explore potential methods for combating obesity and overweight.

The study is a descriptive analytical one that was conducted in the month of Ramadan of Ramadan (August-September 2009) in Rafah City. A total of 128 overweight and obese adult males (BMI=31.18±4.48 kg/m²), without any medical history of diseases underwent empirical assessments one week before and in the last week of Ramadan after an average of 14 hours of daily fasting.

Findings revealed that there was a statistically significant decrease (P=0.001) in BMI, waist circumference and waist to hip ratio at the end of Ramadan. The study also found a statistically significant reduction in fasting blood glucose (P=0.001) and platelet counts (P=0.033) during Ramadan. The means of total cholesterol, HDL-C, LDL-C, TC/HDL-C and lymphocytes have increased significantly at the end of Ramadan (P=0.001, 0.012, 0.001, 0.001, 0.001, respectively). A reduction in blood triglyceride levels was also observed but the differences were not statistically significant (P=0.181).

It was concluded that the changes in the meals frequencies during Ramadan has significantly improved HDL-C, fasting blood glucose, and anthropometric parameters among participants. The increase in total cholesterol and LDL-C can be due to unhealthy dietary habits adopted during month of Ramadan of Ramadan. Changing meal patterns and frequencies can be utilized to control obesity and its consequences.

Keywords: Ramadan, Fasting, Obesity, Overweight, BMI.

INTRODUCTION:

Ramadan is the holiest month of Ramadan on the Islamic calendar. The most prominent event of this month of Ramadan is fasting, which is considered obligatory (Fard).[1] The common practice during Ramadan is to eat two meals, one before dawn (Sohor) and the other after sunset (Iftar).

The total energy intake as well as the proportion of fat, protein and carbohydrate (CHO) intake can differ during month of Ramadan of Ramadan. Previous studies have shown inconsistent findings regarding the total energy intake during month of Ramadan of Ramadan in reference to pre-Ramadan status. Some studies indicated an increase in the total energy intake,[2] while others indicated a decrease in total energy intake.[3,4] Food composition has been reported to shift toward consuming more fat and less CHO during month of Ramadan of Ramadan.[5]

These changes in the quality and quantity of food consumed during month of Ramadan of Ramadan are thought to affect serum lipid profile.[6] Many studies have found that the changes in eating behaviors that occur during month of Ramadan have a beneficial effect on Total Cholesterol (TC), Low-Density Lipoprotein Cholesterol (LDL-C), High-Density Lipoprotein Cholesterol (HDL-C) and Triglyceride (TG).[7,8] The positive effects of fasting during Month of Ramadan were more pronounced in hyper-lipidemic individuals when compared with normo-lipidemics.[9,10] The reduction in blood TG levels were also observed in subjects whose daily energy intake was decreased significantly during Month of Ramadan.[3,11] However, studies in which TC and LDL-C were adversely affected have reported a significant increase in fat consumption.[5,11,12]

The changes in dietary habits, meal frequencies and lifestyle changes during Month of Ramadan are an

excellent model to study the effect of fasting on the body and blood compositions of overweight and obese individuals.

Shariatpanahi et al.[4] found a significant reduction in the mean of body weight, Body Mass Index (BMI), and Waist Circumference (WC) at the end of Month of Ramadan in overweight adults with metabolic syndrome. The weight reduction was explained by the researchers to be a result of skipping the mid-day meal when the body is metabolically active.[3,7] The former study also reported that the percentage of weight loss is greater among overweight compared to normal body weight subjects.

Unlike the previous studies, Frost and Pirrani found a significant increase in body weight during Month of Ramadan.[2] The study also showed that the energy intake was significantly higher during Month of Ramadan than post-Ramadan.

The change in body weight during Month of Ramadan was found to affect serum lipid profile in a study based on previously published studies.[6] The effect of weight loss on blood lipids was also observed by a non-Ramadan study.[13]

This study will therefore provide precise information about the effect of fasting in the month of Ramadan of Ramadan on the anthropometric measurements and the biochemical parameters in overweight and obese individuals who are at higher risk for obesity-related diseases. Precisely, the study aimed at investigating the effect of fasting on the anthropometric measurements and the Atherogenic Index of Plasma (AIP) and other parameters.

