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ORIGINAL ARTICLE

An evaluation of the effects of Ramadan fasting on anthropometric, metabolic and endocrine parameters

Muzaffer Akkoca[1], Ziya Erokay Metin[2], Oya Topaloğlu[3], Serhat Tokgöz[1], Gökhan Cihan[4], İshak Şan[5]

[1] University of Health Sciences, Dışkapı Research and Training Hospital, Department of General Surgery, Altındağ, Ankara 06110, Turkey - E-mail: muzafferakk@gmail.com; [2] Presidency of the Republic of Turkey Health Center, Department of Nutrition and Dietetics, Beştepe, 06560 Ankara, Turkey; [3] Yildirim Beyazit University Faculty of Medicine, Atatürk Research and Training Hospital, Department of Endocrinology and Metabolism, Bilkent, 06560 Ankara, Turkey; [4] Presidency of the Republic of Turkey Health Center, Department of Cardiology, Beştepe, 06560 Ankara, Turkey; [5] Presidency of the Republic of Turkey Health Center, Department of Emergency, Beştepe, 06560 Ankara, Turkey

Summary. *Objective:* The aim of this study was to examine the effects of the energy and nutrients intake at Ramadan fasting on anthropometric measurements, metabolic and endocrine parameters. *Methods:* This prospective study included a total of 80 healthy volunteers, aged 19-50 years, who were fasting during the month of Ramadan. Anthropometric measurements, blood samples were taken and nutritional intake was recorded of all participants at 5 days before Ramadan(BR) and on the 27th day at the end of Ramadan (AR). The anthropometric measurements comprised height, weight, body mass index(BMI), hip-waist circumference, body fat ratio and fat mass measurements. From the blood samples, analysis was made of fasting glucose, insulin, total cholesterol, LDL-C, HDL-C and TG. From the records of food intake, energy and nutrients were calculated. The anthropometric measurements, metabolic and endocrine parameters, energy and nutrients BR and AR were compared generally. *Results:* In the period from BR to AR in the values, a decrease was determined in body weight (77.4±11.0, 76.2±10.7kg, p<0.01), BMI (26.1±2.6, 25.7±2.5kg/m2, p<0.001), waist circumference (94.5±9.0, 91.8±8.3cm p<0.001) and body fat ratio (24.4%±6.4%, 23.8%±5.9%, p<0.01). An increase was determined in the values of fasting glucose (83.5±7.4, 91.1±12.3mg/dl, p<0.01), insulin (8.8±4.1, 10.1±4.5μU/ml, p<0.01) and HOMA-IR (1.8±0.9, 2.2±1.1, p<0.01). There was a decrease in HDL-C levels (p<0.001). *Conclusion:* Ramadan fasting was observed to have positive effects on anthropometric measurements such as body weight, BMI, fat mass and waist circumference, which are cardiovascular risk factors, but no similar positive effect was seen on endocrine and metabolic parameters.

Key words: Ramadan fasting, anthropometric measurement, metabolic and endocrine parameters

1. Introduction

Obesity is a significant health problem in modern societies and according to World Health Organisation (WHO) data, 13% of the adult population worldwide are obese (1, 2). In the formation of obesity, genetic, environmental and physiological factors change the balance between energy intake and consumption (3). Healthy eating has been shown to have positive effects on obesity, and the number and timing of daily meals is also important (1). Increasing the duration of fasting by reducing the number of daily meals is known as intermittent fasting. The beneficial effects of intermittent fasting on glycaemic control, metabolism, cardiovascular risk, cancer and life expectancy have been researched in recent studies (4).

Although previous studies report different results, Ramadan Fasting is appropriate model for researching beneficial effects of intermittent fasting (5). In the ninth month of the Islamic calendar (the month of Ramadan), Muslims fast without eating or drinking from sunrise to sunset. Throughout this month, nutritional intake is obtained from meals in the evening and during the night, and thus the duration of sleep is shortened (6). Energy and glucose metabolism, appetite and hormonal responses are changed by prolonged fasting periods and the changes in nutritional habits also effects lipid profile and body composition during Ramadan (7, 8).

Some previous studies have examined the effects of Ramadan fasting on body composition and biochemical parameters (6). However, the majority of those studies have been conducted on a limited number of subjects. In this study, an examination was made of the effects of Ramadan fasting on anthropometric, metabolic and endocrine parameters and the energy and nutrients intake of individuals who were fasting.

