

Effect of Ramadan Fasting on Body Composition and Dietary Intake: A Prospective Study in the State of Qatar

Ghazi Daradkeh^{1*}, Hassan Abuzaid², Asmaa AL-Muhannadi¹, Mohammad Abuhmaira², Michelle Calapano¹, Abdolrazagh Khalili¹, Hanna Acido¹, Marwa Rustom¹, Cheryl Cajayon¹, Anna Hernando¹

¹Department of Dietetics and Nutrition, AL-Khor hospital Hamad Medical Corporation, Qatar

²Department of Medicine, AL-Khor hospital Hamad Medical Corporation, Qatar

ABSTRACT

Background: During Ramadan, Muslims abstain from eating and drinking from sunrise to sunset. This long fasting period may cause changes in body weight, body composition, eating behaviors and nutrient intake. The purpose of this study was to assess the effects of Ramadan fasting on nutrient intake and changes in body weight and composition in fasting people in the state of Qatar.

Methods: Weight, height, waist, and hip circumferences were measured, while body mass index (BMI), waist hip ratio (WHR), and waist height ratio (WHt.R) were calculated. Fat mass, fat free mass, muscle mass, and percentage body fat were assessed by body analyzer. Measurements were taken before, during and after Ramadan. Energy and macronutrient intakes were assessed using a 24 hour recall through a face to face interview in each stage.

Results: Weight, BMI, fat mass, fat free mass were significantly reduced in most of the participants ($P < 0.05$). Fat mass reduced in more than half of participants, ranging from 4.3% to 6.7% from baseline, while, non-significant reduction in muscle mass was noticed. Waist and hip circumferences insignificantly decreased in most participants. Dietary intake of most nutrients except protein including fat, saturated fat, fiber, sodium, and calcium were significantly increased during Ramadan fasting among most of the participants. On the other hand, a significant reduction in carbohydrate intake (25%) and energy consumption (10%) were reported ($P < 0.05$).

Conclusion: Ramadan fasting leads to weight loss and body composition changes including fat mass and fat free mass. Dietary intake varies depending on age, sex, culture, and dietary behavior of participants.

Keywords: Ramadan fasting; Anthropometry; Body analyzer; Body composition; Nutritional assessment

INTRODUCTION

In the Islamic calendar Ramadan is the holiest month for Muslims [1]. Fasting means that Muslims avoid all intakes of food, water, beverages and smoking from 8 to 18 hours for 29-30 days approximately one hour before sunrise till sunset. Geographical location of the country and the season of the year are the main determinants of fasting period. During Ramadan fasting, the food frequency, quantity, sleeps duration at night, as well as exercise is reduced, and the consumption of food and liquids are mainly nocturnal. Food habits, during Ramadan and the proportion of macronutrients and energy consumption may differ, as well, quality of ingested nutrients and tendency to consume foods and drinks that are high in carbohydrates

compared with those consumed during other months of the year. Macronutrient and micronutrient intake during Ramadan are changed as mentioned by some studies, while other studies found there is no changes [2-7]. In the recent years, several studies have examined the effects of fasting on health and disease [8-13]. Assessment of dietary intake among fasting people is limited. Al-Hourani et al., found that energy and macronutrients intake of 22 people did not change significantly during Ramadan fasting [14]. Besides that, EL Ati et al., reported that energy and macronutrient intake remained unchanged in fasting people [15]. A study indicated that diet diversity and food consumption in Iranian fasting people were significantly different from the recommended values [16]. It seems that

*Corresponding Author: Ghazi Daradkeh, Department of Dietetics and Clinical Nutrition, AL-Khor Hospital, Hamad Medical Corporation, Qatar, Tel: +97466256246; E-mail: drghazidaradkeh@gmail.com

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reduction in each food group may diminish the dietary intake of some nutrients. Therefore, one of the aims of this study is to investigate the nutrient intake of fasting people with reference to daily values (DVs). Dietary habits and lifestyle are changed during Ramadan, consumption one large meal after sunset and one lighter meal before dawn is the most common practice [17]. Special festive foods that are richer in fat, protein and sugar may be consumed more during Ramadan [18].

