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Does Ramadan Fasting Alter the Resting Metabolic Rate, Body Composition and Dietary Intake of Overweight and Obese Adults?

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ABSTRACT

Introduction: Ramadan fasting (RF) is a model of calorie restriction similar to intermittent fasting, which is extensively practiced by a large population of Muslims. Limited and controversial studies have investigated the physiological changes induced by 30 days of RF. The present study aimed to evaluate the effects of Ramadan fasting on the resting metabolic rate and body composition of overweight and obese individuals.

Methods: This study was conducted on 21 men and women aged 18-40 years. The subjects avoided eating and drinking for one month during the holy month of Ramadan (at least 20 days) and received a routine diet without an intervention between Iftar and dawn (Sahur). Before and after the study, the energy of the basal metabolic rate was measured via indirect calorimetry, and body composition was measured by bioimpedance (InBody s10). In addition, the physical activity of each participant was evaluated using a pedometer during one week. During the study, each participant received a 24-hour recall once a week.

Results: Compared to the pre-study period and after four weeks of RF, body weight (77.91±11.83 vs. 77.01 ±11.75 kg; P<0.05) decreased, while the body fat percentage (34.84±7.07 vs. 38.48±5.93%; P<0.001) increased. However, the resting metabolic rate had no significant changes (P=0.641), while the total fat-free mass and visceral fat mass significantly deceased after the study (P<0.001). The mean daily energy intake increased after the study compared to before RF (3,290±785.82 vs. 2,458±535.32 kcal; P<0.05). Moreover, the total carbohydrate and sugar intake increased significantly after RF (437.04±101.02 and 194.04±56.87 g per day vs. 310.09±87.12 and 60.42±31.57 g per day).

Conclusion: According to the results, RF may effectively improve metabolic parameters and prevent the decline of the basal metabolic rate if accompanied by nutritional support and healthy dietary recommendations.

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Introduction

Obesity and overweight have recently reached epidemic proportions in the world. The current prevalence of overweight and obesity in Iran has increased to 36.6% and 22.7%, respectively (1). A sedentary lifestyle and the over-consumption of energy-dense foods are considered to be the primary risk factors for obesity and overweight (2). Weight reduction could be optimally achieved by a multimodality approach and adapting to a healthy lifestyle through diet modification and physical activity (3). Several meta-analyses and systematic reviews have been focused on the effects of various dietary restriction patterns on weight loss and metabolic changes. However, conflicting results have been proposed regarding fasting, starvation, and weight gain (4).

Ramadan fasting (RF) is a model of calorie restriction *similar to intermittent fasting, which is extensively practiced by a large population of Muslims (5). Nevertheless, limited and*

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controversial studies have investigated physiological changes induced by 30 consecutive days of RF (6). The inconsistency of the results could be attributed to confounding factors such as ethnicity, fasting duration, climatic conditions, cultural influences, physical activity, and mostly dietary patterns. The duration of RF on a certain day varies in different geographical regions (8-18 hours) depending on the equator and season of the year (7).

Previous studies have denoted that RF causes profound changes in the body composition and metabolic balance. The basic data regarding the changes in dietary intake and body composition in most of these investigations have indicated that the majority of Muslims typically consume two meals per day during Ramadan, one of which is before dawn, and the other is taken after sunset (8). Recently, investigations on energy intake and body composition changes during Ramadan have drawn varied conclusions, which may be due to the differences in nutritional habits and duration of fasting (9). Changes in dietary habits during Ramadan occur in the form of the reduced frequency of food and beverage intake and the increased tendency to the consumption of high-calorie foods and drinks (10, 11). These changes could lead to declined energy intake, weight loss, and dehydration. Dehydration is reflected in the reduced body weight and changes in the biochemical parameters associated with the body water status (12, 13). In a study in this regard, Al-Hourani H. M. reported that body weight and body mass index (BMI) decreased significantly during fasting periods (14). Although reduced body weight has been reported frequently, the association of weight loss and body fat reduction remains to be further investigated (15). Inconsistent findings have also been reported regarding the effects of fasting on the body composition (16, 17), and some investigations have not detected significant changes in the body weight or body composition during Ramadan (16). In addition, the exact effects of RF on metabolic parameters remain debatable.

