Effect of Ramadan Fasting on Anthropometric Measures and some Biochemical Parameters among Type2 Diabetic Patients in Gaza Governorate, Gaza Strip

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Abstract

Objectives: The aim of this study is to assess the effect of Ramadan fasting on anthropometric measures and some biochemical parameters among type 2 diabetes (T2D) patients in Gaza Governorate, Gaza Strip.

Materials and methods: The design of the study is a case control (2:1). The study was carried out during the last Ramadan (late of July to August, 2011) in Gaza Governorate. A total of 80 patients suffering from the diabetes type 2, aged 40 to 65 years, have no history of diabetic complications or other diseases and treated with the same of oral hypoglycemic drugs (OHD), and compared with 40 healthy individuals as control. Anthropometric and biochemical analysis were carried out one week before Ramadan and one week before its end. Data (obtained through questionnaire interview) were analyzed using SPSS version 14.

Results: The mean ($\pm$ SD) of age of the participants was 53.21 ($\pm$ 7.459) years for diabetic patients and 54.84 ($\pm$ 6.798) years for controls (p>0.05). When the results were summed up and compared statistically, there was a statistically significant reduction in the mean of body weight (p=0.038 and p=0.000 respectively) and body mass index (BMI) (p=0.001 and p=0.000 respectively) at the end of Ramadan month in both groups as compared to pre-Ramadan. This study also found a statistically reduction in the mean ($\pm$ SD) of serum fasting blood glucose (FBG) during Ramadan as compared to values before Ramadan in both groups (p=0.000 and p=0.000, respectively). A statistically significant increase in the mean ($\pm$ SD) of serum triglycerides (TG) levels was also observed at the end of fasting among diabetic group (p-value=0.000). Among diabetic group, the mean ($\pm$ SD) of HDL-C levels also showed significant reduction (P=0.000), while significant elevation in control group was observed (P=0.000) during Ramadan as compared to values before Ramadan. There was also statistically significant elevation in the mean ($\pm$ SD) of serum total cholesterol (TC) (p-value=0.000 in both groups) and low density lipoprotein cholesterol (LDL-C) (p-value=0.000 in both groups) during the period of fasting as compared to the period before fasting in both groups. In addition, during the two periods, there were no statistical differences in the mean ($\pm$ SD) of serum creatinine (p=0.0.193 and p=0.147 respectively) and urea levels (p=0.560 and p=0.143 respectively) in both groups. Concerning the glycated hemoglobin (HbA1c), the results also showed no statistical differences in the mean ($\pm$ SD) of HbA1c levels (p=0.133 and p=0.905 respectively) in both groups.

Conclusion: Ramadan fast is relatively safe among type 2 diabetic patients provided that they should be properly educated about drug regimen adjustment, diet control, daily activities and possible sudden complications.

Keywords: Ramadan fasting, Biochemical parameters, Type 2 diabetes, Anthropometric measurement, Gaza Strip, Palestine.

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أثر صيام شهر رمضان المبارك على القياسات الجسمية وبعض التحاليل البيوكيميائية لدى مرضى السكر النوع الثاني في محافظة غزة

الملخص:

هدف الدراسة: تهدف الدراسة إلى معرفة أثر صيام شهر رمضان على القياسات الجسمية وبعض التحاليل المخبرية لدى مرضى السكر النوع الثاني في محافظة غزة.

أداة الدراسة وعينتها: الدراسة تم تنفيذها في مدينة غزة قبيل وخلال شهر رمضان (يوليو - أغسطس 2011) على ما مجموعه 80 متطوعاً من الذكور والإناث المصابين بمرض السكري النوع الثاني كمجموعة تجريبية حيث كانت تتراوح أعمارهم بين 65 إلى 40 عاماً، ولا يعانون من مضاعفات مرض السكري، ويأخذون نفس العلاج الخافض للسكر عن طريق الفم، بالإضافة إلى 40 متطوعاً من غير المصابين بمرض السكري كمجموعة ضابطة، كلا المجموعتين خضعوا لتقييم القياسات الجسمية و الكيميائية قبل أسبوع واحد من شهر رمضان وفي نهاية الأسبوع الأخير من الشهر.

منهج الدراسة: دراسة مقطعية تعتمد على مقارنة مجموعة ضابطة مع مجموعة تجريبية.