2. Method

The study was prospectively conducted on healthy volunteers, aged 19-50 years, who were fasting during the month of Ramadan 2017. Approval for the study was granted by the Local Ethics Committee (decision no: May 2017, 38/27). Subjects were excluded from the study if they had diabetes mellitus, hypertension, were smokers, had a >5% increase or decrease of body weight in the previous 3 months, or if they were obese (BMI ≥30 kg/m^2).

Nutritional intake was recorded, and blood samples and anthropometric measurements were taken of all participants at 5 days before Ramadan (BR) and on the 27th day at the end of Ramadan (AR). The metabolic and endocrine data obtained from the BR and AR blood samples, the BR and AR anthropometric measurements and the BR and AR nutritional elements intake were evaluated separately for all the individuals. The subjects who had sahur fasted for the 27 days of Ramadan without eating and drinking for approximately 15 hours per day. Apart from the duration of fasting, the subjects ate without calorie restriction.

All participants were contacted by telephone on days 7, 14, 21 and 27 of the month of Ramadan to confirm whether or not they were complying with the study protocol. During the follow-up period, any subjects who had stopped fasting for any reason, who had an interval of not fasting (apart from females who could not fast during the menstrual cycle) were withdrawn from the study.

For all subjects, measurements were taken of body weight, height, waist-hip circumference, body mass index (BMI) and body composition. Body weight was measured with a Tanita MC 780 device, which was sensitive to 0.1 kg, with the individual in a fasting state and without shoes. Height was measured with a rigid measure, sensitive to 0.1 cm. Hip circumference was measured in cm from the highest point of the measure with the subject standing side-on. BMI was calculated with the formula of body weight (kg) / height (m)^2. On the day of measurements, the individual had not had anything to eat or drink for at least 8 hours previously, had not had a bath or sauna and had not done any sport. When taking the measurements, the barefoot individual stood on the metal plate of the device and held the appropriate parts with the hands with the arms parallel to the body. The body fat ratio percentage and body fat mass, as kg, were recorded.

Blood samples were collected after 8-10 hours fasting. Analysis of the serum glucose, insulin, total cholesterol, high density lipoprotein cholosterol (HDL-C), low density lipoprotein cholosterol (LDL-C) and triglyceride (TG) levels was made using a Saturna 300 Crony device. For insulin resistance, the homeostasis model evaluation (HOMA-IR) was used. The formula of "serum insulin level (IU/ml) x serum glucose level (mg/dl) /405" was used in the HOMA-IR calculation.

Energy and nutrients intake was determined with a 3-day record of food consumption. The subjects were instructed how to record 3 days of food intake as 2 consecutive weekdays and one weekend day. Portion sizes were explained using household measures (spoons, plates, slices, water glass, etc). The nutrients and amounts in the food and drink consumed throughout 3 days were calculated using standard meal recipes and the daily amount of consumed nutrition was determined by dividing each nutrient by 3 (9). The

values of the mean energy and nutrients consumed were analysed using the "Computer-assisted nutritional program, nutritional information system".

Data obtained in the study were analysed using SPSS 11.5 software. In the descriptive statistics, continuous variables were stated as mean±standard deviation (SD), median, minimum and maximum values and numerical variables as number (n) and percentage (%). In the comparison of the BR and AR body composition and laboratory values of the individuals fasting during Ramazan, conformity of the data to normal distribution was assessed with the Paired Samples t-test and the Wilcoxon test. A value of $p<0.05$ was accepted as statistically significant.

3. Results

A total of 85 healthy individuals were enrolled in the study and the evaluations were completed with 80 (94.1%) subjects. Due to health reasons, 5 subjects stopped fasting and were withdrawn from the study. The 80 subjects who completed the study comprised 52 (65%) males and 28 (35%) females with a mean age of 37±7.2 years (Table 1).

Anthropometric results; In the measurements of subjects, a significant decrease was determined in body weight (77.4±11.0, 76.2±10.7 kg, $p<0.01$), BMI (26.1±2.6, 25.7±2.5 kg/m2, $p<0.001$), waist- hip circumference (94.5±9.0, 91.8±8.3 cm/ 105.8±5.0, 102.7±4.7 cm, $p<0.001$) and body fat ratio (24.4%±6.4%, 23.8%±5.9%, $p<0.01$) (Table 1). Also, a significant decrease was determined in the BR and AR body fat ratio (24.4±6.4%, 23.8±5.9%, $p<0.01$) and fat mass (18.7±5.0 kg, 18.0±4.8 kg, $p<0.001$).

