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Effects of Ramadan Fasting on Macronutrient and Micronutrient Intakes: An Essential Lesson for Healthcare Professionals

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ABSTRACT

Introduction: Significant changes have been reported in the dietary regimen of fasting Muslims during Ramadan compared to the other months of year. The present study aimed to assess the effects of Ramadan fasting on macronutrient and micronutrient intakes in fasting individuals.
Methods: In total, 119 participants were visited twice (before Ramadan and during the third week of Ramadan). Nutrient intakes were determined using the food frequency questionnaire (FFQ) and based on a three-day food intake recall during Ramadan and other months. In addition, data on the weight, height, and other demographic variables of the subjects were obtained.
Results: One-sample t-test indicated the significantly higher intake of calories, total fats, saturated fatty acids, cholesterol, vitamin A, carotene, total vitamin A, vitamin B2, vitamin B12, vitamin C, niacin, and phosphorous compared to the recommended dietary allowance (RDA) before Ramadan ($P<0.05$). However, the dietary intake of carbohydrates, fibers, polyunsaturated fats, folate, cooper, magnesium, potassium, selenium, and sodium was significantly lower than the RDA before Ramadan. In addition, paired sample t-test showed that the intake of calories, carbohydrates, fibers, total fats, monounsaturated fatty acids, saturated fatty acids, cholesterol, vitamin A, carotene, total vitamin A, vitamin B1, vitamin C, vitamin E, folate, calcium, iron, magnesium, phosphorous, potassium, selenium, and sodium significantly decreased after three weeks of fasting. However, only the intake of calories, protein, carbohydrates, fibers, total fats, saturated fats, monounsaturated fats, polyunsaturated fats, cholesterol, vitamin A, carotene, vitamin B2, vitamin B6, vitamin C, vitamin E, folacin, calcium, copper, iron, magnesium, phosphorous, potassium, selenium, and sodium was significantly lower during the third week of Ramadan compared to the RDA, while the intake of vitamin A and niacin was significantly higher than the RDA during Ramadan.
Conclusion: According to the results, there was a significant reduction in the dietary intake of some micronutrients during Ramadan, which implies the nutritional recommendations in the selection of proper foods by fasting individuals.

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Introduction

The holy month of Ramadan is one of the most important events in the Islamic calendar, during which Muslims refrain from eating and drinking from dawn to sunset (1-5). The routine dietary regimen in Ramadan includes a main meal after sunset and a lighter meal before dawn (6, 7).

Ramadan is a great opportunity to evaluate the long-term effects of reduced meal frequency on metabolism as a unique model of

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intermittent fasting (8, 9). Food quality may also alter during Ramadan compared to the other months of year. Duration of fasting per day depends on the geographical location and seasonal time in a specific area, the length of which might even reach 18 hours in temporal areas in summer (10-15). Significant changes have been reported in the dietary regimen of fasting Muslims during Ramadan compared to the other months of year (12-14).

To date, conflicting data have been proposed regarding the daily intake of calories, fats, protein, and carbohydrates in Ramadan (13-17). One of the main concerns in this regard is the effects of the restricted intake of calories, micronutrients, and macronutrients in prolonged intermittent fasting on health and diseases in fasting individuals.

The present study aimed to assess the effects of macronutrient and micronutrient intakes on fasting individuals during Ramadan and compare the findings with the recommended dietary allowance (RDA) in the other months of year.

Material and methods

This study was performed concomitantly in Bushehr and Shiraz, Iran in 2013. In total, 156 men and women aged 16-64 years were selected from the individuals who were willing to fast in Ramadan. The participants were visited twice (one month before Ramadan and during the third of Ramadan) by the research team.

After explaining the objectives of the study, the micronutrient and macronutrient intakes of the subjects before and during Ramadan were determined based on the quantitative food frequency questionnaire (FFQ) and a three-day, 24-hour dietary recall.