REASEARCH METHODS:

Subjects

This descriptive analytical study was conducted during the month of Ramadan, which fell in 2009 of August-Septemper. Participants for this study were recruited from Rafah City (southern governorate of the Gaza Strip). The researcher used convenience sampling technique to select the study population by recruiting those who were close to hand such as people the researcher knows, neighbors, and people on the streets. A total of 128 adult male volunteers whose ages ranged between 20 and 55 years, had excess body weight (BMI $\geq$ 25 kg/ m^2), and reported no history of chronic diseases underwent anthropometric, biochemical and hematological evaluation one week before and at the end of the last week of Month of Ramadan.

Ethical Clearance

An official approval letter from Helsinki Committee (Ethical Committee in Gaza) to conduct the study and to make the necessary analysis was obtained, and all participants were provided with a written informed consent before their inclusion in the study.

Data Collection

The protocol of the study included a questionnaire in form of an individual face-to-face interview. The objective of the interview was to gather the socio-demographic data, Physical Activity (PA) and lifestyle changes during Month of Ramadan. PA was assessed by using the American guidelines, which classified the amount of PA into four categories.[14] In addition, the questionnaire also contained a section about the medical history and participants were asked about the presence of chronic diseases such as Hypertension, Diabetes Mellitus (DM), heart diseases, liver and kidney diseases and so on.

A qualitative Food Frequency Questionnaire (FFQ) was used to cover the most common foods consumed during Month of Ramadan. This approach has been selected because it is easy, economical and also due to lack of national standardized formulas for calculating the ingredients of the Palestinian food recipes.

For each subject, the anthropometric measurements were taken on the two occasions of the study, one week before Ramadan and the last week of the

month of Ramadan of Ramadan. Body weight was measured by using a professional weighing scale, which was adjusted before and after every measurement. Each participant was asked to take off the heavy clothes and shoes and to keep on light clothes and by stepping onto the scale with weight distributed evenly on both feet, weight was recorded where the arrow aligned. To ensure accuracy, body weight was measured by the same observer and by using the same scale on the two occasions. BMI was calculated by dividing the weight in kg by the square of height in meter. Using the international criteria, BMI of 25-29.9 kg/m2 was considered overweight, 30- 34.9 kg/m2 was considered obese and > 35 kg/m2 was considered gross obesity.[15]

WC was measured by using the National Institution of Health (NIH) protocol at the superior border of the iliac crest by applying a non-stretchable tape measure horizontally around the abdomen at the level of the landmarked point in parallel to the ground.[16] Hip circumference was measured at the widest point around the buttocks where it extended the maximum, when viewed from the side. Both measurements were taken in centimeter.

Blood Sampling and Processing

One week before month of Ramadan of Ramadan and four days before the end of Ramadan, blood samples were collected from subjects in a fasting state of about fourteen hours during daylight as food and drinks were restricted to night hours. All blood measurements were made in the laboratory department of the Medical Relief Center for Chronic Diseases in Gaza City.

Validity and Reliability

To ensure validity and reliability, the authors utilized different techniques including, reviewing relevant literature and included all relevant related variables, and conducting content related validity through experts' assessment. Also, standardization of data collection tools, methods, procedures as well as standardization of the implementation methods were rigorously utilized. Collected data were checked on an on-going basis and immediately entered and analyzed. Standardization of lab testing and the anthropometric measurements were ensured.

Statistical Analysis

Data was analyzed by using the Statistical Package for Social Sciences (SPSS) system (version 13.0, SPSS Inc., Chicago, IL). The frequency tables of the different factors among the study population were generated by using the descriptive statistics. Paired 2-tailed student's t-test was used to test the significance of differences between the means of continuous data (pre-Ramadan and the end of Ramadan values). Confounders' effects were minimal because the pre and post measurements were conducted for the same individuals who were all fasting the entire month of Ramadan of Ramadan. Because the interval between the pre and post measurements were only one month of Ramadan and Ramadan rituals are strictly standardized such as no smoking, standardized hours of fasting and so on, the internal validity in this study is high and unlikely to be affected by these variables as confounders. The investigators used sensitivity analysis and computed inferences over a range of possible values. Values were expressed as mean and Standard Deviation (mean + SD), and the differences were considered statistically significant at p-value of < 0.05.