To the best of our knowledge, no reports have been previously published on the effects of RF on the resting metabolic rate and body composition of obese and overweight individuals. The present pilot study was conducted at *Imam Reza Hospital* in Mashhad, Iran to evaluate the effects of RF on the resting metabolic rate, body composition, and dietary intake of overweight and obese adults.

Materials and Methods

Subjects

This cross-sectional trial was conducted in Mashhad, Iran in 2019. The subjects were randomly selected based on the inclusion and exclusion criteria. In total, 25 subjects were recruited, four of whom withdrew, and 21 subjects (16 females and five males) aged 18-40 years completed the study. The inclusion criteria were as follows: 1) BMI ≥25 and <40 kg/m^2; 2) stable body weight within three months before the study; 3) no history of bariatric surgery; 4) no use of weight loss drugs within the past six months and 5) no medical history of hypertension, diabetes, fatty liver, dyslipidemia, and cardiovascular diseases. The exclusion criteria of the study were pregnancy and lactation.

The patients stated that they had not changed any medications within the past three months and had no acute diseases or infections within two weeks prior to the study. Data were collected on the sociodemographic characteristics, physical activity, food/fluid intake (24-hour recall), anthropometric indices, and indirect calorimetry assessments. Data collection was performed one week before and during the fourth week of Ramadan.

Anthropometric and Body Composition Measurements

Body weight and height were measured by the same person using an electronic balance and a stadiometer (Seca, Germany) and recorded to the nearest 0.1 kilogram and 0.1 centimeter, respectively. Body composition was determined via bioelectric impedance using InBody-S10 (South Korea) to assess the fat mass, skeletal muscle mass (SMM), total body water, fat-free mass (FFM), body fat percentage (BFP), protein, bone mineral content, visceral fat, waist circumference, BMI, and basal metabolic rate (BMR). The analysis was performed in standardized conditions each time, which encompassed two hours of fasting and no intense physical exercise 12 hours prior to the test in the fourth week of Ramadan before midday.

Dietary Intake and Physical Activity

Data on food intake were collected four times 24 hours a day (once a week) using a 24-hour

dietary recall questionnaire, which were completed via phone, and the data were analyzed using the N4 software (First Databank Inc., San Bruno, CA, USA). To evaluate the physical activity of the participants during the study and adjust the effects on the main outcome, all the participants were provided with a step-by-step device (model: HJ303, Omron, made in England) with the measure accuracy of 36.86±28.58 steps, which had to be brought to the study setting every day for one week. Afterwards, the device information was recorded in special forms, and the average of one week of physical activity was calculated for each individual.

Resting Metabolic Rate Assessment

The resting metabolic rate (RMR) value was determined via indirect calorimetry, which was performed using Metalyzer3B-R3 (Cortex Company, Germany). The measurement accuracy of the device covers the O_2 sensor of <0.1 Vol% , Co_2 sensor of <0.1 Vol%, and volume turbine of 50 milliliters (±2%).

Volunteers were advised to fast 6-8 hours before referral, drink sufficient water while fasting, and avoid tobacco, heavy exercise, nutritional supplements, energy drinks, and caffeine and alcoholic beverages within four hours before testing. In addition, it was explained that they should be completely calm and not become excited/stressed, and there would be no need to discontinue possible medications. Before the test, the volunteers were provided with the instructions on using the device, and it was emphasized that no gases should be inhaled by the volunteers through the masks. Before calorimetry, the anthropometric data of the volunteers were made available. The BFP, waist-to-hip ratio, height, and body weight of the volunteers were also recorded in the device. The volunteers rested on a bed for 20 minutes before the test, and the temperature of the site was maintained at 20-25°C. Moreover, it was attempted to test the environment slowly and without commuting in order to prevent the unwanted entry of others.

Statistical Analysis

Data analysis was performed in SPSS version 20 (IBM Co., Armonk, NY, USA). Before performing the statistical tests on the quantitative variables, the distribution normality hypothesis of the quantitative variables was initially evaluated using the Kolmogorov-Smirnov test, and the data were observed to be normal. The obtained data were expressed as the mean values and standard deviations, and the comparison of the group means before and after Ramadan was carried out using paired t-test. In all the statistical analyses, the P-value of less than 0.05 was considered significant.

