Journal of Nutrition and Food Security
Shahid Sadoughi University of Medical Sciences
School of Public Health
Department of Nutrition
Nutrition & Food Security Research Center

Nutrition & Food Security Research Center
Shahid Sadoughi University of Medical Sciences
School of Public Health

eISSN: 2476-7425 pISSN: 2476-7417 JNFS 2017; 2(3): 201-212 Website: jnfs.ssu.ac.ir

Dietary Patterns Associated with Metabolic Syndrome: A Study Conducted in Khorramabad

Ebrahim Falahi; PhD[1,2], Khatere Anbari; PhD[3], Farzad Ebrahimzadeh; MSc[4] & Sajjad Roosta; BSc[*5]

[1] Nutrition Health Research Center, School of Public Health and Nutrition, Lorestan University of Medical Sciences, Khorramabad, Iran.
[2] Department of Nutrition, School of Public Health and Nutrition, Lorestan University of Medical Sciences, Khorramabad, Iran.
[3] Department of Social Medicine, School of Medicine, Lorestan University of Medical Sciences, Khorramabad, Iran.
[4] Department of Public Health, School of Public Health and Nutrition, Lorestan University of Medical Sciences, Khorramabad, Iran.
[5] School of Public Health and Nutrition, Lorestan University of Medical Sciences, Khorramabad, Iran.

ARTICLE INFO

ORIGINAL ARTICLE

Article history:
Received: 2 Apr 2016
Revised: 4 Nov 2016
Accepted: 5 Dec 2016

***Corresponding author:**
sajjad.roosta@yahoo.com
School of Public Health and Nutrition, Lorestan University of Medical Sciences, Khorramabad, Iran.

Postal code: 6816163879
Tel: +986633409974

ABSTRACT

Background: Metabolic syndrome (MetS) is a complex disorder considered as a worldwide epidemic. The aim of this study was to characterize the dietary patterns of Iranian adults and examine its association with metabolic syndrome. **Methods**: In this cross-sectional study, 973 persons were selected using multi-stage cluster, random sampling method in Khorramabad city. Dietary intake was assessed using a validated, 168 food-item, self-administrated, and semi-quantitative food-frequency questionnaire (FFQ). To identify the dietary patterns, factor analysis was used for principal components. **Results**: Three major dietary patterns were identified: the western dietary pattern (WDP), the healthy dietary pattern (HDP), and the traditional dietary pattern (TDP). Participants in the highest quintile of HDP had lower odds of MetS (OR: 0.45; 95% CI: 0.27-0.77) than those in the lowest quintile, whereas those in the highest quintile of the WDP score had greater odds of the MetS (OR: 3.44; 95% CI: 2.08-5.70) than participants of the lowest quintile. Multi linear regression showed that the WDP score was associated negatively with serum high density lipoprotein-cholesterol and positively with other components of MetS. Even after body mass index adjustment, the association remained significant, except for fasting plasma insulin. **Conclusions**: a HDP is associated with reduced risk of MetS. In contrast, a WDP is associated with a greater risk of the MetS.

Keywords: *Metabolic syndrome; Obesity; Dietary pattern; Body mass index*

Introduction

Metabolic syndrome (MetS) is a complex disorder with high socioeconomic cost that is considered as a worldwide epidemic. MetS is defined by a cluster of interconnected factors that directly increase the risk of coronary heart disease (CHD), other forms of cardiovascular atherosclerotic diseases (CVDs), and diabetes

This paper should be cited as: Falahi E, Anbari KH, Ebrahimzadeh F, Roosta S. ***Dietary Patterns Associated with Metabolic Syndrome: A Study Conducted in Khorramabad.*** *Journal of Nutrition and Food Security (JNFS)*, 2017; 2 (3): 201-12.

mellitus type 2 (Kassi *et al.*, 2011). Its main components are central obesity, hyper-insulinemia, insulin resistance and hyperglycemia, hypertension, as well as elevated blood lipids (Noel *et al.*, 2009, Panagiotakos *et al.*, 2007, Wirfält *et al.*, 2001) .

The prevalence of MetS increases with age and varies by ethnicity (Noel *et al.*, 2009). CVDs are one of the main causes of mortality in Iran and Lorestan province (Azadbakht *et al.*, 2005a, Falahi *et al.*, 2012). People with the MetS are also at greater risk of CVDs (Azadbakht *et al.*, 2005a). A recent study in Tehran showed an estimated MetS prevalence of higher than 30% in adults (Azizi *et al.*, 2003).

The cause of this syndrome is largely unknown and variations worldwide have prompted researchers to present hypotheses for the natural development of the syndrome (Azadbakht *et al.*, 2005b). As indicated in several studies, among factors influencing risk of developing metabolic syndrome, dietary pattern seems to play an important role (Panagiotakos *et al.*, 2007). At this point, it should be mentioned that majority of studies followed the approach of assessing single nutrients or food items, instead of assessing dietary patterns; however, people do not eat isolated nutrients. They consume meals consisting of a variety of foods with complex combinations of nutrients. Thus, using a holistic dietary approach is recommended to prevent diseases (Azadbakht *et al.*, 2005b, Panagiotakos *et al.*, 2007) .