RESULTS:

In this study, the mean age of subjects is 33 ± 8.2 years and the mean BMI is 31.18 ± 4.48 kg/m^2. The majority of subjects (51.5%) were obese and 48.5% were overweight (Table 1). The majority of respondents (77.3%) had not performed any exercises before Month of Ramadan, 22.7% were exercising regularly. Of those who were exercising, 44.8% were at medium activity level, and 41.4% were highly active, while 13.8% of the respondents were at low activity level. During Month of Ramadan, the percentage of respondents who were

not performing any exercise increased to 91.4% (77.3% before Ramadan), and the majority of the respondents (54.5%) who continued exercising during Month of Ramadan did so at a low activity level.

Table 1. Distribution of the study population according to age, BMI and PA (n=128)		
Item	No.	%
Age (years)		
20-30	56	43.8
31-40	47	36.7
41-50	25	19.5
BMI		
Overweight (25-29.9 kg/m2)	62	48.4
Obese (30-34.9 kg/m2)	46	35.9
Gross obesity (≥ 35 kg/m2)	20	15.6
Exercising before Ramadan		
No	99	77.3
Yes	29	22.7
Type of exercise before Ramadan		
Walking	19	65.5
Bicycle riding	4	13.8
Football	4	13.8
Athletics	2	6.9
Level of PA among those who were exercising before Ramadan		
Low activity (< 30 min/5 days/week)	4	13.8
Medium activity ($\geq$30 and$\leq$ 60 min/5 days/week)	13	44.8
High activity (>1 hour/5 days/week)	12	41.4
Exercising during Ramadan		
No	117	91.4
Yes	11	8.6
Level of PA among those who were exercising during Ramadan		
Low activity (< 30 min/5 days/week)	6	54.5
Medium activity ($\geq$30 and$\leq$ 60 min/5 days/week)	3	27.3
High activity (>1 hour/5 days/week)	2	18.2
Sleeping after Iftar meal		
Never	112	87.5
Sometimes	10	7.8
Always	6	4.7

Regarding the Iftar meal, the majority of respondents (57%) were relying mostly on food rich in CHO and 31.3% were relying on food high in fat, while the minority of the study population (11.7%) was consuming food high in protein. More than one-third of subjects were eating one snack daily between Iftar and Sohor meals and about the same

percentage reported were eating 2-3 snacks daily. The results also show that, respondents who were eating Sohor meal regularly during Month of Ramadan represented only 65.6%.

Table 2 illustrates the comparison between the values obtained before the month of Ramadan of Ramadan and at the end of Month of Ramadan (pre-Ramadan Vs end-Ramadan); there was a statistically significant (p-value <0.05) decrease in body weight (94.50$\pm$15.56 Vs 93.01$\pm$15.54 kg), BMI (31.18$\pm$4.48 Vs 30.69$\pm$4.46 kg/m^2), WC (102.95$\pm$12.17 Vs 99.84$\pm$11.74 cm), and Waist-to-Hip Ratio (WHR) (0.95$\pm$0.06 Vs 0.94$\pm$0.06) at the end of Month of Ramadan when compared with the baseline means.

