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Original Article

Association between the DASH diet and metabolic syndrome components in Iranian adults

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ABSTRACT

Purposes: Diet has an important role in the management of chronic diseases. This study aimed to investigate the association of adherence to the dietary approaches to stop hypertension (DASH) diet with metabolic syndrome (MetS) and its components.
Methods: This cross-sectional study was performed on 396 Iranian adults, aged ≥18 years. A 147-item food frequency questionnaire (FFQ) was used to assess dietary intakes of participants. Fasting blood sample was obtained to quantify glycemic indicators and lipid profile. Metabolic syndrome was defined based on the guidelines of the National Cholesterol Education Program Adult Treatment Panel III (ATP III).
Results: Mean age of study participants was 38.22 ± 9.58 years. A significant inverse association was observed between adherence to DASH diet and odds of MetS (OR: 0.28, 95% CI: 0.14, 0.54); such that after adjusting for energy intake, socioeconomic status and body mass index (BMI), participants in the highest tertile of DASH diet scores were 49% less likely to have MetS (OR: 0.28, 95% CI: 0.14–0.54). Furthermore, adherence to DASH diet was inversely associated with elevated blood pressure (OR: 0.12, 95% CI: 0.05–0.29), high serum triglyceride (OR: 0.53, 95% CI: 0.28–1.00) and low serum HDL-C (OR: 0.51, 95% CI: 0.25–1.01). However, this association was marginally significant for triglyceride and HDL-C. No significant association was found between adherence to DASH diet and abdominal obesity.
Conclusion: We found that adherence to DASH was inversely associated with odds of MetS and some of its components including elevated blood pressure, low serum HDL-C and high serum triglyceride.

1. Introduction

Metabolic syndrome (MetS) is a clustering of metabolic disorders including glucose homeostasis, abdominal obesity, lipid disorders, and high blood pressure, which is associated with an increased risk of cardiovascular diseases [1]. The prevalence of metabolic syndrome is increasing throughout the world over the recent years [2]. It has been estimated that more than 30% Iranian adults are affected by MetS [3].

The etiology of the MetS is unknown [4]; however, insulin resistance and abdominal obesity have been introduced as the main causes of this syndrome [5]. Several factors such as genetic, metabolic and environmental factors, including diet, can affect rick of MetS [6]. Among dietary factors, high intakes of fruits, vegetables, legume and nuts and low intakes of high fat dairy, red and processed meat decrease the risk of MetS and its components [7]. The effects of nutrients and foods on the development of chronic diseases have been studied individually. On the other hand, given the fact that people do not receive nutrients individually and receive nutrients in a context of diet, considering whole diet in relation to chronic diseases provides further information on the diet-disease relationships. Furthermore, assessing whole diet considers the interaction of nutrients as well as synergistic effects of them on risk of chronic diseases.

Several studies have assessed different dietary patterns such as healthy, Mediterranean and western dietary patterns as well as some indices including dietary inflammatory index, healthy eating index and diet quality indices in relation to MetS. However, the association between dietary approaches to stop hypertension (DASH) diet and MetS has been studied previously, but findings are conflicting. Some studies revealed a significant inverse association between DASH diet and MetS; however, others failed to find any

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significant association. In addition to controversial findings, studies on the association between DASH diet and MetS were mostly from western nations and limited evidences are available in the under-studied regions of the Middle East where the prevalence of MetS is estimated to be high. Furthermore, previous studies did not controlled for some potential confounders such as BMI on the association between DASH diet and MetS. therefore, current study aimed to investigate the relationship between adherence to the DASH diet and MetS as well as its components.