نتائج الدراسة: عندما تم تحليل النتائج إحصائيا، كان هناك انخفاض ذو دلالة إحصائية في وزن الجسم ومؤشر كتلة الجسم عند كل من المجموعة التجريبية والمجموعة الضابطة في نهاية شهر رمضان، وجدت الدراسة أيضاً انخفاضاً ملحوظا في نسبة جلوكوز الدم عند كلا المجموعتين مع الصيام، لوحظ ارتفاع ذو دلالة إحصائية في مستويات الدهون الثلاثية عند المجموعة التجريبية لكن على النقيض لوحظ انخفاضاً في مستويات الدهون الثلاثية عند المجموعة الضابطة، ولكن الفرق لم يكن ذو دلالة إحصائية، وأشارت النتائج إلى انخفاض ذو دلالة إحصائية في مستويات الكولسترول عالي الكثافة عند المجموعة التجريبية في نهاية شهر رمضان بينما يرتفع ارتفاعا ذو دلالة إحصائية عند المجموع الضابطة في نهايته. أيضاً لوحظ ارتفاع ذو دلالة إحصائية في الكولسترول الكلي والكولسترول منخفض الكثافة عند كلا المجموعتين في نهاية الشهر، في حين أن كمية اليوريا والكرياتنين ونسبة مخزون السكر لم تتغير بشكل ملحوظ عند كل من المجموعتين خلال الشهر.

توصيات الدراسة: صيام رمضان يعتبر أمن نسبياً وبلا مضاعفات سلبية بين مرضى السكر الذين يتلقون تعليمات صحيحة ومناسبة من الطبيب المختص حول جرعات العلاج الخافض للسكر و مراقبة النظام الغذائي.

Introduction

Ramadan is the ninth month of the lunar calendar and is considered the holiest month for Muslims around the world and its fasting is obligatory (fard). During this month, all the adult Muslims abstain not only from eating, drinking, smoking and sexual relations but also from oral drug intake and nutritional intravenous injection, from sunrise (dawn) to sunset [1].

T2D is a disorder of both insulin resistance and relative deficiency of insulin [2]. Many factors, such as obesity, family history and lack of physical

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activity, previous diagnosis of gestational diabetes, increasing age, hypertension, and dyslipidemia might develop into diabetes [3]. Globally as of 2010 it is estimated that there are 285 million diabetic people with type 2 making up about 90% of the cases and its incidence is increasing rapidly, and it is estimated that by 2030, this number will almost double [4]. DM is around 9% of population in Palestine, and the same ratio coexisted in Gaza strip [5].

According to Islamic law, Muslims whose health affected by fasting such as sick patients, nursing women, pregnant women, menstruating and travelers can refrain from fasting until the end of their excuse. Patients with diabetes fall under this category because their chronic metabolic disorder may place them at high risk for various complications if the pattern and amount of their meal and fluid intake is markedly altered.

During Ramadan month, T2D patients are exposed to changes in meal times, types of foods, use of medication and daily lifestyle, these changes may affect their health. On the other hand, Physicians commonly face the difficult task of advising T2D patients whether it is safe to fast, as well as recommending the dietary and drug regimens which diabetics should follow it, if they decide to fast. Unfortunately, no study has been undertaken about the effect of Ramadan fasting on T2D patients in Palestine.

Materials and Methods

The study design is a case control (2:1). It was conducted in the Faculty of Science at the Islamic University-Gaza (IUG), Palestine. The study population consisted of T2D patients aged between 40- 65 years whose diabetes was identified maximum 3 years ago, treated the same OHD, presented no diabetic complications or other diseases and reside in Gaza city. Controls were a healthy individuals (20 males & 20 females) aged 40-65 years in average they matched the cases in age, weight and were selected from the same area. The study population were selected from diabetology services, Palestinian Medical Relief Society. The study has been approved by the ethical committees.

The study was carried out in the previous Ramadan late of July to August, 2011) at two points of time; one week before Ramadan (visit-1) and one week before its end (visit-2). The aim of pre-Ramadan visit (visit1) was to assess the physical well being of patients and to assess their diabetic control. They were also educated about the warning symptoms of hypoglycemia, dehydration, and any other possible complications. However they were instructed to carry on with their usual living habits and physical activity.