Table 2. Differences in the anthropometric variables (n=128)			
Variable	Pre-Ramadan	End-Ramadan	P value
Body weight (kg)	94.50$\pm$15.56	93.01$\pm$15.54	0.001
BMI (kg/m²)	31.18$\pm$4.48	30.69$\pm$4.46	0.001
WC (cm)	102.95$\pm$12.17	99.84$\pm$11.74	0.001
WHR	0.95$\pm$0.06	0.94$\pm$0.06	0.001

Values were expressed as mean $\pm$ SD

* P value of student t-test; significant at P $\leq$ 0.05

As shown in Table 3, before the month of Ramadan of Ramadan, 75% of subjects had normal TC level (< 200 mg/dL), 19.5% had borderline-high TC level (200-239 mg/dL), and 5.5% had high TC level ($\geq$240 mg/dL). At the end of the month of Ramadan, the percentage of subjects with high TC level increased to 13.3% and the percentage of subjects with borderline–high TC level had increased to 41.4%. The change in the values of TC in all groups at the end of Month of Ramadan was found to be statistically significant (X^2=36.232, p-value =0.001) (Table 3).

Table 4 shows the differences in FBG, TC, and TG levels within the age groups. There were statistically significant differences in FBG and TC levels among age groups before Month of Ramadan (p-value 0.01, 0.05 respectively); whereas the differences in FBG and TC levels after Month of Ramadan were not statistically significant (p-value > 0.05). The differences in TG levels among age groups before and after Month of Ramadan were not statistically significant (p-value > 0.05) (Table 4).

At the end of Month of Ramadan, the percentage of subjects with normal blood TG level (<150 mg/dL) had increased from 36.7% before Ramadan to 41.4%, and the percentage of those with high blood TG level ($\geq$200 mg/dL) had increased from 34.4% to 39.8%, whereas the percentage of subjects with borderline blood TG level (150-199 mg/dL) had decreased to 18.8% compared with 28.9% before Month of Ramadan (Table 3). This change in blood TG levels at the end of Month of Ramadan was statistically significant (X^2=25.348, p-value =0.001) (Table 3). Before Month of Ramadan, 76.6% of subjects had normal Fasting Blood Glucose (FBG) level (< 110 mg/dl), 20.3% had impaired FBG (110-125 mg/dl), and 3.1 had high FBG ($\geq$126 mg/dl) . At the end of the month of Ramadan, the percentage of subjects who had normal FBG level had increased to 98.4% and those with high FBG

decreased to 1.6 % (Table 3). No statistical differences in the values of FBG were found at the end of Month of Ramadan (X^2= 1.132, p-value = 0.568) (Table 3).

Table 3. Distribution of the study population according to FBG, TC and TG (n=128)					
Item	**Before**		**After**		**P value***
	No	**%**	**No**	**%**	
FBG					
Normal FBG (< 110 mg/dl)	98	76.6	126	98.4	
Impaired FBG (110-125 mg/dl)	26	20.3	0	0	0.568
DM ($\geq$126 mg/dl)	4	3.1	2	1.6	
Total Cholesterol					
Normal TC (< 200 mg/dL)	96	75	58	45.3	
Borderline TC (200-239 mg/dL)	25	19.5	53	41.4	0.001
High blood TC ($\geq$240 mg/dL)	7	5.5	17	13.3	
Triglyceride					
Normal TG (<150 mg/dL)	47	36.7	53	41.4	
Borderline TG (150-199 mg/dL)	37	28.9	24	18.8	0.001
High blood TG ($\geq$200 mg/dL)	44	34.4	51	39.8	

FBG, Fasting Blood Glucose
Values were expressed as mean $\pm$SD
***P value of chi-square test; significant at P value $\leq$ 0.05**

Table 5 shows the differences in the obtained values expressed as mean $\pm$ SD (pre-Ramadan Vs end-Ramadan). It shows a statistically significant (p-value 0.001) increase in TC (175.27$\pm$39.48 Vs 207.22$\pm$33.60 mg/dL) and LDL-C (100.56$\pm$37.89 Vs 133.13$\pm$31.66 mg/dL) at the end of Month of Ramadan when compared to Pre-Ramadan. The mean $\pm$ SD of HDL-C levels had also increased significantly (p-value 0.012) at the end of Ramadan fasting month of Ramadan when compared to pre-Ramadan mean (36.18$\pm$4.89 Vs 37.80$\pm$5.47 mg/dL) (Table5).

