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http://www.jrdiabet.ro
Rom J Diabetes Nutr Metab Dis. **22**(4):385-392
doi: 10.1515/rjdnmd-2015-0045

EFFECT OF RAMADAN FASTING ON SERUM GLUCOSE AND LIPID PROFILE AMONG ALGERIAN TYPE 2 DIABETES PATIENTS

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received: October 05, 2015 *accepted*: November 29, 2015
available online: December 15, 2015

Abstract

Background and aims*: We designed this study to assess the effect of Ramadan fasting on serum lipid profile among type 2 diabetic patients.* ***Material and Methods****: The study was carried out in July 2014 (Ramadan 1421). The total duration of fasting was 17 hours a day. The investigation involved 80 patients. The mean age of the patients was 56± 8 years. The dietary survey lasting three days was recorded. The anthropometric and the biochemical parameters were measured in all subjects before (T1) and during (T2) the fasting month of Ramadan and results were compared using student t-test.* ***Results****: There was a significant decrease in high density lipoprotein cholesterol (HDL-c) levels during T2 (0.35±0,08 g/L) compared to T1 (0.38±0,11 g/L). Apolipoprotein A1 (Apo A1) decreased significantly during fasting compared to pre-fasting days while apo B increased during T2 ($p<0.05$). The dietary fat consumption increased during Ramadan; especially for the saturated one ($p<0.05$).* ***Conclusion****: The present study suggests that fasting month of Ramadan could be beneficial for some patients with type 2 diabetes who are well controlled and balanced. However, some of them may be at risk of cardiovascular complications in which dyslipidemia can be the leading cause.*

key words: *Ramadan, fasting; type 2 diabetes; lipid profile.*

Introduction

Each year, millions of Muslims refrain from eating or drinking from sunrise (Sahur) to sunset (Iftar) during the holy month of Ramadan [1]. Ramadan is based on a lunar calendar, therefore, the duration of daily fast and the overall period of the month of Ramadan vary each year depending on the geographical location and season [2]. Ramadan fasting could not induce any harmful effect in young healthy subjects. However, it can induce several complications in patients with diabetes, mainly for those with poor glycemic control. Islamic rules allow such patients not to fast, although they usually insist on doing so [3], exposing themselves to certain health risk as a direct consequence of fasting, or of change in food and frequency of medication intake. On the other hand, it has been shown that Ramadan fasting could be considered as an ideal hypo-caloric diet and a good opportunity to lose weight for patients with type 2 diabetes, particularly for those who are obese or overweight [4]. Ramadan is associated with the

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decrease in the number of meals and eating pattern which are two metabolically active parameters. Consequently, the observed change of the biological profile accompanying the fast of Ramadan is not surprising [5]. Few studies have been performed regarding the effects of fasting during Ramadan and tolerance among type 2 diabetes, and in particular the effects of fasting on changes in plasma lipids and habits and food consumption [6-8].

Most patients with type 2 or type 1 diabetes show no change or slight decreases in concentrations of total cholesterol (Tc) and triglycerides (TG). As in healthy persons, several studies have reported increases in high density lipoprotein (HDL) cholesterol in diabetes during Ramadan [6]. One report points to an increase in low density lipoprotein (LDL) cholesterol and a decrease in HDL-cholesterol. The differences in results could be explained by the lack of standardizing energy intake and physical activity, which could have an effect on the lipid metabolism [9].

Due to these conflicting data, we designed the present study to investigate the effect of fasting during Ramadan month on certain serum components such as fasting serum glucose (FSG), total cholesterol (TC), triglycerides (TGs), HDL-c, LDL-c and apolipoproteins (apo A-1, apoB) parameters in type 2 diabetic patients.

Materials and methods

The study, conducted during Ramadan in 2014 at the Diabetes Home “ex Guambeta” and University Hospital Hassani Abdelkader of Sidi-bel-Abbes city, was carried out on 80 volunteer patients (31 male and 49 female) diagnosed with type 2 diabetes with a mean age of 56±8 years. Patients were treated either with diet alone or oral hypoglycemic treatment. Diabetes was diagnosed 4.3±2.4 years ago and presented no degenerative complications. All patients were observed while fasting during the entire month of Ramadan, which coincided with the period lasting from 28 June 2014 to 28 July 2014. The fast began between 4:30 am and finished at 20:30 pm, with an average of 17 hours. Subjects were selected if they had had diabetes for less than five years, because those who were preselected with over three years of diabetes presented some degenerative complications. The exclusion criteria were: patients with type 1 diabetes mellitus, pregnant women, seriously sick, renal failure, hepatic impairment, user of weight reducing agents, and subjects who fasted for less than 20 days.