Metabolic and endocrine results; In the individuals, a significant increase was determined in the period from BR to AR in the values of fasting glucose (83.5±7.4, 91.1±12.3 mg/dl, $p<0.01$), insulin (8.8±4.1, 10.1±4.5 μU/ml, $p<0.01$) and HOMA-IR (1.8±0.9, 2.2±1.1, $p<0.01$) (Table 2). Ramadan fasting was not observed to have any significant effect on total cholesterol, LDL-C or triglycerides ($p>0.05$). A significant decrease was determined in HDL values (52.1±16.5, 46.3±13.9, $p<0.05$) (Table 2).

Energy and nutrients intake results; In the evaluation of the data obtained from the records of food intake for 3 days, a significant decrease was determined

Table 1. Demographic data and anthropometric measurements before and after Ramadan

	Sahur	**Without sahur**	**Total**
Age (year)	37±7.3	36.42±6.8	37±7.2
Gender			
Male	42 (% 63.6)	10 (% 71.4)	52 (% 65)
Female	24 (% 36.4)	4 (% 28.6)	28 (% 35)
	Before Ramadan	**After Ramadan**	**P value**
Weight (kg)	77.4±11.0	76.2±10.7	0,003
BMI	26,1±2,6	25.7±2.5	0.000
WC (cm)	94.5±9.0	91.8±8.3	0.000
HC (cm)	105.8±5.0	102.7±4.7	0.000
W/H	0.8±0.07	0.8±0.06	0.921
BF (%)	24.4±6.4	23.8±5.9	0.005
BFM (kg)	18.7±5.0	18.0±4.8	0.005

BMI, body mass index; WC, waist circumference; HC, hip circumference; W/H waist to hip ratio; BF, body fat percentage; BFM, body fat mass

from BR to AR in respect of energy, carbohydrate, fat and fibre intake (p<0.001). Furthermore, polyunsaturated fatty acids (PUFAs) (23.6±10.5 g, 17.4±7.2 g, p<0.05), monounsaturated fatty acids (MUFAs) (29.4±8.9 g, 23±10.6 g, p<0.05), n-3 polyunsaturated fatty acids (n-3) (2.3±1.4 g, 1.6±0.7g, p<0.004) and n-6 polyunsaturated fatty acids (n-6) (20.9±9.8 g, 15.1±7.4 g, p<0.002) intakes decreased significantly and no change observed at n-6/n-3 ratio (10.3±5.4 g, 10.4±5.9 g, p>0.5) and saturated fatty acids (SFAs) intake (28.5±9.1 g, 25.4±13.8 g, p>0.05) (Table 3).

4. Discussion

The results of this study based on fasting during Ramadan showed that, i) there was a reduction in the anthropometric measurements of body weight, BMI, waist circumference and body fat ratio, ii) the metabolic and endocrine parameters of fasting glucose, insulin and HOMA-IR values increased and with the exception of a decrease in HDL-C levels, there was no change in the blood cholesterol levels, and iii) all the parameters of energy and nutrients intake decreased.

Table 2. Metabolic and endocrine parameters before and after Ramadan

	Before Ramadan	After Ramadan	P value
FBG (mg/dl)	83.5±7.4	91.1±12.3	0,003
Insulin (μU/ml)	8.8±4.1	10.1±4.5	0.004
HOMA-IR	1.8±0.95	2.2±1.1	0.004
TC (mg/dl)	191.4±35.2	187.1±33.7	0.062
LDL-C (mg/dl)	116.6±34.2	115.9±33.0	0.897
HDL-C (mg/dl)	52.1±16.5	46.3±13.9	0.000
TG (mg/dl)	106.8±56.7	121.7±88.0	0.521

FBG, fasting blood glucose; HOMA-IR, homeostatic model assessment of insulin resistance; TC, total cholesterol; LDL-C, low density lipoprotein cholesterol; HDL-C high density lipoprotein cholesterol; TG, triglycerides

Table 3. Energy and nutrients intake before and after Ramadan

	Before Ramadan	After Ramadan	P value
Energy (kcal)	1964.3±760.3	1567.7±512.9	0.000
Carbohydrate (g)	207.8±94.8	175.9±69.1	0.008
Protein (g)	73.3±24	56.1±14.7	0,002
Fat (g)	86.5±34.7	69.1±27.1	0.001
Fiber (g)	22.7±8.2	15.9±5.7	0.000
SFAs (g)	28.5±9.1	25.4±13.8	0.207
PUFAs (g)	23.6±10.5	17.4±7.2	0.002
MUFAs (g)	29.4±8.9	23±10.6	0.004
n-3 (g)	2.3±1.4	1.6±0.7	0.004
n-6 (g)	20.9±9.8	15.1±7.4	0.002
n-6/n-3	10.3±5.4	10.4±5.9	0.950