Despite the rising prevalence of MetS, few recent studies have examined the role of dietary patterns and their relationship with MetS (Deshmukh-Taskar *et al.*, 2009). Regarding high prevalence of MetS in Iran, variety of food patterns among various people of the world, cultural differences, and accessibility of foods, this study was carried out to characterize dietary patterns of Iranian adults and to examine its associations with metabolic syndrome.

Materials and Methods

Study population: A descriptive, cross-sectional, and correlational design was used to conduct this research. In the study, 1980 people aged 18 years and higher were selected using multi-stage cluster random sampling method in Khorramabad city, located in west of Iran from July 2011 to February 2012. Exclusion criteria consisted of having history of CVDs, diabetes, stroke, hyper or hypothyroidism, being on diet, having medication, pregnancy or lactation, daily energy intake out of 800-4200 kcal/d range. Therefore, 1009 people (273 men and 736 women) aged 18-75 years participated in the study; 36 participants did not continue the study because of several reasons (e.g., lack of time or unexpected reasons that forced them to cancel the study). Finally, 973 participants were analyzed who had complete data.

Dietary assessment: Dietary intake was assessed with the use of a validated, 168 food-item, self-administrated, and semi-quantitative food-frequency questionnaire (FFQ) (Esmaillzadeh *et al.*, 2007). All the completed questionnaires were evaluated by trained dietitians. The FFQ consisted of a list with a usual portion size. Participants were asked to report their consumption frequency of each food item during the past year. Each food/beverage item provided 9 possible responses, ranging from "never or less than once a month" to "six or more times per day". The selected frequency choice indicated by the participants for each food/beverage was converted to daily intake. Because of their high variety and frequency, food items were categorized into one of the 40 defined food groups (**Table 1**).

Socio-demographic and other lifestyle variables: A questionnaire on age, gender, marital status (single or married), smoking status (non-smoker, current smoker, ex-smoker), alcohol intake (yeas or no), monthly income (less than or equal to 300 $ and higher than or equal to 900 $), and education level (i.e., illiterate, <=12 years, and >12 years) was later completed by the participants. Physical activity was assessed by the international physical activity questionnaire (IPAQ). The short version of IPAQ (seven items) was applied which provided information on

[DOR: 20.1001.1.24767417.2017.2.3.2.0]

weekly time spent for walking, vigorous, moderate, intense, and sedentary activity (Oyeyemi *et al.*, 2011). Finally, metabolic equivalent minutes per week (MET-min/wk.) were calculated and sum of them were determined as physical activity.

Anthropometric, clinical, and biochemical assessments: Weight and height were measured while participants were with light clothes and no shoes. Body mass index (BMI) was calculated as the weight in kilograms divided by square of height in meter. Waist circumference (WC) was measured at the narrowest level between the lowest rib and the iliac crest by an upstretched tape measure without any pressure to body surface. Measurements were recorded to the nearest 0.1 cm.

Blood pressure was measured twice after participants' rest for 15 minutes (Azizi *et al.*, 2002). All blood samples were obtained in the morning following a 12 h fast. Fasting plasma glucose (FPG) concentrations were measured by the glucose oxidase method using a commercial kit (Pars Azmon Co., Tehran, Iran); a commercial radioimmunoassay kit measured plasma immune-reactive insulin concentration (Immunotech co., France). Indices of insulin sensitivity were calculated according to the quantitative insulin sensitivity check index (QUICKI) formula (1/(log FPG (mg/dL) + log fasting plasma insulin (µU/mL); higher QUICKI values indicated greater insulin sensitivity and the homeostasis model assessment of insulin resistance (HOMA-IR) formula (FPG (mg/dL) × fasting plasma insulin (µU/mL))/ 405; higher HOMA-IR values indicated greater insulin resistance. Serum concentrations of total cholesterol (TC), high density lipoprotein-cholesterol (HDl-c), low density lipoprotein-cholesterol (LDL-c), and triacylglycerol (TG) were measured using commercially available enzymatic reagents (Pars Azmoon, Tehran, Iran). Blind duplicates were used for quality control of all analyses.

Definition of MetS: It was defined as presence of at least three of the following risk factors as recommended by ATP Ш (Panel, 2002): 1) abdominal obesity (WC >= 102 cm in men and >= 88 cm in women); 2) elevated blood pressure (>= 130/85 mmHg) 3) high serum TG concentrations (>= 150 mg/dL); 4) low serum HDL-c (<40 mg/dL in men or <50 mg/dL in women 5) high FBG (>= 100 mg/dL).

Data analysis: SPSS software (version 19; SPSS Inc., Chicago IL) was used to conduct data analyses. To identify the dietary patterns based on 40 food groups (**Table 1**), principal components factor analysis was used (**Table 2**). Participants were categorized by dietary pattern scores' quintiles. Linear regression was used to determine association between dietary patterns and MetS. First, age and gender were adjusted, then, adjustment was conducted for smoking, physical activity, drug using, history of diabetes, history of heart disease, and finally for BMI.