The inclusion criteria of the study were willingness to fast during Ramadan and minimum age of ≥15 years (i.e., eligibility for fasting from for the male gender based on Islamic principles). The exclusion criteria included smoking habits, use of thyroid medications, estrogen or hypertension medications, and clinical symptoms of diabetes mellitus and hypothyroidism. Potential participants were interviewed by expert dietitians, and written informed consent was obtained from the selected subjects prior to participation.

Dietary Intake Analysis

Before Ramadan, the dietary intakes at the time of the study were completed based on a 24-hour dietary recall for three nonconsecutive days using the FFQ on an annual, monthly, weekly, and daily basis. After three weeks in Ramadan, weekly and daily dietary intakes were assessed using the FFQ based on the 24-hour dietary recall for three nonconsecutive days, and the obtained data were recorded via interviews by trained dietitians. The FFQ showed the correlation-coefficient of 0.9 based on the 24-recall dietary recall. The reproducibility and relative validity of the 168-item FFQ have been previously confirmed in Tehran lipid and glucose study (18).

Anthropometric Measurements

Height and weight of the participants were measured using a stadiometer. Heavy outer garments and shoes were removed before the measurement of height and weight. In addition, body mass index (BMI) was calculated as weight in kilograms divided by the square of the height in meters (kg/m^2). Waist circumference was measured using an unstretchable measuring tape at the midpoint between the lower edge of the ribcage and iliac crests, and the waist-to-hip ratio was determined as the waist circumference divided by the hip circumference. To measure this parameter, waist circumference was defined as the smallest circumference measured at the navel, and hip circumference was defined as the largest circumference measured at the hips and buttocks.

The experimental protocol of the study was approved by the Research Deputy [DP/8703277/176, 14/4/2013] and Ethics Committee (May 2014). The current research was conducted in accordance with the principles of the Declaration of Helsinki (revised version, 2000).

Statistical Analysis

The analysis of food and beverage intakes in terms of the energy content and amount of other nutrients was performed using Nutritionist III software version 7.0 (N Squared Computing, Salem, OR, USA), which was adapted for Iranian foods and dietary habits. Data analysis was

performed using an IBM computer in SPSS version 15 (SPSS Inc., Chicago, IL, USA).

The distribution of the data was assessed using probability plots and Shapiro-Wilks test. In addition, paired sample t-test was applied to identify the differences between the dietary intakes of micronutrients and macronutrients during Ramadan and other months of year. One-sample t-test was also used to compare the mean intakes of macronutrients and micronutrients based on the RDA. The correlations between the data obtained by the FFQ based on the 24-hour dietary recall were determined using Pearson's correlation-coefficient. In all the statistical analyses, P-value of less 0.05 was considered significant.

Results

In total, 37 subjects were excluded from the study due to not fasting in Ramadan, and 119 subjects (34 males and 85 females) were considered as the final sample size. The participants were aged 15-46 years, with the mean age of 27 years.

The results of one-sample t-test indicated the significantly higher intake of calories before Ramadan compared to the RDA (P<0.05). Moreover, the dietary intake of total fats, saturated fats, cholesterol, vitamin A, carotene, total vitamin A, vitamin B2, vitamin B12, vitamin C, niacin and phosphorous was observed to be significantly higher than the RDA before Ramadan (P<0.05). However, the dietary intake of protein, vitamin B1, vitamin B6, vitamin E, pentatonic acid, calcium, iron, and zinc had no significant difference with the RDA (Table 1). On the other hand, the dietary intake of carbohydrates, fibers, polyunsaturated fats, folate, cooper, magnesium, potassium, selenium, and sodium was significantly lower than the RDA before Ramadan (Table 1).