Results

In total, 21 subjects were enrolled in the study, 76.19% and 23.8% of whom were female and male, respectively. The mean age of the subjects was 27.79±6.09 years, and their mean body weight was 77.91±11.83 kilograms. Table 1 shows the anthropometric and body composition indices of the participants.

Table 1. Anthropometric and Body Composition Indices of Subjects before and after Study

Parameters	Before	After	Mean Changes	SD	P-value
Weight (Kg)	77.91	77.01	0.900	1.27	0.040
BMI (kg/m²)	28.14	28.05	0.0855	0.6174	0.532
Fat (kg)	26.98	29.61	-2.6381	2.73	<0.001
FFM (kg)	50.93	47.39	3.5381	3.05	<0.001
BFP (%)	34.82	38.48	-3.6428	3.30	<0.001
WHR	2.91	2.89	0.0219	0.064	0.135
Visceral Fat (kg)	34.28	33.22	1.0571	0.805	<0.001
SMM (kg)	28.55	26.07	2.48	1.92	<0.001
Protein (kg)	10.12	3.57	0.852	0.65	<0.001
Minerals (kg)	33.54	30.83	2.71	2.11	<0.001
BMR (kcal/kg)	1447.46	1398.67	48.79	107.01	0.012

*BMI: body mass index, FFM: fat-free mass, BFP: body fat percentage, WHR: waist-to-hip ratio, SMM: skeletal muscle mass, BMR: basal metabolic rate; data expressed as mean±SD; *P<0.05*

According to the obtained results, the body weight of the subjects decreased significantly following one month of Ramadan fasting (0.09±1.27 kg; P=0.04). However, the adipose tissue and BFP showed a significant increase (2.6±2.7 kg; P<0.001 and 3.64±3.30%; P<0.001), while the mean visceral fat decreased significantly (-1.05±0.8 kg; P<0.001). Table 2 shows the results of dietary intake assessment during the study.

According to the findings, the mean energy intake significantly increased during Ramadan compared to the pre-intervention phase (3,290.85±785.82 vs. 2,458.23±535.69 kcal/day; P<0.001). Furthermore, the mean fat and carbohydrate intakes of the participants significantly increased during Ramadan compared to the pre-Ramadan phase (127.27±47.70 vs. 92.46±52.31 g/day; P<0.001 and 437.04±101.02 vs. 310.09±87.12 g/day; P<0.001).

Table 2. Dietary Intake of Subjects before and during Study

Parameters	Before Study	SD	During Study	SD	P-value
Energy (kcal)	2,458.23	535.69	3290.85	785.82	<0.001
Starch (g)	198.32	41.89	222.58	56.21	<0.001
Total Sugar (g)	60.42	31.57	194.04	56.87	<0.001
Protein (g)	112.38	21.87	122.46	34.85	<0.001
Fat (g)	92.46	52.31	127.27	47.70	<0.001
Carbohydrate (g)	310.09	87.12	437.04	101.02	<0.001
Iron (mg)	15.23	3.21	16.86	4.75	<0.001
Copper (mg)	2.42	.693	2.55	.829	<0.001
Zinc (mg)	21.96	19.63	23.19	22.24	<0.001
Vitamin D (µg)	2.12	1.02	2.49	1.18	<0.001
Vitamin E (mg)	29.65	21.54	31.14	26.96	<0.001
Vitamin C (mg)	135.25	84.21	140.38	47.52	<0.001

Table 3. Metabolic Parameters of Subjects before and after Study via Indirect Calorimetry

Parameters		N	Before	SD	After	SD	P. Value
RMR (kj/day)		21	1,628.04	396.03	1,664.80	440.46	0.614
RQ		21	0.84	0.05	0.88	0.105	0.009
BMR (kj/day; adjusted for PA)	**Sedentary**	14	1,551.07	237.49	1,386.07	163.29	0.069
	Active	7	1,343.85	107.01	1,411.28	263.34	0.820
RMR (kj/day; adjusted for PA)	**Sedentary**	14	1,620.35	439.43	1,604.42	450.04	0.012
	Active	7	1,643.42	322.48	1,785.57	427.01	0.006