Concerning the experimental protocol, venous blood samples were drawn after 12 hours overnight fast and were collected over two periods. The first sample was taken one month before Ramadan (T1 or pre-fasting period), the second at the second week during the month of Ramadan (T2 or fasting period). FSG, TC, TGs and HDL-c concentrations were measured by enzymatic colorimetric methods (Spin react Spain) [10]. Direct determination of serum LDL-c level was performed without the need for any pre-treatment or centrifugation steps. The serum concentration of apo A-1 and apo B was determined by a turbidimetric assay using a specific antibody (Spinreact, Spain).

All anthropometric parameters (body weight, body mass index- BMI, waist circumferences- WC) were measured throughout the two periods (T1, T2). The body weight (in kilograms) was measured with an electronic balance (Omron Balance Electronique HN286). The height was measured with a body height scale (Seca 206, Germany; measuring range: 0 - 220 cm, Graduation Length: 1 mm). The body mass index (BMI) was calculated as: BMI (kg/m^2) = weight (kg) / height (m)^2. The WC was measured with a measuring tape (Maximum:

150 cm, Graduation Length: 1 mm). We gently tightened the tape around the patient's abdomen roughly in line with the navel without depressing the skin.

The nutrient intake was evaluated (periods T1 and T2) by means of a three day food record. The patients have recorded the nature and quantity of food eaten and the schedule for eating meals over a period of three consecutive days. For each particular dish, the patient was asked whether the eaten portion was small, medium or large. Food quantities were calculated using household measurements (graduated measure, spoons, bowl, plate, slice, etc.). Energy intake and diet composition in nutrients were calculated with Nutrilog v 2.61 software.

Ethical approval. The Medical Committee of Sidi-bel-Abbes University Hospital and "ex Guambeta" Diabetes Home approved the study. An informed consent was obtained from each participant after a full explanation of the study.

Statistical analysis. Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS®) version 20.0 (IBM Corporation, Chicago, IL., 2011). The results were expressed as mean ±SD. Groups' means were compared using Student *t*-test. A p-value of less than 0.05 was considered as statistically significant. The simple linear regression with a confidence interval of 95% was used for correlations. Pearson correlation tests were used in order to describe the strength and direction of relationships between total cholesterol, LDL-c and BMI. However, simple linear regression tests were employed to predict values of total cholesterol, LDL-c as dependant variables expressed in a regression equation (y = a +b)

Results

The physical characteristics of subjects and the results of various blood tests analyzed over the two periods (T1 and T2) are shown in Table 1 and Table 2.

Table 1. Anthropometric parameters during the two periods of evaluation (N=80).

	T1	T2	p-value
Body Weight (kg)	77.11±11.96	77.73±11.58	0.185
BMI (kg/m²)	28.52±4.44	28.83±4.48	0.183
WC (cm)	95.98±10.42	96.39±10.25	0.260

The main finding was a significant decrease in HDL-C levels (p= 0 .003) and apo A-1 (p=0.020) during fasting compared to pre-fasting days. A significant increase was noticed in apoB (apo B=1.24±0.44) during T2.

Table 2. Biochemical parameters during and after Ramadan (N=80).

Blood components	T1	T2	p-value
FSG (g/L)	1.56±0.75	1.60±0.57	0.700
TC (g/L)	1.92±0.42	1.86±0.48	0.196
HDL-c (g/L)	0.38±0.11	0.35±0.08	0.003
LDL-c (g/L)	1.24±0.36	1.19±0.37	0.148
TGs (g/L)	1.52±0.67	1.64±0.90	0.159
apoA-1(g/L)	1.53±0.39	1.42±0.33	0.020
apoB (g/L)	1.11±0.33	1.24±0.44	0.003
TC/HDL-c	5.25±1.58	5.34±1.60	0.599

There were no significant changes in the serum TGs, LDL-c, and TC levels. The body weight and BMI were maintained, while, glycaemia increased non-significantly. Concerning the coronary heart disease risk indicators, such as TC/HDL-c ratio, no significant difference was observed between the two periods. Among our diabetic patients (male and female), BMI was negatively associated to TC during the fasting period (r^2 adj= 0.009) as shown in Figure 1. The relationship between LDL-c and BMI revealed that LDL-c values were almost unchanged regardless of the BMI values (r^2adj=-0.013,) as shown in Figure 2.