Blood samples were also collected for baseline blood levels. They were told to revert back to prior schedule after end of Ramadan. The aim of Ramadan

visit (visit 2) was to collect blood sample for final analysis. Noteworthy that, after the second visit, the study participants have been told about the over all impact of fasting on their health and how they could maintain better diabetic control in future, Results by a printed report was delivered to them. Data was collected by the researcher and his qualified team through direct and indirect methods. The indirect method included a structured interviewed questionnaire. While the direct method included measurements of anthropometric measurements (weight and height) and biomedical parameters (lipid profile, FBG, HbA1c, urea and creatinine).

Standard techniques were adopted for obtaining anthropometric measurements. The anthropometric data were measured at the two period of the study. The participant weighed in light cloths without shoes to the nearest 0.1 Kg by an electronic weighing scale, The height was measured by a stadiometer and the reading was taken at the nearest 0.1cm. The body mass index (BMI) was computed as the ratio of weight (kg) per height squared (m²).

About 5 ml blood sample in a fasting state was withdrawn from all participants after 12- 14 hours (h) fasting by venipuncture into tubes as the following: Three milliliters of the blood were taken and placed into a plain tube (without anticoagulant) and samples were allowed to clot and the serum was centrifuged at room temperature by Fuhua 80-1 centrifuge, China at 4000 round/minute for 10 minutes. Serum was stored at -18°C until analyzed. Serum was used to determine TC, TGs, HDL-C, creatinine, urea, and blood glucose level. LDL-C in mg/dL was measured by using Fried Wald's formula [6]. Two milliliters of blood was collected into Ethylene Diamine Tetra Acetic Acid (EDTA) tube for determination of HbA1c percent.

Serum glucose, urea, creatinine, TC, TGs were analysed by Chemistry Autoanalyzer (BS-120, Guangdong, China (Mainland)) in El Arabi Medical Laboratory- Gaza. Quality assurance program was carried out. Colorimetric calculations of glucose, urea, creatinine, TC, TGs were obtained automatically from autoanalyzer depending on beer's law. Serum high density lipoprotein cholesterol (HDL-C) was measured using spectrophotomer. Data were analyzed using Statistical Package of Social Sciences (SPSS) system (version 14.0). The following statistical tests were applied: Frequency distributions, Chi – Square Test, Pairs samples t-test. Probability values (p) were considered to be significant if it is less than 0.05.

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Results

The mean ages of the study subjects were 53.21 (± 7.459) years and 54.84 (± 6.798) years for cases and controls respectively (P=0.966). The details of age, going on diet, level of education, monthly income (NIS), lifestyle characteristics and frequency of dietary intake among the study subjects during Ramadan are shown in (table 1, 2 and 3).

Table 1 shows distribution of study population with respect to; age, level of education, monthly income and going on diet. The age range of the study population was from 40 to 65 years and grouped into three categories. The highest percentage among cases was noticed among the age group 50-59 years followed by the age group 40-49 years.

Table 1 also illustrates that, the majority (31.3%) of the study cases had attained preparatory education Vs. 27.5% controls and 33.8% of the study cases that received secondary education Vs. 28.0% controls (P = 0.883).

Table 1 reveals that, 46.3% of the cases Vs. 45.4% of the controls had monthly income less than 1000 New Israeli Shekel (NIS). The mean (± SD) of monthly income of the participants was NIS 1456 (± 891) (P = 0.741). On the other hand, 90.0% of the cases Vs. 7.5% of the controls were going on diet (P = 0.000).

Table 1: Some general characteristics of the study subjects

Table 2 shows that, 83.5% of the cases Vs. 75.0% of the controls were non-smokers. Table 2 reveals that, the majority of the study population (81.3%)

Item	Diabetic		Control		Chi-Square Test	P-Value
	N (N=80)	%	N (N=40)	%		
Age (years)						
40 - 49	26	32.5	13	32.5	16.759	0.966
50 - 59	37	46.0	16	40.0		
60 - 65	17	21.5	11	27.5		
Level of education						
Illiterate	5	6.3	4	10.0	1.169	0.883
Primary	13	16.1	5	12.5		
Preparatory	25	31.3	11	27.5		
Secondary	27	33.8	14	35.0		
Undergraduate or more	10	12.5	6	15.0		
Monthly income(NIS)						
Less 1000	37	46.3	18	45.0	0.600	0.741
1000 -2000	27	33.7	15	37.5		
> 2000	16	20.0	7	17.5		
Going on diet						
Yes	72	90.0	7	17.5	81.852	0.000**
No	8	10.0	33	82.5		

of the cases Vs 80.0% of the controls were used to watch TV or PC after Iftar meal during Ramadan month. Also its shown that, 6.3% of the cases Vs. 7.5% of the controls had not attended the Taraweh praying throughout Ramadan month. Regarding the physical activity during Ramadan fasting, study population was classified into four groups as shown in the table 2. About 6.2% of the case Vs. 5.0% of the controls were moderately active and those whose work demands a vigorous physical activity represented 1.3% of the cases Vs 2.5% of the controls.