RMR: resting metabolic rate, RQ: respiratory quotient, BMR: basal metabolic rate

Discussion

The present study aimed to investigate the effects of RF on the body composition and basal metabolic rate of overweight and obese individuals. During Ramadan, the type and amount of energy intake, sleep patterns, and daily physical activity may change, and these changes could affect the body composition. Our research indicated that during one month of fasting, body weight and visceral fat decreased significantly, while the body fat percentage increased significantly. In addition, daily energy intake and consumption of simple carbohydrates and free sugars increased significantly during Ramadan by the participants. Previous studies have reported varying changes in the body weight during Ramadan or even other changes were observed in the mealtime when fasting was not involved (18). Our findings are consistent with the studies by Ziaee et al. (19), Khattak et al. (8), and Mansi et al. (9) in terms of weight loss, decreased BMI, and increased energy intake during Ramadan.

In a research in this regard, Al-Hourani et al. reported that weight and BMI decreased during Ramadan (20). In a meta-analysis conducted in 2019, it was observed that one month of RF significantly decreased the body weight and fat-free mass, which is in line with our study (21). Furthermore, the study by Nachvak et al. (2019), which was conducted on 160 healthy men, indicated that the body weight and BMI decreased significantly during Ramadan. In the mentioned research, the analysis of the dietary intakes demonstrated that carbohydrate intake during Ramadan significantly increased compared to the pre-Ramadan phase, which is in congruence with our findings (22). Contrary to the results of the present study, J. Ramadan et al. reported no significant changes in the body weight and body composition during Ramadan,

which may be due to small sample size of the mentioned research (23).

During Ramadan, changes in the mealtime and fluid intake, along with reduced meal frequency, could cause various physiological changes. Evidently, dietary habits and choices vary depending on culture, and the percentage of the energy obtained from carbohydrates, protein, and fat varies in different Islamic countries (10). In the present study, the energy intake and consumption of simple carbohydrates and free sugars increased significantly during Ramadan, possibly indicating the inappropriate dietary pattern during Ramadan and justifying the increased fat percentage in the participants.

Possible weight loss mechanisms could be defined by metabolic responses. For instance, the glucose load is slower in the afternoon compared to the morning. In addition, gastric emptying and blood flow are better during the day than at night, resulting in the faster absorption of substances from the gastrointestinal tract during the day. Therefore, another possible description for weight loss could be the less absorption of the food eaten at night during Ramadan (11). Weight loss is followed by fatigue and constant tiredness, and decreased fluid intake could lead to the reduction of glycogen levels and the extracellular fluid volume, as well as moderate dehydration.

The impact of Ramadan on metabolism is very complex. Many bodily mechanisms are involved in maintaining balance while fasting, and changes in the physical activity level, mealtime, and bedtime alter the metabolism discretely (13). However, it is difficult to determine the exact effects of each factor alone on the metabolism while fasting. RF involves a particular dietary pattern, which differs from long-term and short-term starvation (12). In short-term starvation (less than four days), RMR may increase due to the increased norepinephrine concentration (14). In the present study, RMR did not change significantly before and after Ramadan, which is consistent with the results obtained by El Ati et al. (15), McNail et al. (16), and Harder-Lauridsen N. M. et al. (17).

Limitations of the Study

The special circumstances associated with RF (e.g., changed daily dietary patterns, fasting hours, fewer daily meals, and reduced physical activity) may limit research in this regard. In addition, differences in the dietary habits of diverse communities and cultures could lead to inaccurate results.

Conclusion

According to the results, fasting during Ramadan may be considered a dietary intervention for weight loss and the improvement of metabolic parameters without the reduction of the basal metabolism as opposed to weight loss diets provided that it is accompanied by nutritional support and healthy eating patterns.