The mean energy intake and specific intake of various nutrients taken before and during Ramadan are shown in Table 3. The main finding was a significant decrease in the amount of saturated fatty acids (SFA) during T2 compared to T1 (p=0.000). The total energy intake (TEI) decreased non-significantly during the fasting period. The Iftar (the meal taken just after sunset) represented 74.23 % of the TEI, while the Sahur (the meal taken before dawn) counted only for 16.34% of the TEI. Furthermore, the amount of carbohydrates, fats, dietary cholesterol and monounsaturated fatty acids (MUFA) decreased non-significantly during T2 when compared to T1.

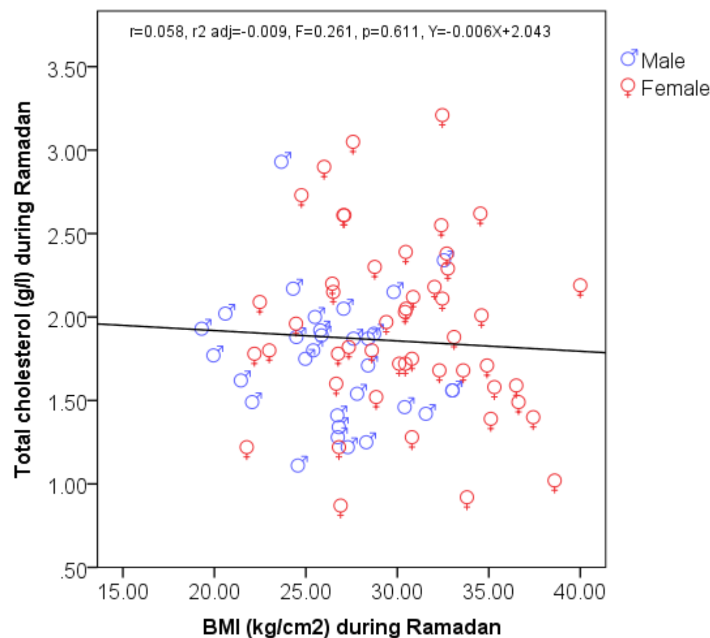

Figure 1. *Effect of BMI on TC levels during Ramadan.*

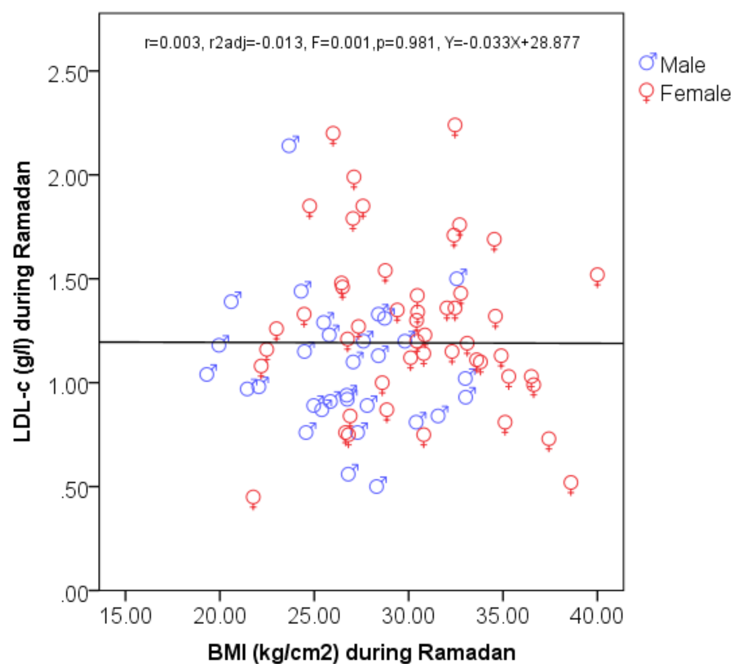

Figure 2. *Effect of BMI on LDL-c levels during Ramadan.*

Table 3. Nutrient intake before and during Ramadan.