Analysis of covariance through Tukey post-hoc test was used to examine differences in mean servings of foods from the dietary pattern; demographic and lifestyle characteristics. Statistical significance was set at P-value <= 0.05.

Ethical considerations: Written informed consents were collected from each participant. The protocol of study was approved by the ethic committee of Lorestan University of Medical Sciences.

Results

Three major dietary patterns were identified: the western dietary pattern (WDP), rich in red meat, processed meat, organ meats, margarine, coffee, sweets and desserts, soft drinks, condiments, and dried fruits, the healthy dietary pattern (HDP), rich in poultry, low- fat dairy products, high- fat dairy products, fish, fruits, yellow vegetables, cruciferous vegetables, green leafy vegetables, other vegetables, legumes, whole grains, and olives, and the traditional dietary pattern (TDP), rich in refined grains, tea, nuts, fruit juices, eggs, pickles, hydrogenated oils, vegetables oils, sugars, salt. These dietary patterns' factor-loading matrixes are shown in **Table 2**.

[DOR: 20.1001.1.24767417.2017.2.3.2.0]

Table 1. Components of food groups used in the dietary pattern analyses

Food groups	Food Items
Fruits	Apples, cherries, bananas, pears, apricots, peaches, nectarine, cantaloupe, watermelon, oranges, tangerine, lemons, pineapples, pomegranates, mulberry, plums, grapefruit, kiwi, grapes, strawberries, persimmons, fresh figs , black cherries
Fruit Juices	Orange juice, apple juice, other fruit juices
Cruciferous vegetables	Cauliflower, cabbage, Brussels sprouts, kale
Green leafy vegetables	Spinach, lettuce
Yellow vegetables	Carrots, Pumpkins
Tomatoes	Tomatoes, tomato sauce, tomato pasta
Other vegetables	Cucumber, celery, green pea, mixed vegetables, eggplant, green beans, green paper, turnip, squash, mushrooms, onions, radish, spring onions
Whole grains	Wheat germ, cornflakes, popcorn, barley bread, dark breads (Sangak, tafton, barbari), bulgur
Refined grains	White breads (lavash, baguettes), noodles, pasta, rice, toasted bread, white flour, starch, biscuits, milled barley
Potatoes	Potatoes
Legumes	Lentils, beans, peas, lima beans, broad beans, soy
Low fat dairy products	Skim or low-fat milk, low–fat yogurt
High fat dairy products	High –fat milk, whole milk, chocolate milk, , fruits milk, cream , high-fat yogurt, cream yogurt, cream cheese, other cheeses, ice cream
Poultry	Chicken with or without skin
Fish	Canned tuna fish, other fish
Red meats	Beef, lamb, hamburger
Processed meats	Sausages, Kalbas
Organ meats	Beef liver, kidney, and heart, lamb liver, kidney, and heart
Eggs	Eggs
Tea	Tea
Coffee	Coffee
Hydrogenated oils	Hydrogenated fats, animal fats
Vegetable oils	Vegetable oils (except for olive oil)
Butter	Butter
Margarine	Margarine
Sweets and desserts	Chocolates, cookies, cakes, confections
Pizza	Pizza
Soft drinks	Soft drinks
Snacks	Corn puffs, Potato chips
French fries	French fries
Mayonnaise	Mayonnaise
Broth	Broth
Nuts	Pistachios, almonds, peanuts, hazelnuts, roasted seeds, walnuts
Olives	Olives, olive oil
Sugars	Sugars, candies, gaz (an Iranian confectionery)
Condiments	Jam, jelly, honey
Dried fruits	Dried figs, dried dates, dried mulberries, other dried fruits
Salt	Salt
Spices	Peppers, turmeric, curry powder
Pickles	Pickles

[DOR: 20.1001.1.24767417.2017.2.3.2.0]

Table 2. Factor-loadings matrix for dietary patterns [a]

Food groups	Dietary patterns		
	Western	**Healthy**	**Traditional**
Fruits	0.22	0.37	0.27
Fruit Juices	0.31	0.26	0.31
Cruciferous vegetables	0.28	0.53	-
Green leafy vegetables	-	0.63	-
Yellow vegetables	-	0.57	-
Tomatoes	-	-	-
Other vegetables	-	0.49	0.30
Whole grains	-	0.24	-
Refined grains	-	-	0.26
Potatoes	0.57	-	-
Legumes	-	0.61	-
Low fat dairy products	-	0.52	-
High fat dairy products	0.27	0.41	0.27
Poultry	-	0.36	-
Fish	-	0.61	-
Red meats	0.75	-	-0.47
Processed meats	0.75	-	-0.47
Organ meats	0.23	-	-
Eggs	-	-	-
Tea	-	-	0.26
Coffee	0.70	-	-
Hydrogenated oils	-	-	0.35
Vegetable oils	-	-	-
Butter	0.38	-	0.27
Margarine	-	-	-
Sweets and desserts	0.62	-	0.36
Pizza	-	-	-
Soft drinks	0.44	-	0.39
Snacks	0.52	-	0.38
French fries	0.26	-	-
Mayonnaise	-	-	-
Broth	-	-	-
Nuts	0.39	0.31	0.42
Olives	-	0.38	-
Sugars	0.43	-	0.49
Condiments	0.34	-	-
Dried fruits	0.61	0.46	-
Salt	-	-	-
Spices	-	-	0.23
Pickles	-	0.34	0.35
Variability explained	12.64%	10.59%	6.65%