Table 2: Lifestyle characteristics among the study subjects during Ramadan

Item	Diabetic		Control		Chi-Square Test	P-Value
	N (N=80)	%	N (N=40)	%		
Taraweh praying						
Never	5	6.3	3	7.5	0.202	0.904
Sometimes	5	6.3	2	5.0		
Always	70	87.4	35	87.5		
Physical activity						
Sedentary	39	58.8	21	52.5		
Light	35	43.7	16	40.0	0.690	0.876
Moderate	5	6.2	2	5.0		
Vigorous	1	1.3	1	2.5		
Smoking status						
Yes	13	16.5	10	25.0	1.345	0.246
No	66	83.5	30	75.0		
Watching TV or PC after Iftar meal						
Yes	65	81.3	32	80.0	0.000	1.000
No	15	18.7	8	20.0		

Table 3 shows that, the majority of the study population were relying on red meats more than white meats during Ramadan month. Regarding the white meat (chickens and fish), 3.8% of the cases Vs. 2.5% of controls of respondents were eating chickens once daily. While 11.3% of the cases Vs. 10.0% of controls were eating fish once a day.

Regarding foods that are high in cholesterol (eggs and liver), Table 3 shows that 6.3% of the cases Vs. 18.8% of controls were eating eggs daily, and 31.2% of the cases Vs. 32.5% of control did not eat eggs during Ramadan month. Table 3 also shows that 38.0 % of the cases Vs. 30.0% of controls were eating vegetables daily during the Ramadan month.

Concerning desserts, 27.5% of the cases Vs. the same percent of controls were eating desserts daily during Ramadan month. Regarding salts, 6.2% of the cases Vs. 12.5% of controls were eating salty foods daily during

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Ramadan, whereas 12.5% of the cases Vs. 25% of controls were eating salts 3-5 times a week.

Table 3: Food frequency intake among study population during Ramadan fasting

Item		Once daily		3-5 Weekly		Once Weekly		Once every 2 Weeks		Never		P-Value
		No	%	No	%	No	%	No	%	No	%	
Eggs	Case	5	6.3	15	18.7	30	37.5	5	6.3	25	31.2	0.099
	Control	4	18.8	7	17.5	9	22.5	4	8.8	13	32.5	
Meats	Case	20	25.0	40	50.0	14	17.5	1	1.3	5	6.3	0.167
	Control	7	17.5	22	55.0	7	17.5	1	1.3	2.5	7.5	
Chickens	Case	3	3.8	29	36.3	42	52.0	4	5.0	2	3.0	0.371
	Control	1	2.5	20	50.0	15	37.5	4	6.3	2	3.8	
Liver	Case	0	0.0	0	0.0	3	10.0	3	3.8	69	86.3	0.308
	Control	0	0.0	1	2.5	2	5.0	1	2.5	36	90.0	
Fish	Case	9	11.3	16	20.0	23	28.8	12	15.0	20	25.0	0.701
	Control	4	10.0	8	20.0	10	25.0	8	20.0	10	25.0	
Legumes	Case	20	25.0	14	17.5	20	25.0	8	10.0	18	22.5	0.372
	Control	10	25.0	6	15.0	8	20.0	5	12.5	11	27.5	
Vegetables	Case	30	38.0	40	50.0	4	5.0	3	3.5	3	3.5	0.387
	Control	12	30.0	25	62.5	2	5.0	1	2.5	0	0.0	
Fruits	Case	23	28.8	42	52.5	10	12.5	4	5.0	1	1.3	1.000
	Control	11	27.5	21	52.5	5	12.5	2	5.0	1	2.5	
Desserts	Case	22	27.5	24	30.0	15	18.7	14	17.5	5	6.3	0.831
	Control	11	27.5	13	32.5	8	20.0	7	17.5	1	2.5	
Soft drinks	Case	6	7.5	9	11.3	26	32.5	8	10.0	31	38.8	0.913
	Control	4	10.0	5	12.5	15	37.5	3	7.5	13	32.5	
Fruit juices	Case	15	18.8	18	22.5	29	36.5	18	22.5	0	0.0	0.991
	Control	7	17.5	10	25.0	14	35.0	9	22.5	0	0.0	
Nuts	Case	5	6.3	5	6.3	40	50.0	21	26.3	9	11.3	0.954
	Control	2	5.0	2	5.0	20	50.0	11	27.5	5	12.5	
Pickles/salt	Case	5	6.2	10	12.5	20	25.0	20	25.0	25	31.3	0.104
	Control	5	12.5	10	25	5	12.5	8	20.0	12	30.0	
Vegetables oil	Case	78	97.5	2	2.5	0	0.0	0	0.0	0	0.0	0.341
	Control	38	95.0	2	5.0	0	0.0	0	0.0	0	0.0	