In Arabian Gulf countries Muslim people lifestyle usually changed during Ramadan fasting, they go for very high calorie food; they sleep and work for less hours and they neither diet nor exercise [19-23]. Despite the large number of Muslims worldwide, there is lack of data on their food intake in Ramadan, to the best of our knowledge, we are not aware of any previous published reports on the effect of Ramadan fasting on the subject's food intake and body composition changes in this region. Therefore, the present study was undertaken at Hamad Medical Corporation (HMC) to evaluate the effect of Ramadan fasting on dietary intake in diabetic and non-diabetic patients attending dietetics clinics at AL-Khor hospital in the state of Qatar. Nutrients intake was analyzed and compared the daily intake with DVs to determine the percentage of each nutrient [24].

MATERIALS AND METHODS

This prospective observational study that was conducted among Muslim type 2 diabetic and non-diabetic patients above 18 years of age, with no chronic diseases e.g.: renal, liver, or thyroid disease. Moreover, the women were not pregnant, lactating or receiving contraceptives following the dietetics clinics at AL-Khor hospital Hamad Medical Corporation Qatar during holly Ramadan from May 2019 to June 2019. Of the total 95 eligible participants, 62 (65.3%) males and 30 females (34.7%) with (M/F ratio 2:1) agreed and gave their consent to take part in this study. This study was approved by the Ethical Committee and IRB from Medical Research Center MRC in Hamad Medical Corporation (protocol No.MRC-01-18-083) before commencing data collection. Three female patients were excluded from the study because they got pregnancy. The sample size was calculated according to a power of 80% and a confidence level of 95%.

Data collection methods

Qualified clinical dietitians were assigned to administer the questionnaires and perform anthropometric measurements. A standardized questionnaire based face to face interview was conducted by the clinical dietitians for each participant. The questionnaire was composed of: (a) sociodemographic data such as: age, sex, nationality, marital status, education level, occupation, and medical history. (b) Anthropometric data such as: height, weight, BMI, waist circumference, hip circumference, waist hip ratio (WHR), and waist height ratio (WHtR) (c) Body composition such as: fat mass, % fat mass, muscle mass, % muscle mass, fat free mass, % fat free mass and body water. Data related to anthropometry based on actual measurements, all these data were done over two stages of the study: before and after Ramadan fasting.

Anthropometric measurements

Height was measured in centimeters using electronic height scale (SECA, Germany) while the patient was standing bare feet and with normal straight posture. Weight was measured in kilograms using a weight scale (SECA), BMI was calculated as the ratio of weight (kg) to the square of height (m). A person was considered obese if the BMI value was at least 30 kg/m² and overweight if BMI was greater than 25 kg/m² and less than 30 kg/m² [25-27]. Waist circumference (WC) was measured by standard method as midway between the lower rib margin and the iliac crest. Body composition was determined based on actual measurements by a medical body composition Analyzer SECA mBCA514 (Germany) including fat mass (FM), muscle mass (MM), fat free mass (FFM) and total body water (TBW). Standardized conditions: at least 2 hours fasting and no exercise for 12 hours prior to the test each time. Nutrient intake using 24 hour recall in two stages of the study: one week prior the study (Before Ramadan (BR)), and one week later (After Ramadan (AR)), through face to face interview with each participant. Food quantities were explained using household measurements (slices, plates, glasses, spoons, cups, and food models, etc.) to get the correct quantities of each food item consumed. All the food recalls were reviewed by clinical dietitians and nutrient analysis was carried out using My Net Diary 2019.

Statistical analysis

Data were entered and analyzed using SPSS version 21 (IBM Corp, Armonk, New York, USA). The nominal or ordinal variables were reported as proportions, and the numerical variables were reported as mean values and standard deviations or medians with minimum and maximum values. The numerical variables that were measured at, before, during and after Ramadan were compared using paired t tests for normal data distribution (parametric analysis). For the abnormal data distribution, the Wilcoxon test was used as the non-parametric analysis. Unpaired t tests, one way analysis of variance (ANOVA) and repeated ANOVA were used for two independent, Kindependent and K-dependent sample analyses, respectively. Statistical significance was associated with a P value below 0.05.