[a]: values <0.20 were exclude

[DOR: 20.1001.1.24767417.2017.2.3.2.0]

Characteristics of participants across quintile categories of dietary pattern scores are represented in **Table 3**. Compared with participants in the lowest quintile; those in the highest quintile of the TDP and WDP had significantly higher BMI and MetS prevalence; they were also more significantly obese. Conversely, in comparison with people in the lowest quintile, those in the highest quintile of the healthy dietary pattern had significantly lower prevalence of the MetS. Participants in the highest quintile of the TDP were significantly older. No significant differences were found in the distribution of current smokers, drug users, diabetic, and heart diseases history across quintile categories of dietary patterns.

Table 4 shows odds ratios (ORs) for the MetS across quintile categories of dietary pattern scores. After adjusting for age, participants in the highest quintile of the HDP had lower MetS odds (OR: 0.45; 95% CI: 0.27-0.77) than did those in the lowest quintile. However, those in the highest quintile of the WDP score had greater odds of the MetS (OR: 3.44; 95% CI: 2.08-5.70) than participants in the lowest quintile. In spite of adjustment for other confounding variables, such as current smoking, physical activity, drug using, and history of diabetic and heart disease, the significant difference remained. However, after adjustment for BMI, the positive association of the TDP with MetS disappeared.

Participants in the highest quintile of the HDP score had lower odds for elevated blood pressure (OR: 0.56, 95%; CI: 0.34-0.93). This association remained even after adjustment for BMI (**Table 5**). In contrast, those in the highest quintile of the WDP score had significantly higher odds for some MetS components (2.28, 1.70, and 2.11 for abdominal obesity, elevated TG, and elevated blood pressure, respectively). This association disappeared after adjustment for BMI, except for elevated blood pressure. However, with or without adjustment for BMI, the association was not significant for elevated blood glucose and low HDL-c. Participants in the highest quintile of the TDP score had higher odds only for abdominal obesity (OR: 2.05, 95% CI: 1.28-3.27). After adjustment for BMI, this significant association disappeared.

Multi linear regression showed that the WDP score was associated negatively with serum HDL-c and positively with other components of MetS. Even after adjustment for BMI, the association remained significant, except for fasting plasma insulin (**Table 6**). The HDP score had independent inverse relation with various metabolic risk factors except serum HDL-c. The TDP score was significantly associated only with HDL-c after adjusting for BMI (**Table 6**).

Discussion

In this study three major dietary patterns were identified among adult Iranian population (west of Iran): the WDP, the HDP, and the TDP. Consumption of the HDP was associated with lower risk of MetS, whereas WDP and TDP were associated with higher risks of this syndrome.

Esmaillzadeh (Esmaillzadeh *et al.*, 2007) identified three major dietary patterns among Tehranian women. They reported a negative association between healthy dietary pattern and a positive association between the Western dietary pattern and the metabolic syndrome. However, no association was noted for occurrence of MetS and WDP in a study by Deshmukh-Taskar et al. (Deshmukh-Taskar *et al.*, 2009). In a longitudinal study, participants who were in the highest quintile of the WDP scores (comprising of refined grains, processed meat, fried foods, and red meat) had an 18% greater risk of MetS than those in the lowest quintile for the WDP scores (Deshmukh-Taskar *et al.*, 2009). Noel et al. showed that meat and French fries pattern was not associated with the overall prevalence of MetS, while prevalence of this syndrome was higher for consuming a traditional diet (comprising of rice, beans, and oils) (Noel *et al.*, 2009). Other studies suggested that increased consumption of healthier foods, including fruits and vegetables, whole grains/ cereals, dairy products, and other low fat foods may prevent chronic diseases. Conversely, meat and alcohol intake were associated with increased levels of clinical and biological markers linked to MetS (Azadbakht *et al.*, 2005a, Bazzano *et al.*, 2002, Deshmukh-Taskar *et al.*, 2009, Johnston *et al.*, 2004, Panagiotakos *et al.*, 2007, Qi *et al.*, 2006, Rolls *et al.*, 2004, Ruidavets *et al.*, 2007, Wirfält *et al.*, 2001, Zemel *et al.*, 2005).