At the end of Month of Ramadan, the mean $\pm$ SD of serum TG concentrations was found to decrease at the end of Month of Ramadan when compared with the baseline (192.66$\pm$114.14 Vs 181.45$\pm$78.88 mg/dL), but this reduction was not statistically significant (p-value 0.181) (Table 5). Similarly, the reduction in the mean $\pm$ SD of AIP at the end of Ramadan (0.29$\pm$0.18) compared to pre-Ramadan (0.31$\pm$0.24) was not statistically significant (p-value 0.197).

A statistically significant increase in the mean $\pm$ SD of TC/HDL-C ratio (p-value 0.001) was reported at the end of the month of Ramadan when compared

with pre-Ramadan mean value (4.97±1.50 Vs 5.57±1.08) (Table 5). The reduction in the mean of FBG at the end of Month of Ramadan compared to

Pre-Ramadan (98.65±16.03 Vs 62.57±14.55 mg/dL), was statistically significant (*p*-value 0.001) (Table 5).

Table 4. FBG, TC and TG within age groups (n=128)				
	Age (year)	No.	Pre-Ramadan (mean ± SD)	End-Ramadan (mean ± SD)
FBG				
	20-30	56	100.75±13.83	62.14±14.51
	31-40	47	93.29±18.52	61.93±10.65
	41-50	25	104±12.92	64.72±20.34
	Total	128	98.65±16.03	62.57±14.55
	P-value		**0.01**	**0.714**
TC				
	20-30	56	167.80±43.73	203±31.67
	31-40	47	176.08±34.75	209.87±40.83
	41-50	25	190.48±34.34	211.68±20.09
	Total	128	175.27±39.48	207.22±33.60
	P-value		**0.05**	**0.449**
TG				
	20-30	56	183.78±113.99	168.41±84.11
	31-40	47	191.68±99.24	194.70±72.44
	41-50	25	214.36±139.10	185.72±76.77
	Total	128	192.66±114.14	181.45±78.88
	P-value		**0.54**	**0.23**

[*] **P value of one-way ANOVA; significant at P ≤ 0.05**

Table 5. Differences in the biochemical parameters (n=128)			
Variable	**Pre-Ramadan**	**End-Ramadan**	**P value***
TC (mg/dl)	175.27+39.48	207.22+33.60	0.001
LDL-C (mg/dl)	100.56+37.89	133.13+31.66	0.001
HDL-C (mg/dl)	36.18+4.89	37.80+5.47	0.012
TGs (mg/dl)	192.66+114.14	181.45+78.88	0.181
FBG (mg/dl)	98.65+16.03	62.57+14.55	0.001
Creatinine (mg/dl)	0.62+0.20	0.64+0.18	0.448
AIP	0.31+0.24	0.29+0.18	0.197
TC/HDL-C	4.97+1.50	5.57+1.08	0.001
Leukocyte count (x103/μL)	8.34+2.15	8.22+1.83	0.438
Lymphocyte count (%)	36.31+8.49	38.56+9.16	0.001
Neutrophils (%)	52.76+9.77	51.28+10.01	0.052
ESR (mm/h)	17.80+12.87	18.15+12.45	0.774
Platelets (cell/μL)	260.27+62.17	251.88+52.24	0.033

AIP = log (TG/HDL-C) with unites expressed in mmol/L
[*] **P value of student t-test;**
significant at P ≤ 0.05

DISCUSSION:

At the end of Month of Ramadan, a significant decrease in BMI and weight loss by 1.5 kg (i.e. 1.6%) was found. This finding is congruent with the majority of the studies conducted in this regard.[4,5]

The former study, which was carried out on male subjects aged 43-61 years with metabolic syndrome, attributed the weight loss that was observed during Month of Ramadan to the reduced number of meals

and calorie intake during the Month of Ramadan. Another study was conducted in Saudi Arabia on 45 healthy male volunteers observed that the percentage of weight loss was greater in overweight subjects compared with normal body weight subjects.[3]

This observation does not agree with the finding reported by Frost and Pirani who observed a significant increase in energy intake of subjects during Month of Ramadan.[2] The findings of this study indicate that the changes in the dietary habits during Month of Ramadan in which energy intake is reduced can serve as an effective strategy in the management and prevention of overweight and obesity.