RESULTS

The participants' age range was 21-64 years and the mean age was 42.0 ± 9.5 years old. Most of the participants (70.4%) were at middle aged. Two third of participants, 62 (67.4%) were males and 30 (32.6%) were females. Male participants were significantly older than female (43.66 ± 16.1 vs. 39.00 ± 14.5, respectively). Overall, about three third of the participants were non-Qatari, with significantly higher proportion among male participants as compared with female participants (males: 93.7% non-Qatari and 6.3% Qatari, whereas females: 66.7% non-Qatari and 33.3% Qatari). In addition, about three quarters of the participants were married and three fourth of them were at secondary education level or above. The mean weight of participants was 82.61 ± 11.25 kg. Almost three fourth of participants were overweight or obese (76.3%). Based on the anthropometric measurements, the mean of the BMI was 30.05

± 3.96 kg/m², and the mean of the WHR and WHt.R was (0.92 ± 0.06 and 0.58 ± 0.21) respectively. Effect of Ramadan fasting on daily energy and nutrients intake of participants is shown in Table 1. There was a significant decrease in the total energy consumption and carbohydrates intake. Total fat, saturated fat, fiber, sodium, and calcium intake were significantly increased during Ramadan fasting (P<0.05), while protein intake slightly increased but this change did not reach significance level (P>0.05). Our findings indicated that significant reduction of energy and carbohydrates intake by (10% and 25%) during Ramadan fasting respectively. On the other hand, fat, saturated fat, fiber, sodium, and calcium intake were significantly increased by (18.3%-60%) because of Ramadan fasting, while protein intake was insignificantly increased by (1%) only Figure 1. Our findings indicated that macronutrients intake including carbohydrate and protein before Ramadan fasting was higher than the recommended values, while fat, dietary fiber, sodium, and calcium were lower than the recommended amounts Table 2.

Table 1: Effect of Ramadan fasting on daily energy and nutrients intake in participants (n=92).

Nutrient	Before Ramadan (BR)	After Ramadan (AR)
	Mean ± SD	Mean ± SD
Energy (Kcal)*	2402.46 ± 708.28	2159.14 ± 398.73
Carbohydrate (gm)*	382 ± 98.41	285.67 ± 59.87
Protein (gm)	84.85 ± 22.96	85.5 ± 24.57
Fat (gm)*	59.82 ± 13.53	75.28 ± 17.80
Saturated fat (gm)*	8.94 ± 9.60	11.20 ± 7.25
Fiber (gm)*	15.49 ± 10.95	22.85 ± 9.80
Sodium (mg)*	1690.85 ± 788.49	2000.75 ± 679.20
Calcium (mg)*	957.53 ± 500.48	1538.39 ± 645.24

Note: *P<(0.05)

Table 2: Daily nutrients intake compared with daily value participants.

Nutrients	Daily intake	Daily value	Change (%)
Carbohydrate (g)	382	300	127.3
Protein (g)	84.8	50	169
Fat (g)	59.8	65	92
Dietary Fiber (g)	15.5	25	62

Sodium (mg)	1690	2400	70.4
Calcium (mg)	957	1000	95.7

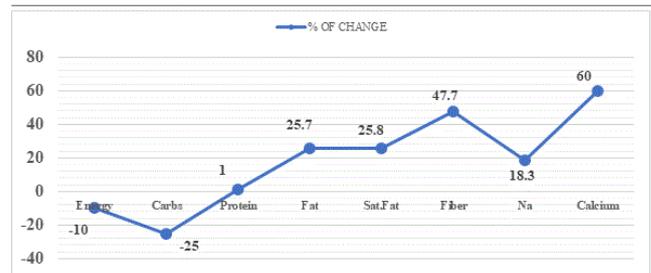


Figure 1: Energy and macronutrient intake changes as (%) before and after Ramadan.

Anthropometric and body composition changes during Ramadan fasting

Anthropometric measurements and body composition before, and after Ramadan fasting are presented in Table 3. Weight, body mass index (BMI), waist circumference (WC), hip circumference (HC) were significantly decreased during Ramadan fasting. Waist hip ratio (WHR) and waist height ratio (WHtR) also decreased but was not statistically significant. Body composition measurements including fat mass (FM), fat free mass (FFM) was significantly reduced, while muscle mass (MM) reduction was not reached the significant level after Ramadan fasting.

Table 3: Changes in anthropometric measures and body composition during Ramadan fasting.