Table 1. Comparison of Macro & Micro nutrition between mean Subject's and mean standard diets

	Macro & Micro nutrition	Mean Subject's diet (before Ramadan)	Mean standard diet	P value	
1	Calorie	2706.62	2505	0.004	↑
2	Protein	13.07	90	0.393	→
3	Carbohydrate	343.45	366.95	0.020	↓
4	Diet fiber	25.62	28.22	0.015	↓
5	Total fat	120.37	84.21	0.000	↑
6	Saturated fat	36.23	28.17	0.000	↑
7	Monounsaturated Fatty Acids	37.28	28.17	0.000	↑
8	Polyunsaturated Fatty Acids	23.28	28.17	0.006	↓
9	Cholesterol	464.95	300	0.000	↑
10	Vitamin A carotene	1303.35	800	0.000	↑
11	Total vitamin A	1273.741	852.11	0.000	↑
12	Vitamin B1	3.54	1.38	0.088	→
13	Vitamin B2	1.84	1.53	0.009	↑
14	Vitamin B3	21.35	16.63	0.000	↑
15	Vitamin B6	21.35.04	5.38	0.940	→
16	Vitamin B12	6.81	3.04	0.010	↑
17	Folacin	281.78	397.18	0.000	↓
18	Pentatonic acid	6.55	6.96	0.649	→
19	vitamin C	137.87	15.97	0.000	↑
20	Vitamin E	15.54	19.05	0.090	→
21	Calcium	887.73	868.17	0.520	→
22	Copper	4.16	36.61	0.000	↓
23	Iron	25.62	26.94	0.563	→
24	Magnesium	335.89	368.07	0.041	↓
25	Phosphorous	1133.10	906.64	0.000	↑
26	Potassium	3240.18	3674.36	0.000	↑
27	Selenium	93.58	142.42	0.000	↑
28	Sodium	1896.06	2147.14	0.008	↑
29	Zinc	14.59	15.04	0.546	→

One sample T-test

According to the results of paired sample t-test, the dietary intake of calories, carbohydrates, fibers, total fats, monounsaturated fats, saturated fats, cholesterol, vitamin A, carotene, total vitamin A, vitamin B1, vitamin C, vitamin E, folate, calcium, iron, magnesium, phosphorous, potassium, selenium, and sodium significantly decreased

after three weeks of fasting (Table 2).

Table 2. Comparison of Macro & Micro nutrition before and during fasting of Ramadan

	Macro & Micro nutrition	Nutrition before Ramadan	Nutrition in 3rd week of Ramadan	P value	
1	Calorie	2705.87	1855.89	0.000	↓
2	Protein	135.97	59.82	0.156	→
3	Carbohydrate	342.49	297.71	0.002	↓
4	Diet fiber	25.42	20.87	0.001	↓
5	Total fat	120.64	46.57	0.000	↓
6	Saturated fat	36.47	12.29	0.000	↓
7	Monounsaturated Fatty Acids	37.27	14.55	0.000	↓
8	Polyunsaturated Fatty Acids	23.27	10.57	0.000	↓
9	Cholesterol	467.37	250.78	0.000	↓
10	Vitamin A carotene	1311.29	583.65	0.000	↓
11	Total vitamin A	2440.34	1176.52	0.000	↑
12	Vitamin B1	3.56	1.38	0.089	→
13	Vitamin B2	1.84	1.27	0.000	↓
14	Vitamin B3	21.24	19.92	0.178	→
15	Vitamin B6	3.07	1.33	0.217	→
16	Vitamin B12	6.85	5.58	0.492	→
17	Folacin	276.54	157.58	0.000	↓
18	Pentatonic acid	6.51	63.28	0.337	→
19	vitamin C	136.75	49.90	0.000	↓
20	Vitamin E	15.59	7.20	0.000	↓
21	Calcium	890.27	496.14	0.000	↓
22	Copper	4.13	3.49	0.093	→
23	Iron	25.67	16.37	0.000	↓
24	Magnesium	335.08	241.25	0.000	↓
25	Phosphorous	1130.79	772.01	0.000	↓
26	Potassium	3226.81	2389.72	0.000	↓
27	Selenium	94.14	77.08	0.002	↓
28	Sodium	1875.34	1169.37	0.000	↓
29	Zinc	14.62	13.74	0.446	→