SFAs, saturated fatty acids; PUFAs, polyunsaturated fatty acids; MUFAs, monounsaturated fatty acids; n-3, n-3 polyunsaturated fatty acids; n-6, n-6 polyunsaturated fatty acids

Body fat ratio and excessive body weight are known to be risk factors for cardiovascular disease (10). The lack of fluid intake together with food intake during Ramadan fasting could cause total weight loss by increasing loss of body fluid (11). However, in the current study, together with the reduction in total body weight, the body fat mass was also observed to have decreased. Therefore, it is not correct to explain the body weight loss by fluid loss only. Furthermore, as there was seen to be a reduction in energy intake at AR, it can be thought that the total weight loss occurred more through the oxidation of fat and the reduction in fat mass.

Morbidity and mortality associated with cardiovascular disease are known to be affected by total body fat and the accumulation of abdominal body fat (12). In recommendations for healthy living given by Sadiya et al, a significant decrease was shown in the waist circumference values of patients with metabolic syndrome who were monitored during Ramadan (13). In addition, a study investigating the effects of Ramadan fasting reported significant reduction in body fat percentage of nonalcoholic fatty liver disease patients (14). On the other hand fat oxidation was increased because of Ramadan fasting (15). But, Lessan et al showed no significant change on resting metabolic rates of healthy nonobese volunteers (7). So, Ramadan-induced body fat and abdominal fat loss can be attributed to a reduction in energy intake. Although a systematic rewiev concluded that Ramadan fasting has neutral effects on cardiovascular risk factors (16), Syam et al showed significant reduction in body fat without protein loss in Ramadan (6). We found a significant decrease in abdominal fat and total body fat due to intermittent fasting. This decrease can be attributed to energy deficit in Ramadan fasting. So, in the current study a significant reduction was observed in abdominal fat mass and waist circumference values supports the view that Ramadan fasting has positive effects on cardiovascular health in particular.

Conflicting results have been reported from studies that have investigated the effects of Ramadan fasting on lipid profiles (17, 18). Changes in nutritional habits in the month of Ramadan, reduced physical activity and cultural factors could affect these results (19). In the current study, while no difference was seen in the BR and AR total cholesterol, LDL-C and triglyceride values, a signifcant difference was determined in the HDL-C values, which were observed to have reduced from BR to AR. In contrast, in another study that was conducted on a small number of healthy individuals, a 30% increase was shown in HDL-C values (20). Ziaee et al reported that Ramadan fasting increased LDL-C and this could have been an indicator of the difference between BR and AR energy and fat intake (19). High consumption of fatty acids is associated with atherosclerosis and the structures of this fatty acids determine the real impact (21). The SFAs are more likely to contribute CVD, but PUFAs are known to be antiatherogenic (22). SFAs were shown to raise serum TC levels, so dietary guidelines recommend limiting amounts of saturated fat intake (23). On the other hand, a diet low in n-6/n-3 ratio are known to have beneficial effects on cardiovascular risk and data shows lowering n-6/n-3 ratio decreases TG and TC levels even a high fat diet (24). In the current study, nutrient consumption was calculated from the 3-day food intake records and according to these, energy intake was reduced compared to BR. Therefore, the reduction in HDL-C values could be related to lower levels of physical activity during Ramadan rather than reduced energy intake. Also, in our study we observed any change in n-6/n-3 ratio and SFAs intake but significant decreases occured in PUFAs, MUFAs, n-3 and n-6 fatty acids consumption. Altough the consumption of SFAs remain similar levels according to BR, the percent of energy coming from SFAs increase because of declining total energy intake. Both the increasing energy percent from SFAs and decreasing intake of PUFAs could influence significantly decreased HDL-C and increased TG levels in our study.