	T1	T2	P value
TEI (kcal)	1305.15 ± 881.46	1198.18 ± 372.86	0.308
Proteins (g)	46.52 ± 43.77	37.25 ± 12.32	0.057
Fats (g)	50.78 ±42.48	44.07 ± 23.16	0.218
Carbohydrates (g)	157.76 ± 96.75	137.09 ± 40.11	0.086
Cholesterol (mg)	121.29 ± 94.19	90.74 ± 127.56	0.065
SFA (g)	36.68 ± 25.53	60.40 ± 48.24	<0.001
MUFA (g)	49.76 ± 34.96	43.46 ± 32.75	0.192
PUFA (g)	42.18 ± 33.09	43.17 ± 41.43	0.844
Water (g)	2123.60 ± 403.17	1099.01 ± 238.72	0.640

PUFA: polyunsaturated fatty acids

Discussion

The Ramadan model of changes induced by fasting is abundantly available, but not extensively studied and the physiological changes induced by Ramadan fasting are not well known. Although there have been reports on the metabolic changes during and after Ramadan in healthy subjects and in patients with diabetes, the results are conflicting [11]. The body has regulatory mechanisms that activate during fasting. There is an efficient utilization of fat, and the basal metabolism slows down during fasting [12].

In the current study, the mean body weight and BMI of the patients showed no change between the two periods (T1 and T2), despite the marked changes in food habits. Our finding was similar to that of Azizi *et al.* and Bouguerra *et al.* [6-8]. Usually, most people with diabetes reduced deliberately their daily activities during Ramadan period to avoid hypoglycemia [6]. In contrast to our study, many studies reported weight loss during the month of Ramadan [4,13-15]. Similarly, waist measurements did not show any statistically significant differences (p>0.05) in agreement with the study of Khaled et al. in 2009 [16] and Khan et al. in 2011 [14]. However, Yarahmadi *et al.* [17] reported a significant decrease in waist-to-hip ratio of Iranian men due to Ramadan fasting. Regarding the FSG, no incidents or accidents of hypoglycemia events were reported during the fasting month of Ramadan in our study, FSG remaining stable. These results are in agreement with those of other authors [6,8,14]. It was suggested that if there were changes in glucose level, it was due to variation in the amount of food, physical activity, or irregular medication [9].

On the other hand, the lipid parameters showed no significant changes in serum TC, LDL-c and TGs levels during the two periods ($p \geq 0.05$). A decrease in HDL-c level during Ramadan fasting was noticed; these findings being similar to those obtained by Khaled *et al.* and Bouguerra *et al.* [13,15] who found a decrease in serum HDL-c level among type 2 diabetic patients during the fasting period compared to pre-fasting period, while Khan *et al.* [14] showed that HDL-c decreased non-significantly. Other studies reported an increase in HDL-c in diabetics during Ramadan [8,18,19]. These observations may be attributed to the quantity or the quality of consumed meals and by the fact that our patients tried to substitute their sweet foods by more fattening ones [13].

Low HDL-c is recognized as a risk factor for atherosclerosis. Clinicians find raising HDL-c a challenge and patients often inquire about dietary advice that may help raise HDL-c [20]. Dietary measures and pharmacological agents are often not sufficient to reach the HDL-c target level of 40 mg/dl in patients with low baseline HDL-c [21]. Non-pharmacological means that

increase HDL-c levels in diabetics are primarily weight loss, physical activity, glycemic control and smoking cessation [8]. At baseline, there is no specific guidelines on dietary therapy of HDL-c; however; the American Heart Association (AHA) published diet and lifestyle recommendations in 2006 [22]. Those guidelines recommend a diet low in fat, saturated fat, *trans* fat, and cholesterol in addition to minimizing sodium, added sugars and alcohol intakes. The AHA recommends the consumption of oily fish and the DASH (Dietary Approaches to Stop Hypertension) diet. In multiple regression analysis, HDL cholesterol was positively associated with pulse rate and fat intake and negatively with weight loss and higher systolic blood pressure [23].