Anthropometric measurements	Before (BR)	After Ramadan (AR)
	Mean ± SD	Mean ± SD
Weight (kg)*	84.80 ± 18.89	83.17 ± 18.39
BMI (kg/m ²)*	30.21 ± 5.75	28.38 ± 5.66
Waist Circumference (WC) (cm)*	94.69 ± 1.84	93.04 ± 15.05
Hip Circumference (HC) (cm)*	105.01 ± 13.01	103.20 ± 13.15
Waist Hip Ratio (WHR)	0.95 ± 0.06	0.94 ± 0.03
Waist Height Ratio (WHt.R)	0.57 ± 0.09	0.548 ± 0.09
Fat Mass (FM) (kg)*	27.93 ± 10.58	26.19 ± 10.89
Fat Free Mass (FFM) (kg)*	53.12 ± 11.14	52.06 ± 11.12
Muscle Mass (MM) (kg)	25.26 ± 5.45	24.62 ± 5.69

Note: *P<(0.05)

DISCUSSION

Usually Muslims eat two meals a day during Ramadan fast, one before the sunrise and the other shortly after sunset. During Ramadan, most Muslims change their lifestyle, sleep hours, physical activities, food consumption, frequency of meals, and dietary patterns for different reasons [25-31]. The general opinion is that fasting has a potential non-pharmacological intervention for improving health and increasing longevity [32]. While religious fasting is often a time of great spiritual growth, it can also be a time of great improvement to one's physical health. Previous research indicated that a significant reduction was found in total body weight despite insignificant changes in the total energy intake. This weight loss is partly attributed to efficient utilization of body fat during Ramadan fasting. In this study, total energy intake was significantly decreased during Ramadan fasting; this observation was consistent with many studies [33-36]. Our findings indicated that macronutrients intake including carbohydrate and protein before Ramadan fasting was higher than their commended values (127.3% and 169%) respectively, a significant reduction of carbohydrates intake (25%) during Ramadan fasting was reported by this study, while fat, dietary fiber, sodium and calcium intake were lower than the recommended amounts before Ramadan fasting, these nutrients intake was significantly increased after Ramadan fasting while protein intake was non significantly increased, these observations were consistent with many studies, and it can probably be attributed to the unique food habits peculiar to different Islamic countries, as well meals are exclusively nocturnal and less frequent, and consequently, this may affect energy and nutrient intake [37-39].

Changes of weight and body composition during and after Ramadan fasting

Our study found that Ramadan fasting can decrease body fat without the loss of muscle mass. This could be significant for addressing the safety and benefit of Ramadan fasting and could be considered as a rule of fasting for a patient with a metabolic disturbance, i.e. diabetic patients. Our study findings indicated that Ramadan fasting influences body weight, BMI, and fat percentage. Significant weight reduction was noticed because of Ramadan fasting in the current study, this finding is consistent with findings of other studies [33,34,37-41]. It has been suggested that this decrease in body weight could be attributed to a decrease in fluid intake [34-41], and to a decrease in glycogen bound water stores [42]. Regarding body composition changes, in the present study, we found that, a significant loss of fat mass and fat free mass during Ramadan, these changes could be attributed to reduction in total energy and macronutrient intake. The reduction in fat free mass during Ramadan may also be attributed to an increased rate of protein breakdown in relation to protein synthesis in the post absorptive state leading to loss of lean tissue [43]. In our study, fat component contributing the greatest proportion of weight loss, this finding is consistent with Hosseini et al., and Sadiya et al., who reported a significant decrease only in body fat [44,45]. In this study, we

found a non-significant decrease in WHR, WHtR and muscle mass. The non-significance of muscle mass loss in our study was consistent with the findings of other researchers [44,45]. These findings suggest that in Ramadan fasting, the body metabolism is switched to lipolysis but not gluconeogenesis. A decrease in body fat, especially visceral body fat, is beneficial, as an increase in abdominal adipose tissue confers an independent risk of cardiometabolic and cerebrovascular disease [46,47].

CONCLUSION

Ramadan fasting leads to weight loss and body composition changes including fat mass and fat free mass. Dietary intake varies depending on age, sex, culture, and dietary behavior of participants.

