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Ramadan Major Dietary Patterns

Zhaleh Shadman [1]; Nooshin Poorsoltan [1]; Mahdieh Akhoundan [1]; Bagher Larijani [1]; Mozhdeh Soleymanzadeh [1]; Camelia Akhgar Zhand [1]; Zahra Alsadat Seyed Rohani [1]; Mohsen Khoshniat Nikoo [1,*]

[1]Endocrinology and Metabolism Research Center, Endocrinology and Metabolism Clinical Sciences Institute, Tehran University of Medical Sciences, Tehran, IR Iran

[*]*Corresponding Author*: Mohsen Khoshniat Nikoo, Endocrinology and Metabolism Research Center, Tehran University of Medical Sciences, Tehran, IR Iran. Tel/Fax: +98-2184902477, E-mail: khoshniatmohsen@yahoo.com

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Background: There has been no data on population based dietary patterns during the Ramadan fasting month.
Objectives: The purpose of this study was to detect Ramadan major dietary patterns among those who fast in Tehran.
Materials and Methods: This cross-sectional study included 600 subjects, aged 18-65 with body mass index (BMI) of 18.5-40, who had decided to fast during Ramadan. Anthropometric measurements, usual physical activity level and educational status were collected two weeks before Ramadan. Information on Ramadan dietary intakes was obtained using a food frequency questionnaire and factor analysis was used to identify major dietary patterns.
Results: We identified four major dietary patterns: 1) Western-like pattern; high in fast foods, salty snacks, nuts, potato, fish, poultry, chocolates, juices; 2) high cholesterol and high sweet junk food pattern; high in pickles, sweets and condiments, butter and cream, canned fish, visceral meats and eggs; 3) Mediterranean-like pattern; high in vegetables, olive oil, dates, dairy, dried fruits, fruits, red meats, tea and coffee and 4) Ramadan-style pattern; large consumption of Halim, soups, porridges, legumes and whole grains, soft drinks, Zoolbia and Bamieh. Age was positively and inversely associated with Mediterranean-like ($P = 0.003$; $r = 0.17$) and Ramadan style ($P = 0.1$; $r = -0.13$) dietary pattern, respectively. Pre-Ramadan physical activity level was associated with a Mediterranean-like dietary pattern ($P < 0.0001$; $r = 0.20$).
Conclusions: This study showed a Ramadan-specific dietary pattern has unique characteristics, which has not yet been identified as a model of dietary pattern. Also, among identified dietary patterns, Mediterranean-like was the healthiest.

*Keywords:*Ramadan; Fasting; Diet

1. Background

In the holy month of Ramadan Muslims avoid eating, drinking and smoking from dawn (Sahar) to sunset (Iftar). Thus, lifestyle and eating habits of fasting individuals change during this month. In the holy month of Ramadan, people prefer to have a meal with their family (1). Indeed, both quantity and quality of their diet may be changed. Most physiological changes seen during Ramadan fasting are possibly related to the altered food pattern, food frequency and sleep pattern (2). Food intake frequency is decreased in Ramadan (3, 4). The Sahar meal is considered as breakfast (almost 30% of daily calorie) and the greatest proportion is allocated to the Iftar meal (almost 60%) (5). Based on some studies, dietary carbohydrates and proteins may be increased (1, 4, 6-8) and dietary fat decreased (1, 6, 7). While, a study in Algeria did not show any change in the amount and type of dietary fat (saturated and unsaturated fat) and cholesterol (4). In some cases, carbohydrate intake was increased due to consumption of dates, honey, sweets and soft drinks (4). Decreased vegetable intake has been reported, as well (8). The intake of dairy products decreases during Ramadan, thus calcium is consumed less during this month (5).

Data on food intake of fasting individuals in Ramadan are scare and often have focused on food items or macro-micro nutrients. Furthermore, to study the dietary habits of populations it is better to consider a group of nutrients together instead of each food or nutrient separately. From the aspect of public health, results of dietary pattern analysis could be easily used to set clinical guidelines (9). There is no data on food intake patterns of the Ramadan fasting period.