References

1. Djalalinia S, Saeedi Moghaddam S, Sheidaei A, Rezaei N, Naghibi Iravani SS, Modirian M, et al. Patterns of obesity and overweight in the iranian population: findings of steps 2016. Front Endocrinol. 2020;11:42.
2. Bastard J-P, Maachi M, Lagathu C, Kim MJ, Caron M, Vidal H, et al. Recent advances in the relationship between obesity, inflammation, and insulin resistance. Eur *Cytokine* Netw . 2006;17(1):4-12.
3. Tremblay A, Therrien F. Physical activity and body functionality: implications for obesity prevention and treatment. Can J Physiol Pharmacol. 2006;84(2):149-56.
4. Alinezhad-Namaghi M, Eslami S, Nematy M, Khoshnasab A, Rezvani R, Philippou E, et al. Intermittent fasting during Ramadan and its effects in individuals with metabolic syndrome. Nutr Today. 2019;54(4):159-64.
5. Ali Babaei A, Ghasemi M, Tavakoli Ghouchani H, Yousefi A. Evaluation of the effects of Islamic fasting on the biochemical markers of health. *J* Nutr Fast *Health*. 2016;4(2):88-91.
6. Kul S, Savaş E, Öztürk ZA, Karadağ G. Does Ramadan fasting alter body weight and blood lipids and fasting blood glucose in a healthy population? A meta-analysis. J Relig Health. 2014;53(3):929-42.
7. Maughan RJ, Fallah J, Coyle EF .The effects of fasting on metabolism and performance. Br J *Sports Med*. 2010;44(7):490-4.
8. Khattak MMAK, Bakar IA, Yeim L. Does religious fasting increase fat free mass (FFM) and reduce abdominal obesity?. Nutr Food Sci. 2012.
9. 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.
10. Sadeghirad B, Motaghipisheh S, Kolahdooz F, Zahedi MJ, Haghdoost AA. Islamic fasting and weight loss: a systematic review and meta-analysis. *Public Health* Nutr. 2014;17(2):396-406.
11. Mazidi M, Karimi E, Rezaee P, Nematy M, Salehi M. The effects of Ramadan fasting on body composition. *Shiraz E Med* J. 2014;15(1).
12. Lessan N, Saadane I, Alkaf B, Hambly C, Buckley AJ, Finer N, et al. The effects of Ramadan fasting on activity and energy expenditure. Am J Clin Nutr. 2018;107(1):54-61.

13. Haghdoost AA, Poorranjbar M. The interaction between physical activity and fasting on the serum lipid profile during Ramadan. Singapore Med J. 2009;50(9):897-901.
14. Zauner C, Schneeweiss B, Kranz A, Madl C, Ratheiser K, Kramer L, et al. Resting energy expenditure in short-term starvation is increased as a result of an increase in serum norepinephrine. Am J Clin Nutr. 2000;71(6):1511-5.
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):302-7.
16. McNeil J, Mamlouk MM, Duval K, Schwartz A, Nardo Junior N, Doucet É. Alterations in metabolic profile occur in normal-weight and obese men during the Ramadan fast despite no changes in anthropometry. J Obes. 2014; 2014.
17. Harder-Lauridsen NM, Rosenberg A, Benatti FB, Damm JA, Thomsen C, Mortensen EL, et al. Ramadan model of intermittent fasting for 28 d had no major effect on body composition, glucose metabolism, or cognitive functions in healthy lean men. Nutrition. 2017;37:92-103.
18. Mansoori A, Khosravi M, Asadi M. Effects of Evening Meal Timing on Weight Loss: A Pilot Open-Labelled Randomized Clinical Trial. J Adv Med Biomed Res. 2020; 28 (126): 41-6.
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 Med J. 2006;47(5):409-14.
20. 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.
21. Fernando HA, Zibellini J, Harris RA, Seimon RV, Sainsbury A. Effect of Ramadan fasting on weight and body composition in healthy non-athlete adults: a systematic review and meta-analysis. Nutrients. 2019;11(2):478.
22. Nachvak SM, Pasdar Y, Pirsaheb S, Darbandi M, Niazi P, Mostafai R, et al. Effects of Ramadan on food intake, glucose homeostasis, lipid profiles and body composition composition. Eur J Clin Nutr. 2019;73(4):594-600.
23. A Babaei AA, Khosravi M, Ghasemi M, Tavakoli Ghouchani H. Evaluation of the Effects of Islamic Fasting on the Biochemical Markers of Health. J Fast Health. 4 (2), 88-91.