This study found a statistically significant reduction in the mean of WC at the end of Month of Ramadan. This reduction in the abdominal fat of overweight and obese subjects lowers the risks of developing Cardiovascular Diseases (CVDs) and DM, and therefore reinforces the positive health benefits of fasting during Month of Ramadan. Similar findings were reported by other investigators.[4]

This study also reported a statistically significant reduction in the mean of WHR at the end of Month of Ramadan. This result contradicts other reported findings.[5,17] The discrepancy between the former studies and this study could be due to the small number of respondents included in the former studies as well as the involvement of non-obese individuals. One study showed that overweight subjects are likely to lose more weight, during Month of Ramadan, than those deemed normal or underweight.[3] It was anticipated based on previous studies' findings that the magnitude of weight loss to some extent may encompasses a reduction in WC, and thus lower WHR.[4,17] Another possible contributing factor to the lack of change in WHR in these studies is the involvement of women, as men

tend to have more muscle mass and less body fat than women, which makes men more metabolically active (use more calorie) and lose more weight than women.[18]

In this study, a statistically significant increase in TC and LDL-C was observed at the end of Month of Ramadan. This result is consistent with the findings of other studies,[5,11] These studies have also observed an association between high fat intake and the increase in TC and LDL-C levels during Month of Ramadan among type 2 diabetic women as well as healthy male subjects. On the contrary, the findings of this study contradict other studies' findings.[3,8,19] The increase in TC levels that was observed in this study seems to be a result of the dietary mismanagement during Ramadan, in which subjects tend to substitute their usual meals with more fattening ones, which in turn imposes an additional health risk on the overweight and obese individuals.

In this study, the baseline mean of HDL-C levels was slightly lower than the normal range, which is expected for overweight and obese subjects. At the end of Ramadan, the mean HDL-C increased significantly when compared with the baseline value. This finding is in agreement with two different studies were carried out on healthy volunteers during Month of Ramadan.[8,20] The increase in HDL-C levels was found to be associated with dietary fat intake in a study was carried out on twenty healthy male in Bangladesh.[19] This observation was confirmed by a non-Ramadan study that was carried out to determine the effect of low-fat diet, similar to NCEP step 2 diet, on low and normal HDL-C subjects and observed that low fat diet resulted in lower HDL-C levels of both groups.[21]

However, the weight loss that was observed in this study may asset for the increase in HDL-C levels. The inverse correlation between body weight and

HDL-C concentration was reported by a meta-analysis study based on 70 previously published studies.[13] The improvement in HDL-C levels of overweight and obese individuals with weight loss in this study reinforces the beneficial effect of dieting during Month of Ramadan.

Findings also showed a statistically non-significant reduction in blood TG levels at the end of Month of Ramadan. This finding is in line with other studies reported in literature and found no change in TG levels at the end of Month of Ramadan when compared to pre Ramadan.[19,20] The slight reduction in TG levels may be due to the reduction in energy intake that resulted from the change in meal frequency during Month of Ramadan. Two different studies have been carried out on healthy male and female subjects during Month of Ramadan and found a significant decrease in serum TG at the end of Month of Ramadan when compared to pre-Ramadan.[22,23]

Another explanation that may apply to the slight reduction in blood TG levels, is the weight loss experienced by these subjects. It was observed that blood TG levels of overweight subjects are more likely to decrease during Month of Ramadan than that of normal weight subjects.[10] One non-Ramadan study indicated that each kilogram of weight loss is associated with a 1.3 mg/dL decrease in TGs level.[13] These observations indicate that blood TGs of overweight and obese individuals can benefit from the hypo-caloric diet induced by Month of Ramadan and perhaps the reduction that was observed in TG levels of the present subjects shows statistical differences once these dietary habits practiced during Ramadan are continued after that month of Ramadan.