In a study by Unalacak et al, the fasting glucose levels in obese individuals were shown to be significantly reduced compared to those of subjects who were not obese (25). Another study of 115 subjects showed that fasting glucose levels were significantly reduced with Ramadan fasting (26). The results of the current study showed a similar effect of Ramadan fasting on fasting glucose and insulin levels. Ramadan fasting was observed to have significantly increased the fasting glucose, insulin and HOMA-IR levels in healthy individuals. The nutrient intake records in the current

study showed a significant reduction in fibre intake. This suggests that the increasing glucose and insulin levels were associated with reduced fibre intake and the associated reduced digestive energy expenditure**.** In addition, as the evening meal taken before the blood sample collection was not standard, this could have affected the fasting glucose and insulin values.

Insulin resistance is known to play a role in the development of type 2 DM, hypertension, hyperlipidemia and atherosclerosis (27). In a study by Gnanou et al, it was reported that HOMA-IR values were reduced together with glucose and insulin levels in healthy subjects fasting during Ramadan (28). In contrast, Unalacak et al showed that in individuals with normal body weight HOMA-IR values were increased by Ramadan fasting (25). The high HOMA-IR values of the current study are similar to the findings of that study. When it is taken into consideration that the participants of both studies were from the same sociocultural background, the elevated HOMA-IR levels can be explained by the similarity of nutritional habits.

In the evaluation of the 3-day food intake records in the current study, the AR energy intake was observed to have reduced. In contrast, previous studies have shown an increase in energy intake and Al-Hourani et al observed no significant change (29-32). Despite no calorie restrictions, that the carbohydrate and energy intake was reduced suggests that it could have been due to the month of Ramadan occuring in the summer and thus the time for eating and drinking was shorter. Similarly, there was a reduction in fibre intake and it can be said that this contributed to the reduced energy requirement.

Limitations of this study were primarily that there was no measurement of the resting energy expenditure of the participants at BR and AR, and levels of physical activity were not recorded.

In conclusion, the results of the study showed that there were positive effects of Ramadan fasting on anthropometric measurements such as body weight, BMI, fat mass and waist circumference, which are cardiovascular risk factors, but similar positive effects were not observed on endocrine and metabolic parameters.

References

1. Mattson MP, Allison DB, Fontana L, Harvie M, Longo VD, Malaisse WJ, et al. Meal frequency and timing in health and disease. Proceedings of the National Academy of Sciences. 2014;111(47):16647-53.
2. Organization WH. Obesity and overweight: World Health Organization. 2017.
3. Spiegelman BM, Flier JS. Obesity and the regulation of energy balance. cell. 2001;104(4):531-43.
4. Hutchison AT, Heilbronn LK. Metabolic impacts of altering meal frequency and timing–Does when we eat matter? Biochimie. 2016;124:187-97.
5. Sana'a AA, Ismail M, Baker A, Blair J, Adebayo A, Kelly L, et al. The effects of diurnal Ramadan fasting on energy expenditure and substrate oxidation in healthy men. British Journal of Nutrition. 2017;118(12):1023-30.
6. Syam AF, Sobur CS, Abdullah M, Makmun D. Ramadan fasting decreases body fat but not protein mass. International journal of endocrinology and metabolism. 2016;14(1).
7. Lessan N, Saadane I, Alkaf B, Hambly C, Buckley AJ, Finer N, et al. The effects of Ramadan fasting on activity and energy expenditure. The American journal of clinical nutrition. 2018;107(1):54-61.
8. Yeoh EC, Zainudin SB, Loh WN, Chua CL, Fun S, Subramaniam T, et al. Fasting during Ramadan and associated changes in glycaemia, caloric intake and body composition with gender differences in Singapore. Ann Acad Med Singap. 2015;44:202-6.
9. Kutluay, T. Toplu Beslenme Yapılan Kurumlar için Standart Yemek Tarifleri. Cihan Matbaası, Ankara. 1991.
10. Myint PK, Kwok CS, Luben RN, Wareham NJ, Khaw K-T. Body fat percentage, body mass index and waist-to-hip ratio as predictors of mortality and cardiovascular disease. Heart. 2014;100(20):1613-9.
11. Memari A-H, Kordi R, Panahi N, Nikookar LR, Abdollahi M, Akbarnejad A. Effect of Ramadan fasting on body composition and physical performance in female athletes. Asian journal of sports medicine. 2011;2(3):161.
12. Saleh SA, Elsharouni SA, Cherian B, Mourou M. Effects of Ramadan fasting on waist circumference, blood pressure, lipid profile, and blood sugar on a sample of healthy Kuwaiti men and women. Malaysian Journal of Nutrition. 2005;11(2):143-50.
13. 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, metabolic syndrome and obesity: targets and therapy. 2011;4:409.
14. Aliasghari F, Izadi A, Gargari BP, Ebrahimi S. The effects of Ramadan fasting on body composition, blood pressure, glucose metabolism, and markers of inflammation in NAFLD patients: An observational trial. Journal of the American College of Nutrition. 2017;36(8):640-5.
15. El Ati J, Beji C, Danguir J. Increased fat oxidation during Ramadan fasting in healthy women: an adaptative mecha-