2. Objectives

The purpose of the present study was to determine the major dietary patterns of fasting subjects.

3. Materials and Methods

This cross-sectional study was approved by the Endocrinology and Metabolism Research Centre ethics committee (EC-00180) and conducted from July to August 2012, which covered the entire month of Ramadan and two

weeks before. The ethical consideration was the confidentiality of personal information. Among 18,039 individuals, 600 cases who intended to fast and were aged 18-65 years with BMI of 18.5-40 Kg/m^2 were entered in the study by the cluster sampling method, which selected individuals from the north, south, east and west of Tehran. Fasting was considered as 25 fasting days for men and 20 for women. Exclusion criteria were suffering from acute or chronic disease such as cardiovascular, renal, hepatic, thyroidal disease, cancer and etc.

Physical activity level (PAL) was assessed two weeks before Ramadan by a validated questionnaire defined by nine different metabolic equivalent (MET) levels, which ranged from sleep/rest (0.9 METs) to high-intensity physical activities (> 6 METs) (10). Over 24 hours, for each activity level, MET equivalent was multiplied by the time spent for that physical activity. Daily MET average was calculated as dividing the sum of MET-time by 24. All anthropometric measurements were assessed by standard methods.

An adjusted validated food frequency questionnaire (FFQ) (11) was completed by trained dietitians to assess the usual food intakes of participants. This was done by face-to-face interviews. To identify major dietary patterns, categorization of food items into 29 food groups (Table 1) was applied and each food was placed in groups based on its similarity of nutrient content and previous Iranian studies (12).

Table 1. Food Grouping Used in Factor Analysis

Group	Subgroup
Breads and rice	Lavash, Taftoon, Baget, rice, spaghetti, Barbari, Sangak, barley bread
Potato	Potato, fried potato
Sweets and condiments	Biscuit, cake, donate, Gaz, Sohan, candy, sugar, honey, jam, halva
Legumes and whole grains	Corn, barley, legumes, beans, soy
Red meats	Beef, lamb, ground meat
Fish and poultry	Chicken, fish
Canned fish	Canned fish
Eggs	Eggs
Fast foods	Hamburger, sausage, pizza
Visceral meats	Liver, visceral meats
Dairy	Milk, cocoa milk, yogurt, cheese, dough, ice cream
Butter and cream	Cream, butter
Vegetables	Salads, eggplant, celery, cucumber, pea, string bean, carrot, garlic, onion and etc.
Pickles	Pickles
Fruits	Cantaloupe, melon, watermelon, pear, apricot, cherry, apple, peach, mango, fig, grape, kiwi, orange, plum, banana and etc.
Dates	Dates
Juices	Fruit juices
Dried fruits	Raisin, dried fruits
Olive oil	Olive, olive oil
Nuts	Almonds, pistachio, hazelnut, walnuts, seeds
Soft drinks	Soft drinks, bear
Salty snacks	Chips, salty snacks
Chocolate	Chocolate, dark chocolate
Tea and coffee	Tea, green tea, coffee
Water	Water
Halim	Halim
Soups	Ash, soup
Porridges	Porridges
Zoolbia and bamieh	Zoolbia, Bamieh

3.1. Statistical Analysis

Data were analyzed using the Statistical Package Software for Social Science software, version 16 (SPSS Inc., Chicago, IL, USA). Principal Component Analysis (PCA) was used to extract major dietary patterns. Kaiser-Meyer-Olkin (KMO) value was 0.62 and Bartlett's test of sphericity was < 0.0001, which confirmed sampling adequacy and inter-correlation of variables. The numbers of factors were determined by Eigen values greater than 1.5, and to review the correlations, between variables and factors, Varimax rotation was applied. Food groups with positive loadings in each pattern indicated a direct relationship and food groups with negative loadings showed an inverse relationship with that pattern. The factor score for each pattern was calculated by summing the consumption of each food group that were weighted by factor loading and each person received an individual factor score for each identified pattern (9). Factor scores were then categorized into three groups based on the tertiles of factor score. Analyses of variance were used to compare the mean variables among tertiles of each dietary pattern. Post hoc tests were used to detect which groups showed significant differences. Pearson correlations were used to assess the association of adherence to each dietary pattern with the mean age, BMI and waist circumference. Scatter-plot was used to check linearity and outliers and Shapiro-Wilk test was used to examine normality. Chi square was used to compare the distribution of qualitative variables in tertiles of dietary patterns. An alpha level of less than 0.05 was accepted for all tests as statistically significant and with the sample size of 500, a power value of 95% was generated.