Table 3. Characteristics of participants by quintile (Q) categories of dietary pattern scores

Variables	HDP score				TDP score				WDP score			
	Q1	Q3	Q5	P-value [a]	Q1	Q3	Q5	P-value	Q1	Q3	Q5	P-value
Age (y)												
	34.3±10.5[b]	33.6±10.9	32.1±11.1	0.12	31.7±10.3	35.5±10.4	33.6±10.8	0.001	35.2±10.4	34.5±11.0	32.7±10.9	0.06
Body mass index (kg/m^2)												
	26.5±5.4	26.6±4.9	26.2±4.8	0.65	25.4±4.4	27.1±4.7	27.3±5.4	<0.001	26.0±4.8	26.8±5.3	27.3±5.6	0.04
Waist circumference (cm)												
	89.1±13.6	89.0±12.5	87.9±11.9	0.63	86.0±11.8	91.1±11.5	89.8±13.2	<0.001	87.9±12.3	89.2±12.9	90.9±14.0	0.07
Physical activity (Met.min/wk)												
	3382±5972	3022±3405	3696±4792	0.39	3553±4875	3334±4025	3086±4062	0.57	3481±5256	3274±4803	3186±4059	0.82
Female (%)												
	75.3	76.3	78.9	0.79	74.2	74.4	80.4	0.38	76.3	79.0	70.6	0.36
Family history of diabetes (%)												
	3.1	3.6	2.1	0.65	0.5	3.1	3.1	0.14	2.6	2.1	3.6	0.63
History of heart disease (%)												
	2.1	2.6	4.6	0.30	2.1	5.6	3.6	0.17	4.1	2.1	3.1	0.49
Current daily smoker (%)												
	2.1	1.5	2.6	0.77	1.5	2.6	3.1	0.60	2.6	2.6	3.6	0.78
Drug using (%)												
	17	21.1	19.6	0.58	19.1	19.5	17.5	0.87	19.6	18.5	21.1	0.80
Obesity (%) [c]												
	23.2	24.7	19.1	0.38	14.4	22.1	28.9	0.003	18.0	22.6	29.9	0.02
Metabolic syndrome (%)[d]												
	30.4	29.4	16.0	0.001	19.1	31.8	34	0.002	22.7	28.2	39.7	0.001

Met: metabolic equivalent; HDP: healthy dietary pattern; TDP: traditional dietary pattern; WDP: western dietary pattern, [a]: One way ANOVA for age, body mass index, waist circumference, and physical activity and chi-square test for other variables, [b]:mean±SD, [c] : Obesity defines as the BMI >= 30 kg/m^2, [d]: defines as the presence of >= 3 of the following components: 1) waist circumference > 88 cm for women and >102 for men; 2) serum triacylglycerol >= 150 mg/dL; 3) High density lipoprotein-cholesterol (50 mg/ dL for women and < 40 for men); 4) fasting blood glucose >= 100 mg/dL; 5) blood pressure >= 130/85 mmHg)

Table 4. Multivariate adjusted odds ratios (95% CIs) for metabolic syndrome[a] across quintile (Q) categories of dietary pattern scores

	HDP score					TDP score					WDP score				
	Q1	Q3	Q5	OPPM[b]	P-value	Q1	Q3	Q5	P-value	OPPM	Q1	Q3	Q5	OPPM	P-vaule
Model 1[c]	1	0.99 (0.62-1.60)	0.45 (0.27-0.77)	77.8	0.005	1	1.56 (0.94-2.58)	2.06 (1.24-3.40)	0.020	75.6	1	1.51 (0.91-2.50)	3.44 (2.08-5.70)	73.9	<0.001
Model 2[d]	1	0.98 (0.61-1.59)	0.47 (0.27-0.81)	78.7	0.011	1	1.53 (0.91-2.56)	2.05 (1.23-3.42)	0.023	77.7	1	1.51 (0.90-2.53)	3.49 (2.09-5.84)	75	0.001
Model 3[e]	1	0.92 (0.54-1.57)	0.39 (0.21-0.71)	79.7	0.004	1	1.24 (0.70-2.18)	1.43 (0.80-2.54)	0.480	79.4	1	1.29 (0.72-2.28)	2.70 (1.52-4.79)	79.9	0.002

HDP: healthy dietary pattern; TDP: traditional dietary pattern; WDP: western dietary pattern ' [a]: defines as the presence of >= 3 of the following components: 1) waist circumference > 88 cm for women and >102 for men; 2) serum triacylglycerol >= 150 mg/dL; 3) High density lipoprotein-cholesterol (50 mg/ dL for women and < 40 for men); 4) fasting blood glucose >= 100 mg/dL; 5) blood pressure >= 130/85 mmHg), [b]: OPPM, overall prediction power of model, [c]: Adjusted for age and gender, [d]: further adjusted for smoking, physical activity, drug using, history of diabetes, and history of heart disease, [e]: additionally adjusted for BMI

The inverse association between the HDP and MetS could be attributed to that pattern's healthy constituents including vegetables, fruits, legumes, dairy products, whole grains, and fish (Azadbakht *et al.*, 2005a, Panagiotakos *et al.*, 2007, Ruidavets *et al.*, 2007, Ventura *et al.*, 2008). This association may be explained by their vitamin/mineral, phytochemical, fiber content, and antioxidant contents. Reduced insulin demand may be another protective mechanism associated with higher intake of such foods. Furthermore, most foods in HDP have a low glycemic load and are rich in fiber, so their consumption may increase insulin sensitivity and plasma levels of anti-inflammatory cytokines and reduce serum markers of systemic inflammation (McKeown *et al.*, 2004, Qi *et al.*, 2006). The identified HDP in this study is somewhat similar to the 'prudent dietary pattern' in other studies (Deshmukh-Taskar *et al.*, 2009, Lopez-Garcia *et al.*, 2004), DASH eating plan recommended for decreasing blood pressure (Ramond and Couch, 2016), and improvement of MetS features (Azadbakht *et al.*, 2005a). A positive association was observed between TDP and MetS. Some studies showed no association between TDP and MetS that could be attributed to complex nature of these patterns (Esmaillzadeh *et al.*, 2007, Naja *et al.*, 2013) . These dietary patterns were loaded with both healthy (whole grain, legume, fruits and vegetables) and unhealthy (refined grains, potatoes, and hydrogenated fats) foods. Whereas, other studies on TDP confirmed results of the current study (Murakami *et al.*, 2006, Noel *et al.*, 2009). Song and Joung reported that traditional Korean dietary pattern have beneficial effects on some metabolic abnormality. However, high prevalence of low HDL-c, attributable to a high carbohydrate diet should be considered (Song and Joung, 2012). These differences between various studies may be related to difference in the contents of various traditional dietary patterns from one country to another.