nism for body-weight maintenance. The American journal of clinical nutrition. 1995;62(2):302-7.
16. Mazidi M, Rezaie P, Chaudhri O, Karimi E, Nematy M. The effect of Ramadan fasting on cardiometabolic risk factors and anthropometrics parameters: a systematic review. Pakistan journal of medical sciences. 2015;31(5):1250.
17. Mansi KMS. Study the effects of Ramadan fasting on the serum glucose and lipid profile among healthy Jordanian students. Am J Appl Sci. 2007;4(8):565-9.
18. Ara T, Jahan N, Sultana N, Choudhury R, Yeasmin T. Effect of Ramadan Fasting on Total cholesterol (TC) Low density lipoprotein cholesterol (LDL-C) and High density lipoprotein cholesterol (HDL-C) in Healthy Adult Male. Journal of Bangladesh Society of Physiologist. 2016;10(2):46-50.
19. 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 medical journal. 2006;47(5):409.
20. Maislos M, Khamaysi N, Assali A, Abou-Rabiah Y, Zvili I, Shany S. Marked increase in plasma high-density-lipoprotein cholesterol after prolonged fasting during Ramadan. The American journal of clinical nutrition. 1993;57(5):640-2.
21. DiNicolantonio JJ, Lucan SC, O'Keefe JH. The evidence for saturated fat and for sugar related to coronary heart disease. Progress in cardiovascular diseases. 2016;58(5):464-72.
22. 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. Journal of health, population, and nutrition. 2011;29(5):486.
23. Walrand S, Fisch F, Bourre J-M. Do saturated fatty acids have the same metabolic effect? Nutrition Clinique et Métabolisme. 2010;24(2):63-75.
24. Riediger ND, Othman R, Fitz E, Pierce GN, Suh M, Moghadasian MH. Low n-6: n-3 fatty acid ratio, with fish- or flaxseed oil, in a high fat diet improves plasma lipids and beneficially alters tissue fatty acid composition in mice. European journal of nutrition. 2008;47(3):153-60.
25. Ünalacak M, Kara IH, Baltaci D, Erdem Ö, Bucaktepe PGE. Effects of Ramadan fasting on biochemical and hematological parameters and cytokines in healthy and obese individuals. Metabolic syndrome and related disorders. 2011;9(2):157-61.
26. Larijani B, Zahedi F, Sanjari M, Amini M, Jalili R, Adibi H, et al. The effect of Ramadan fasting on fasting serum glucose in healthy adults. Medical Journal of Malaysia. 2003;58(5):678-80.
27. Kahn BB, Flier JS. Obesity and insulin resistance. The Journal of clinical investigation. 2000;106(4):473-81.
28. Gnanou JV, Caszo BA, Khalil KM, Abdullah SL, Knight VF, Bidin MZ. Effects of Ramadan fasting on glucose homeostasis and adiponectin levels in healthy adult males. Journal of Diabetes & Metabolic Disorders. 2015;14(1):55.
29. Adlouni A, Ghalim N, Benslimane A, Lecerf JM, Saïle R. Fasting during Ramadan induces a marked increase in high-density lipoprotein cholesterol and decrease in low-density lipoprotein cholesterol. Annals of nutrition and metabolism. 1997;41(4):242-9.
30. Frost G, Pirani S. Meal frequency and nutritional intake during Ramadan: a pilot study. Human nutrition Applied nutrition. 1987;41(1):47-50.
31. Aksungar FB, Eren A, Ure S, Teskin O, Ates G. Effects of intermittent fasting on serum lipid levels, coagulation status and plasma homocysteine levels. Annals of nutrition and metabolism. 2005;49(2):77-82.
32. Al-Hourani H, Atoum M. Body composition, nutrient intake and physical activity patterns in young women during Ramadan. Singapore medical journal. 2007;48(10):906.

Correspondence:
Muzaffer Akkoca
University of Health Sciences,
Dışkapı Research and Training Hospital,
Department of General Surgery, Altındağ,
Ankara 06110, Turkey
E-mail: muzafferakk@gmail.com