4. Results

Among the 600 included participants, 13 individuals were excluded from the study because of not possessing the fasting defined criteria. Factor analysis revealed four main dietary patterns, which were labeled on the basis of the highest loading food groups in each pattern. Factor loadings for each dietary pattern are presented in Table 2. Food groups with absolute factor loadings > 0.20 were considered as having significant contribution to the

Table 2. Factor Loading Matrix for Major Dietary Patterns Identified by Factor Analysis (n=587) [a]

Food Items	Western-Like	High Cholesterol, Sweet Junk Food	Mediterranean-Like	Ramadan Style
Fast foods	0.87			
Salty snacks	0.86			
Nuts	0.66			
Potato	0.66			
Fish and poultry	0.62			
Chocolates	0.48			
Juices	0.28			0.26
Pickles		0.81		
Sweets and condiments		0.78		
Butter and cream	0.27	0.33		
Canned fish		0.30		0.25
Visceral meats	0.23	0.30		
Eggs		0.26		
Vegetables			0.70	
Olive oil			0.69	-0.20
Dates			0.47	
Dairy	0.23		0.36	0.29
Dried fruits			0.31	-0.27
Fruits			0.29	
Red meats			0.28	0.24
Tea and coffee			0.28	
Halim				0.57
Soups				0.52
Porridges				0.51
Legumes and whole grains			0.32	0.39
Soft drinks	0.22			0.38
Zoolbia and Bamieh				0.39
Percentage of variance explained (%)	12.94	7.30	5.75	5.40

[a] Omitted from the table were food groups with factor loading < ± 0.20 for all dietary patterns.

Table 3. Characteristics of the Population by Tertiles of Western-Like Dietary Pattern [a]

	T1	T2	T3	P [b]	P [c]
Gender, %				0.076	-
Male	25.3	24.7	37.8		
Female	74.7	75.3	62.2		
Educational status, %				0.201	-
Illiterate	1.0	0.0	0.0		
Primary school	4.1	2.1	0.0		
Guidance school	5.2	4.2	2.0		
High school	34.0	26.3	25.5		
University	55.7	67.4	72.4		
BMI, Kg/m^2	25.48 ± 6.50	26.27 ± 4.60	25.09 ± 4.25	0.277	0.601 (-0.03)
Age, y	36.86 ± 14.53 [d]	34.25 ± 11.97	32.17 ± 12.93 [d]	0.046	0.013 (-0.14)
Waist circumference, cm	85.14 ± 11.85	85.53 ± 11.87	83.62 ± 11.37	0.490	0.369 (-0.05)
PAL (MET)	1.47 ± 0.19	1.48 ± 0.22	1.45 ± 0.18	0.684	0.607 (-0.03)

[a] PAL physical activity level, MET metabolic equivalent.
[b] P-value of analysis of variance for quantitative and chi square for qualitative variables.
[c] P-value of Pearson correlation.
[d] Post hoc test showed a significant difference between T1 and T3.

Table 4. Characteristics of the Population by Tertiles of High Cholesterol-Sweet Junk foods

	T1	T2	T3	P [a]	P [b]
Gender, %				0.001	-
Male	19.6	25.3	42.9		
Female	80.4	74.7	57.1		
Educational status, %				0.842	-
Illiterate	1.0	0.0	0.0		
Primary school	1.0	2.1	3.1		
Guidance school	3.1	5.2	3.1		
High school	27.1	27.8	30.9		
University	67.7	64.9	62.9		
BMI, Kg/m^2	25.42 ± 5.36	25.83 ± 4.31	25.57 ± 5.92	0.862	0.843 (0.01)
Age, y	35.21 ± 13.74	34.84 ± 13.87	33.29 ± 12.27	0.565	0.314 (-0.05)
Waist circumference, cm	84.51 ± 11.12	83.71 ± 11.24	86.11 ± 12.65	0.353	0.347 (0.05)
PAL (MET)	1.49 ± 0.22	1.46 ± 0.20	1.45 ± 0.18	0.385	0.180 (-0.07)