However, food frequency intake among the study population was not significantly different for all mentioned food items (P>0.05).

According to the results shown in table 4, there was a significant weight reduction (p=0.038 and p=0.000 respectively) and BMI reduction (p=0.001 and p=0.000 respectively) at the end of Ramadan fast as compared to before Ramadan in both groups.

Table 4: Effect of fasting on anthropometric variables among the study subjects

Variable	T2D patients n=80			controls n=40		
	Visit 1 Mean ±SD	Visit 2 Mean ±SD	P-value	Visit 1 Mean ±SD	Visit 2 Mean ±SD	P- value
Body weight (Kg)	83.5±18.3	82.9± 17.8	0.038*	85.9±12.8	84.6±12.5	0.000**
BMI (Kg m2-)	30.8.8±6.1	30.4±5.9	0.001*	31.4±5.1	30.9±4.9	0.000**

P < 0.05: Significant

Table 5: Biochemical parameters laboratory values tested among the study subjects before fasting (Visit 1) and during Ramadan (Visit 2)

Variable	T2D patients n=80			controls n=40		
	Visit 1 Mean ±SD	Visit 2 Mean ±SD	P- value	Visit 1 Mean ±SD	Visit 2 Mean ±SD	P-value
Total cholesterol (mg/dL)	184.0±38.2	215.7± 39.9	0.038*	149.5±25.2	182.1±23.0	0.000**
Triglyceride (mg/dL)	165.3±66.0	190.1±62.3	0.001*	143.8±35.2	139.8±38.7	0.690
HDL-C (mg/dL)	53.0±13.3	51.4±12.9	0.000**	45.2±9.1	46.9±9.1	0.000**
LDL-C (mg/dL)	100.8±38.0	125.3±36.9	0.000**	84.2±23.6	110.4±21.8	0.000**
Fasting blood glucose (mg/dL)	192.3±66.8	156.0±60.4	0.000**	99.4±9.1	81.0±13.9	0.000**
HbA1c (%)	7.0±0.8	7.0±0.8	0.133	4.9±0.5	4.9±0.5	0.905
Urea (mg/dL)	30.2±4.5	30.4±5.0	0.560	31.8±5.5	31.5±5.5	0.143
Creatinine (mg/dL)	0.93±0.18	0.94±0.18	0.193	0.92±0.15	0.89±0.18	0.147

P < 0.05: Significant

The study also found statistically significant reduction in FBG during Ramadan month in the study population (p-value = 0.000 and 0.000 respectively). A significant increase (p-value <0.05) in the TG levels was observed at the end of fasting in the diabetic patients [Table 5]. In contrast, a reduction in the TG level was observed at the end of fasting in the controls (p-value >0.05). A statistically significant (p-value <0.05) reduction in the

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HDL-C levels was observed at the end of fasting in the diabetic patients, In contrast, a significant increasing in the HDL-C level was observed at the end of fasting among the controls.

Serum TC and LDL-C were increased significantly (p-value <0.05) at the end of Ramadan month when compared with the baseline means in the study population [Table 5]. There were no statistical differences (p-value >0.05) in the mean (± SD) of serum creatinine, urea and HbA1c levels at the end of Ramadan month fasting when compared with pre-Ramadan values among the study population (p-value >0.05) [Table 5].

Discussion

Dietary intake and anthropometric measurements: The reduction in BMI probably may be due to two reasons: the first one, a decrease in the number of meals (two meals instead of three meals) that significantly contributed to reduce the amount of calories intake in both groups during Ramadan as compared to values before Ramadan. The second reason, loss of the midday meal, especially at this time that the body is metabolically active. This loss in body weight and BMI among the study populations was in line with the previous studies that found statistically significant loss among T2D patients [7] and healthy individual [8] at the end of Ramadan month. Dennis [9] reported that the reduction of the BMI among diabetic patients is clearly associated with the reduction in the cholesterol plasmatic concentrations.