In this study, the mean of AIP values of subjects fell within the high range, which is not surprising since overweight and obese individuals tend to have higher TG and lower HDL-C levels than normal subjects. Unfortunately, none of the other studies in this area of research has evaluated AIP, thus comparison cannot be made. However, the absence of statistical significance in the mean of AIP can be due to the non-significant change in TG levels, and if TG levels decreased significantly, the mean of AIP would have shown a statistically significant reduction, especially when the HDL-C levels were found to increase significantly in this study. Nonetheless, further research to determine the effect of fasting during Month of Ramadan on AIP is required.

Unlike AIP, the mean of TC/HDL-C ratio increased significantly at the end of Month of Ramadan. Similar finding was reported in literature.[24] In contrast, a previously published study has observed a significant reduction in TC/HDL-C at the end of Month of Ramadan.[3] However, the increase in TC/HDL-C ratio in this study is somehow reasonable as TC increased significantly at the end of Ramadan, whereas the HDL-C levels remained below the normal range.

The mean of FBG levels was also found to decrease significantly at the end of Ramadan, which indicates a lower risk of developing DM. This finding is in line with the majority of the studies reported in literature.[4,22,23] One study based on one hundred and thirteen previously published studies about the effect of Ramadan fasting month of Ramadan indicated that the reduction in the total energy intake during Month of Ramadan and the subsequent depletion in glycogen stores can contribute to the reduction in FBG levels.[6] Therefore, overweight and obese individuals, who are at high risk for developing DM, are encouraged to take Month of Ramadan as a dietary model that can help in regulation of blood glucose levels through lowering the total energy intake.

In summary, the results of this study suggest that the change in the number and time of meals during Month of Ramadan has a significant beneficial effect on the HDL-C, FBG, and the anthropometric measurements in this sample of overweight and obese Palestinian population. It seems that the increase in TC and LDL-C levels during Month of Ramadan is due to the dietary mismanagement (tendency to consume foods high in cholesterol and fat).

Limitations of the Study

Women were not included in his study because during menstruation they are not allowed to fast during Ramadan. This could distort findings as the number of fasting days will be less, at least by one week. Also, in the Palestinian culture, women carry the main responsibilities of housework including food preparation at the time at which data collection was planned (afternoon hours). Thus, it is unknown if the results of this study will apply to women as well or not. It is recommended to conduct another study on women with a suitable design. In addition, the inability to find a control group, as it was impossible to find eligible adults who did not fast during the month of Ramadan of Ramadan, has presented a limitation in this study. The study also could have benefited from a more sensitive measure of dietary intake i.e. food records, but because of the large sample size, time constrains and lack of cooperation, it was not possible to do so. Standardized formulas to calculate the ingredients of the Palestinian food recipe are still lacking.

REFERENCES:

1. **Al-Hilali MT, Khan M.** *The Noble Qur'an: English translation of the meanings and commentary.* King Fahd Complex for the printing of Holy Qur'an. Madinah, Kingdom of Saudi Arabia, 1998, 2:183-187.

2. **Frost G, Pirani S.** Meal frequency and nutritional intake during Ramadan: A pilot study. *Hum Nutr Appl Nutr* , 1987, 41:47-50.

3. **Al-Numair K. Body Weight and Some Biochemical Changes Associated with Ramadan Fasting in Healthy Saudi Men. *J Med Sci* , 2006, 6:112-116**.

4. **Shariatpanahi ZV, Shariatpanahi MV, Shahbazi S, Hossaini A, Abadi A.** Effect of Ramadan fasting on some indices of insulin resistance and components of the metabolic syndrome in healthy male adults. *Br J Nutr,* 2008, 100:147–151.

5. **Khaled BM, Belbraouet S.** Effect of Ramadan fasting on anthropometric parameters and food consumption in 276 type 2 diabetic obese women. *Int J Diabetes Dev Ctries,* 2009, 29:62-68.

6. **Azizi F.** Islamic fasting and health. *Ann Nutr Metab,* 2010, 56:273-282.