The apo A-1 showed a significant decrease, while apo B was significantly higher during Ramadan. Our results are in agreement with those of Khaled *et al.* [16]. The association between plasma apo B concentration and the development of vascular disease is well established [24], apo B identifies high-risk dyslipidemic phenotypes that are not detected by standard lipid profile in type 2 diabetic patients. The addition of apo B to standard lipid profile measurement could aid in timely introduction of lipid lowering therapy in these unidentified high risk patients and thus reduce mortality and morbidity due to future cardiovascular complications in them [25]. Sniderman *et al.* [26] has shown that only 23% of diabetics had abnormal LDL-c, while 40% had abnormal apo B.

As shown in Figure 1, BMI was inversely related to TC, whereas no association between LDL-c and BMI was foud in both genders (Figure 2).

Concerning diet during Ramadan, our results reported a decrease of energy intake during the fasting period, compared to that of pre-fasting, this was probably due to a reduction of meal frequency. Our findings are in agreement with those of Bouguerra *et al.* and Khaled *et al.* [8,13]. During Ramadan most patients engage in some activities such as walking, leisure activities or el-Taraouih prayers, after their evening meal. In addition, sleep duration is shorter during Ramadan [27]. The dietary fat consumption, particularly the saturated one increased significantly ($p<0.001$), this was probably due to the Ramadan diet of our patients, which brought more food rich in fat such as eggs, meat, fried food and shortening, that were highly consumed during this month. These findings are in accordance with those of Khaled *et al.* [8]. A non significant decrease in dietary cholesterol and MUFA has been recorded in the present study, whereas the PUFA increased non significantly. This was related to the dietary habits observed in the month of Ramadan. In our study, Ramadan fasting induced a non significant decrease in proteins and carbohydrates.

The variability in the results concerning the effect of Ramadan fasting in metabolic profile among type 2 diabetic patients is probably attributed to several confounding variables like ethnicity, hours of fasting, climatic conditions, cultural influences, physical activity and most commonly the dietary patterns [11].

Conclusion

According to this study Ramadan fasting appears to have a significant effect on HDL-c and apolipoproteins in balanced type 2 diabetic patients receiving oral treatment that could translate into an increase of cardiovascular risk. This was correlated to the increase in SFA brought by the food rich in fat. Our results highlight the lack of significant consequences of Ramadan fasting on the other lipid parameters (Tc, LDL-c, TGs). The body weight and FSG of patients remained unchanged despite the change

in food habits. During the month of Ramadan, there is a need for nutrition education adequately before allowing diabetic patients fasting.

Conflict of interest: The authors have no conflicts of interest.

Acknowledgments: The volunteers who participated in the study are gratefully thanked. Also, we would like to thank Sidi-bel-Abbes University Hospital and the staff of Guambeta Diabetes Home for all support in performing needed analysis.

REFERENCES

1. **Trepanowski JF, Bloomer RJ**. The impact of religious fasting on human health. *Nutr J* 9:57, 2010.

2. **Hui E, Devendra D**. Diabetes and fasting during Ramadan. *Diabetes Metab Res Rev* 26: 606-610, 2010.

3. **Benaji B, Mounib N, Roky R et al**. Diabetes and Ramadan: review of the literature. *Diabetes Res Clin Pract* 73(2):117-125, 2006.

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

5. **Barkia A, Mohamed K, Smaoui M, Zouari N, Hammami M, Nasri M**. Change of diet, plasma lipids, lipoproteins, and fatty acids during Ramadan: a controversial association of the considered Ramadan model with atherosclerosis risk. *J Health Popul Nutr* 29: 486-493, 2011.

6. **Azizi F, Siahkolah B.** Ramadan fasting and diabetes mellitus. *Int J Ramadan Fasting Res* 28: 17, 1998.

7. **Belkhadir J, el Ghomari H, Klocker N, Mikou A, Nasciri M, Sabri M**. Muslims with non-insulin-dependent diabetes fasting during Ramadan: treatment with glibenclamide. *BMJ* 307: 292-5, 1993.