REFERENCES

1. The Holy Quran. Sura II (Al-Baghara: The Cow), verse 183.
2. 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.
3. Nematy M, Alinezhad-Namaghi M, Rashed MM, Mozhdehifard M, Sajjadi SS, Akhlaghi S, et al. Effects of Ramadan fasting on cardiovascular risk factors: a prospective observational study. *Nutr J.* 2012;11:69.
4. Sadiya A, Ahmed S, Siddiq 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 Syndr Obes.* 2011;4:409-416.
5. Afrasiabi A, Hassanzadeh S, Sattarivand R, Mahboob S. Effects of Ramadan fasting on serum lipid profiles on 2 hyperlipidemic groups with or without diet pattern. *Saudi Med J.* 2003;24:23-26.
6. 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.
7. Al-Hourani HM, Atoum MF. Body composition, nutrient intake and physical activity patterns in young women during Ramadan. *Singapore Med J.* 2007;48:906-910.
8. Azizi F, Siahkalah B, Shahraz S, Sherafat-Kazemzadeh R, Zali M, Beheshti S. Ramadan fasting and diabetes mellitus. *Arch Iran Med.* 2003;6(4):237-242.
9. Azizi F. Medical aspects of Islamic fasting. *Med J Islam Repub Iran.* 1996;10(3):241-246.
10. 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(3-4):175-181.
11. Alkandari JR, Maughan RJ, Roky R, Aziz AR, Karli U. The implications of Ramadan fasting for human health and well-being. *J Sports Sci.* 2012;30(1):S9-S19.
12. Nematy M, Alinezhad-Namaghi M, Rashed MM, Mozhdehifard M, Sajjadi SS, Akhlaghi S, et al. Effects of Ramadan fasting on cardiovascular risk factors: a prospective observational study. *Nutr J.* 2012;11(1):1-7.
13. Nomani MZ, Hallak MH, Nomani S, Siddiqui IP. Changes in blood urea and glucose and their association with energy-containing nutrients in men on hypocaloric diets during Ramadan fasting. *Am J Clin Nutr.* 1989;49(6):1141-1145.
14. Al-Hourani H, Atoum M. Body composition, nutrient intake and physical activity patterns in young women during Ramadan. *Singapore Med J.* 2007;48(10):906.