Paired T-test

According to the obtained results, the dietary intake of calories, protein, carbohydrates, fibers, total fats, saturated fats, monounsaturated fats, polyunsaturated fats, cholesterol, vitamin A, carotene, vitamin B2, vitamin B6, vitamin C, vitamin E, folacin, calcium, copper, iron, magnesium, phosphorous, potassium, selenium, and sodium was significantly lower than the RDA in the third week of Ramadan. However, the dietary intake of vitamin A and niacin was significantly higher compared to the RDA, while the dietary intake of total vitamin A, vitamin B1, and zinc had no significant difference with the RDA during Ramadan (Table 3).

Table 3. Comparison of macro & micro nutrition during fasting of Ramadan with standard diet

	Macro & Micro nutrition	Mean nutrition in 3rd week of Ramadan	Mean standard diet	P value	
1	Calorie	1855.89	2505	0.000	↓
2	Protein	59.82	89.66	0.000	↓
3	Carbohydrate	297.71	366.95	0.000	↓
4	Diet fiber	20.87	28.22	0.000	↓
5	Total fat	46.57	84.21	0.000	↓
6	Saturated fat	12.29	28.17	0.000	↓
7	Monounsaturated Fatty Acids	14.55	28.17	0.000	↓
8	Polyunsaturated Fatty Acids	10.57	28.17	0.000	↓
9	Cholesterol	250.78	300	0.008	↓
10	Vitamin A carotene	53.65	800	0.000	↑
11	Total vitamin A	1176.52	852.11	0.097	→
12	Vitamin B1	1.38	1.38	0.095	→
13	Vitamin B2	1.27	1.53	0.001	↓
14	Vitamin B3	19.92	16.63	0.000	↑
15	Vitamin B6	1.33	5.38	0.000	↓
16	Vitamin B12	5.58	3.04	0.029	↑
17	Folacin	157.58	397.18	0.000	↓
18	Pentatonic acid	63.28	6.96	0.341	→

19	vitamin C	49.90	115.97	0.000	↓
20	Vitamin E	7.20	19.05	0.000	↓
21	Calcium	496.14	868.17	0.000	↓
22	Copper	3.49	36.61	0.000	↓
23	Iron	16.37	26.94	0.000	↓
24	Magnesium	241.25	368.07	0.000	↓
25	Phosphorous	772.01	906.64	0.000	↓
26	Potassium	2389.72	3674.36	0.000	↓
27	Selenium	77.08	142.42	0.000	↓
28	Sodium	1169.37	2147.14	0.000	↓
29	Zinc	13.74	15.04	0.208	→

One sample T-test

What's more, there was significant change in subjects' weight (66.67 ± 15.56 kg vs 66.07 ± 15.12 kg , P value=0.02) and body mass index (23.43 ± 4.89 kg/m2 vs 23.22 ± 4.69 kg/m2 , P value= 0.02) before and during Ramadan fasting.

Discussion

Ramadan fasting has spiritual, physical, psychological, and social benefits (19-27). According to the results of the present study, some nutritional components significantly decreased during Ramadan compared to before Ramadan, including calories, protein, cholesterol, total fats, carbohydrates, fibers, vitamin A, vitamin B2, niacin, vitamin C, vitamin E, calcium, magnesium, phosphorous, iron, selenium, sodium, and potassium. However, the reduction in these parameters was not associated with health risks for humans. For instance, the food shortage on diverse organisms from yeast to human mediates its enormous impact through decreasing circulating insulin, such as the level of insulin like growth factor-1 (IGF-1). IGF-1R-signaling cascades contribute to several threatening diseases, including diabetic retinopathy, muscular degeneration, cardiovascular diseases, and cancer (28-30). In this regard, various mutations that extend the lifespan could act through suppressed nourishing signaling pathways (31). In fact, fasting causes various endocrine changes, which direct energy utilization toward survival functions. On the other hand, it has been well established that calorie restriction decreases insulin levels, while increasing insulin sensitivity (32).