Table 5. Adjusted odds ratio and confidence intervals (95% CIs) for metabolic syndrome components across quintile (Q) categories of dietary pattern scores

	HDP score					TDP score					WDP score				
	Q1	Q3	Q5	P-value	OPPM[a]	Q1	Q2	Q3	P-value	OPPM	Q1	Q2	Q3	P-value	OPPM
Model 1[b]															
Abdominal obesity	-	0.99(0.62-1.59)	1.08(0.67-1.74	0.928	73.9	-	1.61(1.01-2.57)	2.05(1.28-3.27)	0.01	72.2	-	1.15(0.72-1.86)	2.28(1.40-3.70)	0.002	74.3
Elevated TG	-	1.07(0.68-1.17)	0.72(0.45-1.17)	0.246	73.2	-	1.33(0.84-2.10)	1.14(0.72-1.81)	0.474	71.5	-	1.08(0.68-1.72)	1.70(1.07-2.70)	0.050	71.0
Elevated blood pressure	-	1.01(0.63-1.59)	0.56(0.34-0.93)	0.043	75.6	-	1.09(0.68-1.76)	1.26(0.78-2.03)	0.621	75.3	-	1.17(0.73-1.87)	2.11(1.32-3.36)	0.004	71.7
Abnormal fasting glucose	-	0.82(0.45-1.50)	0.50(0.25-0.99)	0.139	88.7	-	1.68(0.84-3.39)	1.77(0.87-3.59)	0.237	89	-	1.11(0.58-2.10)	1.70(0.91-3.16)	0.201	87.5
Low HDL-c	-	1.04(0.68-1.58)	1.06(0.70-1.62)	0.962	64.1	-	0.85(0.55-1.30)	1.08(0.70-1.66)	0.530	65.5	-	1.16(0.77-1.76)	1.60(1.04-2.44)	0.092	62.8
Model 2[c]	-					-									
WC	-	0.74(0.38-1.44)	0.91(0.46-1.79)	0.675	85.7	-	1.34(0.74-2.50)	1.51(0.81-2.83)	0.402	84.2	-	0.84(0.44-1.60)	1.28(0.66-2.48)	0.489	85.4
Elevated TG	-	1.04(0.65-1.66)	0.70(0.43-1.15)	0.238	72.3	-	1.17(0.73-1.88)	0.93(0.57-1.51)	0.591	70.7	-	0.97(0.60-1.56)	1.42(0.88-2.30)	0.206	71.2
Elevated blood pressure	-	0.98(0.61-1.58)	0.54(0.32-0.91)	0.036	77.0	-	0.94(0.57-1.55)	1.01(0.61-1.66)	0.957	74.6	-	1.03(0.63-1.68)	1.72(1.06-2.79)	0.044	73.1
Abnormal fasting glucose	-	0.80(0.44-1.48)	0.49(0.25-0.98)	0.129	88.7	-	1.50(0.74-3.04)	1.43(0.69-2.94)	0.504	88.9	-	1.02(0.53-1.95)	1.44(0.76-2.72)	0.441	87.7
Low HDL-c	-	1.01(0.66-1.55)	1.04(0.68-1.59)	0.983	64.6	-	0.78(0.51-1.21)	0.98(0.63-1.52)	0.472	66.0	-	1.06(0.69-1.62)	1.36(0.88-2.11)	0.349	65.2

HDP: healthy dietary pattern; TDP: traditional dietary pattern; WDP: western dietary pattern, TG: triglyceride, WC: waist circumference, HDL-c: High density lipoprotein-cholesterol, [a]: OPPM, overall prediction power of model, [b]: without adjustment for body mass index, [c]: Adjusted for body mass index

In this study, TDP contents refined grains, hydrogenated fats, vegetable oils, and sugar which may be responsible for the positive relation to MetS. Of course the positive association between TDP and MetS in the present study disappeared after adjustment for BMI that can explain this association. The positive relation between the WDP and the MetS could be attributed to lower amounts of beneficial foods and nutrients of this pattern. Higher intake of processed meat, meat, sweets and desserts, soft drink, snacks, and condiments (Deshmukh-Taskar *et al.*, 2009, Esmaillzadeh *et al.*, 2007, Panagiotakos *et al.*, 2007, Song and Joung, 2012) in this food patterns also explain part of this relation.