In contrast, the present study findings were inconsistent with some of the previous studies that reported no change in the mean of BMI among T2D patients [10] and healthy individual [11] during Ramadan month fasting. The reduction in the insulin concentration during the fasting can be an adaptive mechanism able to explain the maintenance of a normal weight among diabetic patients [12].

Moreover, few studies reported a statistically significant increase in the energy intake during Ramadan than post-Ramadan period that associated with a significant weight gain among T2D patients [13] and healthy individual [14] at the end of Ramadan month.

Lipid profile measurements

Serum total cholesterol: In the t-test analysis, the results of this study observed a statistically significant increase in the mean of TC levels during fasting in both groups. This increase is attributed by the researcher to higher consumption of dietary fat, especially the saturated fatty acids and dietary cholesterol during the month. A previous study conducted by Khaled and Belbraouet, [15] reported that dietary fat, particularly saturated fat, was higher in the diet during Ramadan month. Similar findings were found by

other researchers, where they found an increase in TC levels during Ramadan month among T2D patients [16] and healthy individuals [17].

Hallak and Nomani, [18] found that significantly increased in TC levels with the high fat diet and compared to the levels obtained after the high CHO diet. The present finding was not in agreement with the previous studies that found no change in TC levels during Ramadan month among T2D patients [19] and healthy individuals [20]. In contrast to the present finding, other researchers found a significant decrease in TC levels among T2D patients [21] and healthy individuals with Ramadan fasting [22].

Serum triglycerides: The present findings found that a significant elevation in the mean of serum TG levels at the end of Ramadan month among T2D patients only. Similarly, a significant increase in blood TGs during Ramadan month was observed among T2D patients [22] and a slightly increase in blood TGs during Ramadan month among healthy individuals [26]. The elevation in blood TG among T2D patients might be as a result of an increased in the lipolytic effect of fat tissues during Ramadan month. This interpretation is supported by studies done by Gumaa et al. [21] and Nagra et al. [25] which announced an increase of TG levels consequently to the lipolytic effect of fat tissues during the Ramadan fasting.

Other interpretation suggested that insulin concentration decreased during energy restriction (fasting hours) because of the low availability of glucose. This decrease in insulin with fasting in T2D patients lead to more deficiency in adipose tissue lipoprotein lipase function which result in elevating of TG level among these patients. Insulin deficiency causes excessive mobilization of free fatty acids, this may lead to a disorder in lipid metabolism [24]. The no change of the mean of blood TG levels in the present study with fasting among healthy individuals attributed to decrease in the number of meals which led to reduction in total calories intake during Ramadan month. In contrast, other studies have reported a statistically significant decrease in blood TG levels during the month of Ramadan among T2D patients [12] and healthy individuals [25].

In previous report by Al Hourani & Atoum, [26] reported that fat intake during Ramadan was similar to pre Ramadan in healthy young Jordanian females. Therefore, this result supports the fact that inherent metabolic changes during Ramadan may lower serum TG. On the other hand, more than one study have found a significant elevation in the mean of blood TG levels during fasting among healthy individuals [21]. However, one study tied between the increase in carbohydrate intake and high triglycerides [21].

HDL cholesterol: The statistically significant decrease which happened in HDL-C levels during fasting among diabetics is attributed to two reasons.

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The first was due to decline in physical activity among patients during the Ramadan. PA reduction was observed among both groups, especially among the diabetes in fear of hypoglycemia. Moreover, both groups was trend toward sedentary lifestyle during Ramadan month. Toth, [27] reported that sedentary lifestyle may lead to the low HDL-C levels. and the second causative was attributed to high CHO rich food in spite of tendency to eat high fat rich food.

On the other hand, the rise in HDL-C levels observed in this study among healthy individuals is attributed to weight loss that occurred with fasting, in addition to increase in the dietary fat intake during it. Mansi, [28] reported that the increase in HDL-C level during Ramadan month was positively associated with fat intake.

The finding of present study was in line with the most previous studies that found a statistically significant reduction in HDL-C levels during Ramadan fasting among T2D patients [29] and statistically significant increase in HDL-C levels among healthy individuals with the fasting [20]. The present study findings were also inconsistent with the previous reports that showed a significant increase in HDL-C levels during Ramadan month among T2D patients [30] and statistically significant decrease in HDL-C levels among healthy individuals [31].