In the present study, a significant reduction was observed in the weight and BMI of the subjects, which is consistent with the results obtained by Maghan et al. and Fakhrzadah et al. (33, 34). Although some studies have reported no changes in the body composition, they have also demonstrated no changes in the intake of nutrients during Ramadan compared to before Ramadan (7). Furthermore, there seems to be a significant correlation between caloric restriction and the changes in anthropometric indices in some of the studies in this regard, which have denoted a significant reduction in calorie intake (35-39), body weight, BMI, and waist-to-hip ratio. This could explain the discrepancies in various studies regarding anthropometric parameters (39).

According to the current research, total fat consumption decreased in the fasting individuals. This is in line with the report by Ahmad et al., while inconsistent with the findings of Hozoori et al. This discrepancy could be attributed to the differences in culture and dietary habits (40, 41). The study by Hozoori was conducted in Qom city (Iran), which has a different culture, dietary habits, and geographical location than Bushehr port.

The results of the present study indicated a significant reduction in vitamin A, vitamin B2, niacin, vitamin C, and vitamin E. In contrast, Ibraham et al. reported no significant changes in vitamin C and retinol during Ramadan (42), while Barkia et al. denoted a significant increase in vitamin E consumption during Ramadan (40). Furthermore, a significant decrease was observed in calcium consumption during Ramadan in the current research, which is in line with the repot by Harifi et al. (43). These conflicting results could be attributed to the differences in culture, time of studies, and dietary habits, while it is warranted to assess nutrient intakes during Ramadan in order to avoid the adverse effects of fasting on human health.

In most of the studies conducted in Ramadan to evaluate the nutritional status of fasting individuals, the obtained values have been

compared to the RDAs for various nutrients, which was first developed and presented in 1943 by the Food and Nutrition Broad (FNB) of the Institute of Medicine (IOM) (44). It is noteworthy that RDA indicates the amount of the nutrients needed to meet the requirements of 98% of the healthy population, for which RDA has been developed. In 1993, the FNB revised the RDA and established the dietary reference intake (DRI), which included the estimated average requirement (EAR) in addition to the RDA. EAR is defined as the average daily requirement of a nutrient for a healthy individuals based on gender and stage of life. It is the amount of a nutrient with which approximately half of healthy individuals could meet their dietary needs, while the other half could not (44). EAR is used to assess nutrient adequacy in a specific population rather than individuals.

In the present study, we used the N3 software, which has been designed to compare dietary intakes with the RDA. If the EAR is considered as a standard value for comparison, the results are likely to change. According to the findings of the current research, the dietary intake of calcium, iron, magnesium, phosphorous, potassium, selenium, sodium, vitamin E, vitamin C, niacin, vitamin B2, vitamin A, fiber, carbohydrates, protein, and calories was significantly lower than the RDA. Therefore, it is recommended that a list of foods needed by a fasting individual during Ramadan be prepared in order to recompense these deficits.

In the present study, some changes were observed in the nutrient intakes during Ramadan compared to the other months of year. Although the impact of fasting on nutritional status has been assessed in several studies, few studies have been focused on total macronutrient and micronutrient intakes. Since hundreds of million Muslims may fast during Ramadan each year, further research is required on the nutritional status of fasting individuals during Ramadan. Moreover, the healthcare professionals that are engaged in Muslim regions across the world should become familiar with the physiological changes occurring during Ramadan, as well as the influence of Ramadan fasting on nutrient intake.

Conclusion

According to the results, the intake of some nutritional components significantly decreased during Ramadan, including calories, protein, cholesterol, total fats, carbohydrates, fibers, vitamin A, vitamin B2, vitamin B3, vitamin C, vitamin E, calcium, magnesium, phosphorous, iron, selenium, sodium, and potassium. It is warranted that nutritional recommendations be implied in the selection of proper foods in Ramadan. Furthermore, proper follow-ups must be designed to evaluate some of the findings of the current research.

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Conflict of interest

None declared.

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