Some of the associations remained even after BMI adjustment. This shows that general obesity cannot explain all relations between diet and chronic diseases and that other factors, such as abdominal adiposity, may be responsible.

A positive relation between the HDP and HDL-c and a significantly inverse association between the HDP and other components of the MetS was observed. This relation remained even after adjustment for BMI. In a cross-sectional study a healthy dietary pattern (comprising of raw vegetables, fruits, fish, pasta, and rice) was inversely associated with central obesity, FPG, and TG; it was also positively correlated with HDL-c (Williams *et al.*, 2000). Multi linear regression did not show any significant relationship between the TDP and the MetS components. This food pattern contains both healthy (eggs, nuts, fruit juices, and tea) and unhealthy (refined grains, hydrogenated fats, sugar, salt, and condiments) foods which may explain the findings. A positive association was found between components of MetS with the WDP. However, a significant invers relation was found between HDL-c and the WDP. These associations were remained even after controlling for BMI. Deshmukh-Tasker et al. (Deshmukh-Taskar *et al.*, 2009), reported the same results similar to our findings. Conversely, Other studies are not in agreement with our result (Pelkman *et al.*, 2004, Samaha, 2005). In general, diets high in saturated fatty acids (the same as WDP in our study) tend to increase the cardio-protective HDL-c levels along with increasing other chronic heart disease-causing lipid (e.g., TC) (Samaha, 2005). Conversely, low-fat high carbohydrate diets tend not only to decrease HDL-c, but also decrease TC and LDL-c (Pelkman *et al.*, 2004).

The use of factor analysis to identify dietary patterns is the major strength of the present study. Although using factor analysis for dietary data reduction has been criticized for its subjectivity in nature and difficulty of results' replication in other populations (Martínez *et al.*, 1998). However, similarity of dietary patterns and MetS' results achieved from the present study to those reported in longitudinal (Lutsey *et al.*, 2008) and cross-sectional studies (Bazzano *et al.*, 2002, Deshmukh-Taskar *et al.*, 2009, Esmaillzadeh *et al.*, 2007, Panagiotakos *et al.*, 2007) strengthens the current results.

This study has some limitations. First, the cross-sectional design and therefore its findings can mainly be used to test association rather than assessing causal relationships. Second, the FFQs have some limitation (such as semi quantitative nature) that may affect dietary information collection. Third, food items could not be analyzed to their nutrient contents. Better explanation could be provided if this has been done.

Conclusions

The present results indicate that a dietary pattern characterized by high consumption of poultry, dairy products, vegetables, fruits, legumes, whole grains, fish, and olives are associated with reduced metabolic syndrome risk in both male and female. In contrast, a dietary pattern with high amounts of red meats, organs meat, processed meats, soft drinks, snacks, sweets and deserts, condiments, margarine, and coffee is associated with a greater risk for metabolic syndrome.

Acknowledgements

We are grateful to the deputy of Research and Technology of Lorestan University of Medical Sciences for financial support of this project.

[DOR: 20.1001.1.24767417.2017.2.3.2.0]

Authors' contributions

Falahi E, Anbari K, Ebrahimzadeh F and Roosta S designed research; Falahi E and Roosta S conducted research; Anbari K and Ebrahimzadeh F analyzed the data; and Falahi E and Roosta S wrote the paper. Roosta S had primary responsibility for final content. All authors read and approved the final manuscript.

Conflicts of interest

The authors declare no conflict of interest.

References

Azadbakht L, Mirmiran P, Esmaillzadeh A & Azizi F 2005a. Dairy consumption is inversely associated with the prevalence of the metabolic syndrome in Tehranian adults. *The American journal of clinical nutrition.* **82 (3)**: 523-530.

Azadbakht L, Mirmiran P, Esmaillzadeh A, Azizi T & Azizi F 2005b. Beneficial effects of a Dietary Approaches to Stop Hypertension eating plan on features of the metabolic syndrome. *Diabetes care.* **28 (12)**: 2823-2831.

Azizi F, Ghanbarian A, Madjid M & Rahmani M 2002. Distribution of blood pressure and prevalence of hypertension in Tehran adult population: Tehran Lipid and Glucose Study (TLGS), 1999-2000. *Journal of human hypertension.* **16 (5)**: 305-312.

Azizi F, Salehi P, Etemadi A & Zahedi-Asl S 2003. Prevalence of metabolic syndrome in an urban population: Tehran Lipid and Glucose Study. *Diabetes research and clinical practice.* **61 (1)**: 29-37.

Bazzano LA, et al. 2002. Fruit and vegetable intake and risk of cardiovascular disease in US adults: the first National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. *The American journal of clinical nutrition.* **76 (1)**: 93-99.

Deshmukh-Taskar PR, et al. 2009. Dietary patterns associated with metabolic syndrome, sociodemographic and lifestyle factors in young adults: the Bogalusa Heart Study. *Public health nutrition.* **12 (12)**: 2493-2503.

Esmaillzadeh A, et al. 2007. Dietary patterns, insulin resistance, and prevalence of the metabolic syndrome in women. *The American journal of clinical nutrition.* **85 (3)**: 910-918.