15. El Ati J, Beji C, Danguir J. Increased fat oxidation during Ramadan fasting in healthy women: An adaptative mechanism for body-weight maintenance. *Am J Clin Nutr.* 1995;62(2):302-307.
16. Kohandani A, Hozoori M, Aasafari M. Surveying the dietary diversity of fasting individuals in qom in Ramadan. *Health Spiritual Med Ethics.* 2015;2(1):6-10.
17. Trepanowski JF, Bloomer RJ. The impact of religious fasting on human health. *Nutr J.* 2010;9:57.
18. Sakr AH. Fasting in Islam. *J Am Diet Assoc.* 1975;67:17-21.
19. Khaled BM, Belbraouet S. Ramadan fasting diet entailed a lipid metabolic disorder among type 2 diabetic obese women. *Amer J Appl Sci.* 2009;6(3):471-477.
20. Wannamethee SG, Shaper AG, Lennon L, Morris RW. Metabolic syndrome vs Framingham risk score for prediction of coronary heart disease, stroke, and type 2 diabetes mellitus. *Arch Intern Med.* 2005;165:2644-2650.
21. Manson JE, Skerrett PJ, Greenland P, VanItallie TB. The escalating pandemics of obesity and sedentary lifestyle. A call to action of clinicians. *Arch Intern Med.* 2004;164:249-258.
22. Esposito K, Marfella R, Ciotola M. Effect of a Mediterranean-style diet on endothelial dysfunction and markers of vascular inflammation in the metabolic syndrome: a randomized trial. *J American Med Asso.* 2004;292:1440-1446.
23. Klein S, Sheard NF, Pi-Sunyer X. Weight management through lifestyle modification in the prevention and management of type 2 Diabetes: Rationale and strategies. A statement of the American diabetes association, the north American association for the study of obesity and the American Society for Clinical Nutrition. *Amer J Clin Nutri.* 2004;27:2067-2073.
24. Mahan LK, Raymond JL. *Krauses food and the nutrition care process.* Netherlands: Elsevr Heal Sci. 2016.
25. Bener A, Azhar A, Bessiso M. Do fasting and lifestyle eating habits in Ramadan affect headache? *Nutr Food Sci.* 2007;37:427-433.
26. WHO Expert Consultation. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lanc.* 2004;363:157-163.
27. Bener A, Darwish S, Al-Hamaq AO, Mohammad RM, Yousafzai MT. Association of PPAR γ 2 gene variant Pro12Ala polymorphism with hypertension and obesity in the aboriginal Qatari population known for being consanguineous. *Appl Clin Genet.* 2013;6:103-111.
28. Toda M, Morimoto K. Effects of Ramadan fasting on the health of Muslims. *Nip Eiseig Zass.* 2000;54:592-596.
29. Bahammam A. Does Ramadan fast affect sleep? *Intern J Clin Pract.* 2006;60:1631-1637.
30. Chaouachi A, Leiper JB, Souissi N, Coutts AJ, Chamari K. Effects of Ramadan intermittent fasting on sports performance and training: A review. *Intern J Sport Physiol Perform.* 2009;4:419-434.
31. Trepanowski JF, Bloomer RJ. The impact of religious fasting on human health. *Nutr J.* 2010;9:57.
32. Azizi F. Islamic fasting and health. *Ann Nutr Metabol.* 2010;56:273-282.
33. Husain R, Duncan MT, Cheah SH, Ch'ng SL. Effects of fasting in Ramadan on tropical Asiatic Moslems. *Br J Nutr.* 1987;58:41-48.
34. Sweileh N, Schnitzler A, Hunter GR, Davis B. Body composition and energy metabolism in resting and exercising muslims during Ramadan fast. *J Sports Med Phys Fitness.* 1992;32:156-163.
35. Poh BK, Zawiah H, Ismail MN, Henry CJK. Changes in body weight, dietary intake and activity pattern of adolescents during Ramadan. *Malay J Nutr.* 1996;2:1-10.
36. Fakhzadeh H, Larijani B, Sanjari M, Baradar-Jalili R, Amini MR. Effect of Ramadan fasting on clinical and biochemical parameters in health adults. *Ann Saudi Med.* 2003;23:223-226.
37. Rahman M, Rashid M, Basher S, Sultana S, Nomani MZ. Improved serum HDL cholesterol profile among Bangladeshi male students during Ramadan fasting. *East Mediten Health J.* 2004;10:131-137.
38. Sweileh N, Schnitzler A, Hunter GR, Davis B. Body composition and energy metabolism in resting and exercising muslims during Ramadan fast. *J Sports Med Phys Fitness.* 1992;32:156-163.
39. Frost G, Pirani S. Meal frequency and nutritional intake during Ramadan: a pilot study. *Hum Nutr Appl Nutr.* 1987;41:47-50.
40. Ziaee V, Razaee M, Ahmadinejad Z. The changes of metabolic profile and weight during Ramadan fasting. *Singapore Med J.* 2006;47:409-414.
41. Gumaa KA, Mustafa KY, Mahmoud NA, Gader AM. The effects of fasting in Ramadan. Serum uric acid and lipid concentrations. *Br J Nutr.* 1978;40:573-581.
42. Leiper JB, Molla AM, Molla AM. Effects on health of fluid restriction during fasting in Ramadan. *Eur J Clin Nutr.* 2003;57(2):S30-S38.
43. Maughan RJ, Fallah J, Coyle EF. The effects of fasting on metabolism and performance. *British J Sport Med.* 2010;44:490-494.
44. Attarzadeh-Hosseini SR, Sardar MA, Hejazi K, Farahati S. The effect of ramadan fasting and physical activity on body composition, serum osmolarity levels and some parameters of electrolytes in females. *Int J Endocrinol Metab.* 2013;11(2):88-94.
45. 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 Syndr Obes.* 2011;4:409-416.
46. Amato MC, Guarnotta V, Giordano C. Body composition assessment for the definition of cardiometabolic risk. *J Endocrinol Invest.* 2013;36(7):537-543.
47. Karcher HS, Holzwarth R, Mueller HP, Ludolph AC, Huber R, Kassubek J, et al. Body fat distribution as a risk factor for cerebrovascular disease: An MRI-based body fat quantification study. *Cerebrovasc Dis.* 2013;35(4):341-348.