7. **Adlouni A, Ghalim N, Benslimane A, Lecerf JM, Saile R.** Fasting during Ramadan induces a marked increase in high-density lipoprotein cholesterol and decrease in low-density lipoprotein cholesterol. *Ann Nutr Metab,* 1997, 41:242-249.

8. **Jamil-ur-Rehman, Shafiq M.** Changes in blood glucose and lipid profile during Ramadan fasting. *J Ayub Med Coll Abbottabad,* 2000, 12:13-15.

9. **Mahboob S, Sattarivand R, Nouri M, Arefhosseini S.** Effect of Ramadan fasting on

serum lipid profiles in normal and hyperlipidemic subjects. *Saudi Med J,* 1999, 20:947-950.

10. Ziaee V, Razaei M, Ahmadinejad Z, Shaikh H, Yousefi R, Yarmohammadi L et al. The changes of metabolic profile and weight during Ramadan fasting. *Singapore Med J,* 2006, 47:409-414.

11. Hallak MH, Nomani MZA. Bodyweight loss and changes in blood lipid levels in normal men on hypocaloric diets during Ramadan fasting. *Am J Clin Nutr ,* 1988, 48:1197-1210.

12. Khaled BM, Bendahmane M, Belbraouet S. Ramadan fasting induces modifications of certain serum components in obese women with type 2 diabetes. *Saudi Med J,* 2006, 27:23-26.

13. Dattilo AM, Kris-Etherton PM. Effects of weight reduction on blood lipids and lipoproteins: a meta-analysis. *Am J Clin Nutr,* 1992, 56:320-328.

14. United States Department of Health and Human Services. Physical activity guidelines for Americans. US Department of Health and Human Services, Washington DC, 2008, p4.

15. World Health Organization. Obesity, Preventing and Managing the Global Epidemic. Report of a WHO Consultation, Geneva, 2000, Technical Report Series, No. 894.

16. Ross R, Berentzen T, Bradshaw AJ, Janssen I, Kahn HS, Katzmarzyk PT et al. Does the relationship between waist circumference, morbidity and mortality depend on measurement protocol for waist circumference?. *Obes Rev,* 2008, 9:312-25.

17. Yucel A, Degirmenci B, Acar M, Albayrak R, Haktanir A. The effect of fasting month of Ramadan of Ramadan on the abdominal fat distribution: Assessment by Computed Tomography. *Tohoku J Exp Med,* 2004, 204:179-187.

18. Carpenter WH, Fonong T, Toth MJ, Ades PA, Calles-Escandon J, Walston JD et al. Total daily energy expenditure in free-living older African-Americans and Caucasians. *Am J Physiol,* 1998, 274:E96-E101.

19. Rahman M, Rashid M, Basher S, Sultana S, Nomani MZA. Improved serum HDL cholesterol profile among Bangladeshi male students during Ramadan fasting. *East Mediterr Health J,* 2004, 10:131-7.

20. Maislos M, Abou-Rabiah Y, Zuili I, Iordash S, Shany S. Gorging and plasma HDL cholesterol-the Ramadan model. *Eur J Clin Nutr,* 1998, 52:127-130.

21. Asztalos B, Lefevre M, Wong L, Foster TA, Tulley R, Windhauser M et al. Differential response to low-fat diet between low and normal HDL-cholesterol subjects. *J Lipid Res,* 2000, 41:321-328.

22. Furuncuoglu Y, Karaca E, Aras S, Yonem A. Metabolic, Biochemical and Psychiatric Alterations in Healthy Subjects During Ramadan. *Pakistan J Nutr,* 2007, 6:209-211.

23. Ibrahim WH, Habib HM, Jarrar AH, Al Baz SA. Effect of Ramadan Fasting on Markers of Oxidative Stress and Serum Biochemical Markers of Cellular Damage in Healthy Subjects. *Ann Nutr Metab,* 2008, 53:175-181.

24. Khaled MB and Belbraouet S. Ramadan fasting diet entailed a lipid metabolic disorder among type 2 diabetic obese women. *Am J Applied Sci,* 2009, 6:471-477.