On the other hand, few studies observed no change in HDL-C among T2D patients [12] and healthy individuals [22]. Avignon, [29] found a significantly reduction in HDL-C levels during Ramadan month among T2D patients and explained it to the slowing of metabolic hydrolysis of the VLDL.

Serum LDL cholesterol: The elevation in LDL-C levels observed in the present study was attributed to higher consumption of dietary fat, especially the saturated fatty acids and dietary cholesterol during the holy month among both groups. The same results were reported in literture studies among T2D [22] and healthy individuals [18]. Nevertheless, this result was inconsistent with the majority of the studies reported in literature that showed no significance difference in LDL-C levels with fasting among T2D patients [30] and healthy individuals [23].

Many studies have also reported a significant decrease in the LDL-C levels during Ramadan fasting month among T2D patients [31] and healthy individuals [22]. Iacano and Daugherty, [31] also confirmed that the ingestion of a diet rich in fatty acids poly unsaturated induced a notable reduction of the plasmatic levels of LDL-C.

Fasting blood glucose: The decrease in FBG among both groups that has been observed in the current study was attributed by the researcher to the

decrease in the number of meals during Ramadan and in turn led to low calorie intake within the body and the consequent depletion in glycogen stores. More than one of study support this interpretation, one of this study carried out by Nomani et al. [32] and it suggested that the FBG and HbA1c values depend on diet composition, energy metabolism, and energy intake regulation. This finding observed in the present study coincides with the literature studies that reported a statistically significant reduction in FBG at the end of Ramadan month compared to pre-ramadan among T2D patients [33] and healthy individuals [28].

However, this result was not in agreement with the few studies that showed no statistically significance differences in FBG levels at the end of Ramadan when compared with pre-Ramadan levels among T2D patients [25] and healthy individuals [34].

The present study findings were also inconsistent with the studies that were reported in literature, showing a statistically significant elevation in FBG levels during Ramadan month among T2D patients [29] and healthy individuals [35]. These controversial data regarding the impact of fasting on blood sugar can be due to a quantitative and qualitative food diversity consumed by the patients during the period of fasting; but also to the difference in the eating habit of the studied populations. Other factors such as the regular taking of medicines, the daily length of fasting, the individual variations in the quantity of blood glucose and the lack of physical exercise were also found to influence the outcome [35].

Glycated haemoglobin: The present finding about HbA1c levels among study subjects was consistent with the most studies reported in literature that found no significant change in blood HbA1c levels during Ramadan month among T2D patients [12]. On other hand, other research studies have reported a statistically significant decrease in blood HbA1c levels during the month of Ramadan among T2D patients [25]. The reduction in the rate of HbA1c is a proof justifying the beneficial effect of the medicinal treatment taken during the fasting of Ramadan.

Serum creatinine: Most of the previous studies showed that, Ramadan fasting was associated with no statistically significant change in serum creatinine levels among T2D patients [7] and healthy individuals [26], these studies agree with our study. In contrast, the result of the present study was not in agreement with the previous work that showed statistically significant reduction in blood creatinine levels among T2D patients [36] and healthy individuals [37]. The finding that serum creatinine levels did not show any significant change in either group in this study is acceptable particularly as

diabetics who were chosen in this study does not complain of diabetic complications.

Serum urea: Few studies were carried out to investigate the effect of Ramadan fasting on blood urea, Most of these in accord with the present finding showing no change in serum urea levels during Ramadan month among T2D patients [20] and healthy individuals [26].

In contrast to the study findings, Sulimani et al. [38] noticed a significant rise of the urea rate which results according to the same author from a bad glomerular filtration among T2D patients. Other authors explained the increase in the values among diabetic patients with the dehydration caused by the food restriction liquids during fasting period [39].

Conclusion

Ramadan Fasting causes weight loss and decrease in calorie intake in both groups, which was correlated with a decreased in meal frequency. Ramadan fasting also led to a significant beneficial effect on the FBG level in both groups. Unfortunately, the fasting increased TC, LDL-C levels in both groups and TG levels among diabetic group. On the other hand, fasting did not affect the levels of serum creatinine and urea in both groups and HbA1c among the control groups. Therefore, Ramadan fast is relatively safe among diabetic patients provided they are properly educated about drug regimen adjustment, diet control, daily activities and possible complications.

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