[a] P-value of analysis of variance for quantitative and chi square for qualitative variables.
[b] P-value of Pearson correlation.

pattern. These four dietary patterns explained 41.39% of the total variance in food intake. The first pattern was high in fast foods, salty snacks, nuts, potato, fish, poultry, chocolates, juices. The second was high in pickles, sweets and condiments, butter and cream, canned fish, visceral meats and eggs. The third was high in vegetables, olive oil, dates, dairy, dried fruits, fruits, red meats, tea and coffee, and the fourth was high in Halim, soups, porridges, legumes, whole grains, soft drinks, Zoolbia and Bamieh.

The normality of variables was confirmed by the Kolmogorov-Smirnov test. Estimates of the variables within the tertiles of dietary patterns are presented in Tables 3, 4, 5 and 6. Adherence to the Mediterranean-like and Ramadan style dietary patterns were positively (P = 0.003; r = 0.17) and inversely (P = 0.1; r = -0.13) associated with age, respectively (Tables 5 and 6). A positive association was seen between physical activity level and Mediterranean-like dietary pattern (P < 0.0001; r = 0.20) (Table 5). In high cholesterol-high sweet junk foods, the proportion of males was increased by the tertiles of the pattern (P = 0.001) (Table 4). No associations were seen between derived dietary patterns and other studied variables.

Table 5. Characteristics of the Population by Tertiles of Mediterranean Dietary Pattern

	T1	T2	T3	P [a]	P [b]
Gender, %				0.607	-
Male	25.5	30.9	31.3		
Female	74.5	69.1	68.7		
Educational status, %				0.766	-
Illiterate	0.0	0.0	1.0		
Primary school	2.1	1.1	3.0		
Guidance school	4.1	5.3	2.0		
High school	25.8	30.9	29.3		
University	68.0	62.8	64.6		
BMI, Kg/m^2	25.37 ± 4.92	25.93 ± 5.68	25.53 ± 5.08	0.745	0.831 (0.01)
Age, y	31.64 ± 13.28 [c]	34.30 ± 12.14	37.33 ± 13.89 [c]	0.011	0.003 (0.17)
Waist circumference, cm	84.29 ± 12.49	84.78 ± 12.10	85.21 ± 10.55	0.861	0.584 (0.03)
PAL (MET)	1.40 ± 0.18 [d]	1.50 ± 0.20	1.50 ± 0.20	0.000	0.000 (0.20)

[a] P value of analysis of variance for quantitative and chi square for qualitative variables.
[b] P value of Pearson correlation.
[c] Post hoc test showed a significant difference between T1 and T3.
[d] Significant difference between T1 and T2, T3.

Table 6. Characteristics of the Population by Tertiles of Ramadan Style Dietary Pattern

	T1	T2	T3	P [a]	P [b]
Gender, %				0.441	-
Male	25.5	28.7	33.7		
Female	74.5	71.3	66.3		
Educational status, %				0.761	-
Illiterate	0.0	1.1	0.0		
Primary school	2.0	3.3	1.0		
Guidance school	4.0	3.3	4.1		
High school	29.0	23.9	32.7		
University	65.0	68.5	62.2		
BMI, Kg/m^2	25.60 ± 5.56	26.16 ± 4.56	25.09 ± 5.45	0.368	0.495 (-0.04)
Age, y	36.77 ± 14.13	34.06 ± 12.80	32.38 ± 12.59	0.062	0.019 (-0.13)
Waist circumference, cm	85.45 ± 11.55	85.47 ± 11.70	83.39 ± 11.83	0.366	0.221 (-0.07)
PAL (MET)	1.45 ± 0.21	1.47 ± 0.20	1.48 ± 0.19	0.543	0.296 (0.06)

[a] P-value of analysis of variance for quantitative and chi square for qualitative variables.
[b] P-value of Pearson correlation.