Falahi E, Ebrahimzadeh F & Anbari K 2012. Determination of the causes of tendency toward red meat and meat products in the west of Iran. *Journal of research in medical sciences.* **17 (4)**.

Johnston CS, Tjonn SL & Swan PD 2004. High-protein, low-fat diets are effective for weight loss and favorably alter biomarkers in healthy adults. *The journal of nutrition.* **134 (3)**: 586-591.

Kassi E, Pervanidou P, Kaltsas G & Chrousos G 2011. Metabolic syndrome: definitions and controversies. *BMC medicine.* **9 (1)**: 1.

Lopez-Garcia E, et al. 2004. Major dietary patterns are related to plasma concentrations of markers of inflammation and endothelial dysfunction. *The American journal of clinical nutrition.* **80 (4)**: 1029-1035.

Lutsey PL, Steffen LM & Stevens J 2008. Dietary Intake and the development of the metabolic syndrome the atherosclerosis risk in communities study. *Circulation.* **117 (6)**: 754-761.

Martínez ME, Marshall JR & Sechrest L 1998. Invited commentary: Factor analysis and the search for objectivity. *American journal of epidemiology.* **148 (1)**: 17-19.

McKeown NM, et al. 2004. Carbohydrate nutrition, insulin resistance, and the prevalence of the metabolic syndrome in the Framingham Offspring Cohort. *Diabetes care.* **27 (2)**: 538-546.

Murakami K, et al. 2006. Dietary glycemic index and load in relation to metabolic risk factors in Japanese female farmers with traditional dietary habits. *The American journal of clinical nutrition.* **83 (5)**: 1161-1169.

Naja F, et al. 2013. Association between dietary patterns and the risk of metabolic syndrome among Lebanese adults. *European journal of nutrition.* **52 (1)**: 97-105.

Noel SE, Newby P, Ordovas JM & Tucker KL 2009. A traditional rice and beans pattern is associated with metabolic syndrome in Puerto Rican older adults. *The journal of nutrition.* **139 (7)**: 1360-1367.

Oyeyemi AL, et al. 2011. The Short International Physical Activity Questionnaire: cross-cultural adaptation, validation and reliability of the Hausa language version in Nigeria. *BMC medical research methodology*. **11 (1)**: 1.

Panagiotakos DB, Pitsavos C, Skoumas Y & Stefanadis C 2007. The association between food patterns and the metabolic syndrome using principal components analysis: The ATTICA Study. *Journal of the American Dietetic Association.* **107 (6)**: 979-987.

Panel NCEPNE 2002. Third report of the National Cholesterol Education Program (NCEP) expert panel on detection, evaluation, and treatment of high blood cholesterol in adults (Adult Treatment Panel III) final report. *Circulation.* **106 (25)**: 3143.

Pelkman CL, et al. 2004. Effects of moderate-fat (from monounsaturated fat) and low-fat weight-loss diets on the serum lipid profile in overweight and obese men and women. *The American journal of clinical nutrition.* **79 (2)**: 204-212.

Qi L, et al. 2006. Whole-grain, bran, and cereal fiber intakes and markers of systemic inflammation in diabetic women. *Diabetes care.* **29 (2)**: 207-211.

Ramond JL & Couch SC 2016. Medical nutrition therapy for cardiovascular disease. In *Krause's food & the nutrition care process* (ed. L. K. Mahan, S. Escott-Stump and J. L. Raymond), pp. 758-769. Elsevier Health Sciences: USA.

Rolls BJ, Ello-Martin JA & Tohill BC 2004. What can intervention studies tell us about the relationship between fruit and vegetable consumption and weight management? *Nutrition reviews.* **62 (1)**: 1-17.

Ruidavets J-B, et al. 2007. High consumptions of grain, fish, dairy products and combinations of these are associated with a low prevalence of metabolic syndrome. *Journal of epidemiology and community health.* **61 (9)**: 810-817.

Samaha FF 2005. Effect of very high-fat diets on body weight, lipoproteins, and glycemic status in the obese. *Current atherosclerosis reports.* **7 (6)**: 412-420.

Song Y & Joung H 2012. A traditional Korean dietary pattern and metabolic syndrome abnormalities. *Nutrition, metabolism and cardiovascular diseases.* **22 (5)**: 456-462.

Ventura EE, et al. 2008. Dietary intake and the metabolic syndrome in overweight Latino children. *Journal of the American dietetic association.* **108 (8)**: 1355-1359.

Williams DE, et al. 2000. A cross-sectional study of dietary patterns with glucose intolerance and other features of the metabolic syndrome. *British journal of nutrition.* **83 (03)**: 257-266.

Wirfält E, et al. 2001. Food patterns and components of the metabolic syndrome in men and women: a cross-sectional study within the Malmö Diet and Cancer cohort. *American journal of epidemiology*. **154 (12)**: 1150-1159.

Zemel MB, Richards J, Milstead A & Campbell P 2005. Effects of Calcium and Dairy on Body Composition and Weight Loss in African-American Adults. *Obesity research.* **13 (7)**: 1218-1225.