8. **Bouguerra R, Belkadhi A, Jabrane J et al**. Metabolic effects of the month of Ramadan fasting on type 2 diabetes. *East Mediterr Health J* 9: 1099-1108, 2003.

9. **Mohamed GA, Car N, Muačević-Katanec D**. Fasting of persons with diabetes mellitus during Ramadan. *Diabetol Croat* 31: 75-84, 2002.

10. **Bergmeyer HU**. In Methods of enzymatic analysis. Bergmeyer HU (ed) 2nd ed vol 3. Weinheim/Academic Press; New York, London, pp 1323-1330, 1974.

11. **Sadiya A, Ahmed S, Siddieg HH, Babas IJ, Carlsson M**. Effect of Ramadan fasting on metabolic markers, body composition, and dietary intake in Emiratis of Ajman (UAE) with metabolic syndrome. *Diabetes Metab Synd Obes* 4: 409-416, 2011.

12. **el-Ati, J, Beji C, Danguir J**. Increased fat oxidation during Ramadan fasting in healthy women: an adaptive mechanism for body-weight maintenance. *Am J Clin Nutr* 62: 302-307, 1995.

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

14. **Khan NB, Khan MH, Shaikh MZ, Khanani MR**. Effects of Ramadan fasting on glucose levels and serum lipid profile among type 2 diabetic patients. *Saudi Med J 31*: 1269-1270, 2010.

15. **Bouguerra R, Jabrane J, Maâtki C, et al**. Ramadan fasting in type 2 diabetes mellitus. *Ann Endocrinol (Paris)* 67: 54-59, 2006.

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

17. **Yarahmadi SH, Larijani B, Bastanhagh MH, et al**. Metabolic and clinical effects of Ramadan fasting in patients with type II diabetes. *J Coll Physicians Surg Pak* 13: 329-332, 2003.

18. **Khatib F**. Effect of fasting in Ramadan on blood glucose and plasma lipids in diabetics with NIDDM. Proceedings of the 2nd International Congress on Health and Ramadan. 1997 Dec 1 – 3; Istanbul, Turkey.

19. **Uysal A, Erdogan M, Sahin G, et al**. The clinical, metabolic, and hormonal effects of fasting on 41 NIDDM patients, during the Ramadan 1997. Proceedings of the 2nd International Congress on Health and Ramadan. 1997 Dec 1 – 3; Istanbul, Turkey.

20. **Crawford P, Paden SL, Park MK**. Clinical inquiries: What is the dietary treatment for low HDL cholesterol? *J Fam Pract* 55: 1076-1078, 2006.

21. Devroey D, De Swaef N, Coigniez P, Vandevoorde J, Kartounian J, Betz W. Correlations between lipid levels and age, gender, glycemia, obesity, diabetes, and smoking. *Endocr Res* 30: 83-93, 2004.

22. Tapsell LC, Gillen LJ, Patch CS, et al. Including walnuts in a low-fat/modified-fat diet improves HDL cholesterol-to-total cholesterol ratios in patients with type 2 diabetes. *Diabetes Care* 27: 2777-2783, 2004.

23. Mansi KM. Study the effects of Ramadan fasting on the serum glucoses and lipid profile among healthy Jordanian students. *Am J Appl Sci* 4: 565-569, 2007.

24. Walldius G, Jungner I, Holme I, Aastveit AH, Kolar W, Steiner E. High apolipoprotein B, low apolipoprotein A-I, and improvement in the prediction of fatal myocardial infarction (AMORIS study): a prospective study. *Lancet* 358(9298): 2026-2033, 2001.

25. Kanani FH, Alam JM. Apolipoprotein B in Type 2 diabetics — a cross sectional study in a tertiary care set-up. *J Pak Med Assoc* 60: 653-656, 2010.

26. Sniderman AD, Lamarche B, Tilley J, Seccombe D, Frohlich J. Hypertriglyceridemic hyperapoB in type 2 diabetes. *Diabetes Care* 25: 579-82, 2002.

27. Lamri–Senhadji MY, El Kebir B, Belleville J, Bouchenak M. Assessment of dietary consumption and time–course of changes in serum lipids and lipoproteins before, during and after Ramadan in young Algerian adults. *Singapore Med J* 50: 288-294, 2009.