5. Discussion

The present study showed four major dietary patterns among those who fast during Ramadan. The patterns were named Western-like, high cholesterol-high sweet junk foods, Mediterranean-like and Ramadan style dietary patterns. The fourth pattern had unique characteristics that have not been shown in previous extracted dietary patterns with high loading of specific food groups (Halim, porridges, Zoolbia and Bamieh). Also, amongst the identified dietary patterns, Mediterranean-like was the healthiest.

Dietary patterns identified among those who fast in Ramadan were similar but not the same as the patterns that have been previously reported for other months. Two local population-based studies have shown two and three major dietary patterns among Tehranian residents (13, 14). The first study extracted three major dietary patterns

including: healthy dietary pattern (high in fruits, other vegetables, tomatoes, poultry, legumes, cruciferous and green leafy vegetables, tea, fruit juices, and whole grains), western dietary pattern (high in refined grains, red meat, butter, processed meat, high-fat dairy products, sweets and desserts, pizza, potatoes, eggs, hydrogenated fats, and soft drinks and low in other vegetables and low fat dairy products) and Iranian dietary pattern (high in refined grains, potato, tea, whole grains, hydrogenated fats, legumes, and broth) (13). The second study suggested two major patterns, including: healthy (high consumption of other vegetables, fruits, yellow vegetables, cruciferous vegetables, tomato, low fat dairy products, yogurt drink, poultry, olive, nuts, fruit juice, potato, coffee, and garlic) and unhealthy (high in processed meat, mayonnaise, soft drinks, sweets, refined grains, snacks, industrial juice, red meat, nuts, hydrogenated fats, butter, French fries, high-fat dairy products, egg, organ meats, and sugars) (14). While, the present study on fasting subjects revealed some differences; never before seen Ramadan style dietary pattern and three other patterns (a combination and interaction of previously defined dietary patterns). Furthermore, pre-Ramadan BMI, waist circumference and educational status were not determining factors of tendency to each dietary pattern. Age was positively associated with adherence to Mediterranean-like dietary pattern ($P = 0.003$) and inversely associated with Ramadan style dietary pattern ($P = 0.02$). Age ($b = 0.31$, $P < 0.01$) was positively associated with healthy dietary pattern and negatively ($b = -0.33$, $P < 0.01$) associated with unhealthy dietary pattern (14).

Physical activity level showed a positive association with adherence to the Mediterranean-like dietary pattern ($P = 0.003$, < 0.0001 respectively). Individuals in the upper quintile of healthy, and Iranian dietary patterns were more physically active with a low prevalence of obesity, and in the upper quintile of Western were less physically active with a high prevalence of obesity (13). Physical activity ($b = 0.01$, $P < 0.05$) was positively associated with a healthy dietary pattern. (14). Unhealthy dietary pattern was associated with general (OR = 7.33, 95% CI: 2.39-22.51) and central obesity (OR = 4.99, 95% CI: 2.08-11.94), whereas, healthy dietary pattern was inversely associated with general (OR = 0.38, 95% CI: 0.15-0.98) or central obesity (OR = 0.33, 95% CI: 0.16-0.71) (15).

Among educational status factors, university degree ($b = 0.85$, $P < 0.01$), was positively associated with a healthy dietary pattern (14). However, our study did not show any association between educational status and tendency towards specific dietary patterns.

To our knowledge, this is the first study that has extracted major dietary patterns and their association with some related factors. Subjective or arbitrary decisions derived from limitations of factor analysis should also be taken into account. Also, we cannot generalize our findings to all fasting people in the country or the world, because dietary habits are somewhat different in different populations. Our findings revealed a new specific dietary pattern for the month of Ramadan named the Ramadan style dietary pattern. Furthermore the results showed that the Mediterranean-like pattern was the healthiest pattern among the four major identified dietary patterns.

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There are no financial or non-financial competing interests (political, personal, religious, ideological, academic, intellectual, commercial or any other) to declare, in relation to the content of this manuscript.

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