2. Methods and materials

2.1. Participants

This is a cross-sectional study which was carried out between April 2017 and March 2018. Participants were recruited from the Endocrine Clinic of Imam Khomeini Hospital, Tehran University of Medical Sciences, Tehran, Iran. Firstly, we included 500 individuals with age of ≥18 years. Then, we excluded 55 participants due to pregnancy, postmenopausal status, lactation, suffering from any kinds of cancers, using medication for modifying fat, blood sugar and blood pressure, having ischemic heart disease, use of sedative or hypnotic drug, use of antihistamine, use of immune system inhibitors, following any special diet for any reasons under the supervision of a diet therapist, being professional athlete, use of weight loss drugs. Furthermore, we excluded 49 participants who reported energy intake out of reasonable range (800−4200 kcal/day) as underreporting and overreporting. Totally, 396 participants with complete data were remained for final analysis. All participants provided a written informed consent before participating in this study. The study was approved by Board of Directors and the ethics committee of Tehran University of Medical Sciences, Tehran, Iran.

2.2. Dietary intakes

We used a validated 147-item semi-quantitative food frequency questionnaire (SQ-FFQ) to assess usual dietary intakes. This questionnaire contains a list of food items and a standard serving size for each item. At first, subjects were instructed how to fulfil the questionnaire by one trained dietitian, who had more than 3 years' experience for administration of this questionnaire. Then, subjects were asked to report their consumption frequency of each item during the previous year on a daily (e.g., bread), weekly (e.g., rice or meat), monthly (e.g., fish), or yearly basis, and then report the amount of consumption for each time based on serving size. We converted the portion size of consumed foods to grams using booklet of "household measures". Daily intake of nutrients for each subject was calculated using the US Department of Agriculture's (USDA) national nutrient databank [8]. The previous studies have shown that the FFQ provided valid and reliable data on long-term intake of food groups and nutrients [9].

2.3. Development of DASH diet

To assess participants' adherence to the DASH diet, we developed the DASH diet score based on eight dietary components including high intake of fruits, vegetables, nuts and legume, dairy products, and low intake of grains, sugar-sweetened beverages and sweets, sodium, and red and processed meats. We used total dairy intake, instead of low-fat dairy consumption, because the SQ-FFQ in our study did not provide data on the type and amount of fat in dairy products. We considered both refined and whole grains as a single group of grains in this study. In the original scoring of DASH diet, whole-grain intake was given a high score. However, we considered total grain intake as a non-healthy food due to low intake of whole grain in Iranian population (<10 g/day) [10]. First, we calculated energy-adjusted intakes of these foods and nutrients using residual method [11]. Then, individuals were categorized into deciles of the energy-adjusted intakes of foods and nutrients. Individuals in the highest decile of fruits, vegetables, dairy products, legume and nuts were given the score of 10 and those in the lowest decile were given the score of 1. For total grains, red and processed meat, sugar-sweetened beverages and sweets, and sodium, individuals in the highest decile of foods and nutrients intakes were given the score of 1 and those in the lowest decile were given the score of 10. Finally, the DASH diet score for each participant was calculated by summing up the scores of all food and nutrients. Therefore, minimum and maximum scores of the DASH diet for each participant were between 8 and 80.

2.4. Anthropometric measures

Weight was measured with minimal clothing and without shoes by analogue scale with a precision of 100 g and height was determined in a standing position without shoes by a tape measure with the nearest 0.5 cm. Body mass index (BMI) was calculated as weight in kilograms divided by height in square meters. To measure waist circumference (WC), we measured the middle of bottom ribs and pelvic bones after a normal exhale using an inelastic tape.

2.5. Biochemical assessments

Blood sample was collected after 12 h overnight fasting to quantify serum levels of fasting blood sugar (FBS), high-density lipoprotein (HDL), and triglyceride (TG). FBS was measured on the day of blood collection by enzymatic colorimetric method using glucose oxidase. Serum triglyceride concentrations were assayed using enzymatic colorimetric tests with glycerol phosphate. To measure serum HDL-C concentrations, precipitation of the apo B-containing lipoproteins with phosphotungstic acid was determined. We applied commercially available enzymatic reagents (Pars Azmoon, Tehran, Iran), adopted to an auto-analyser system (Selectra E; Vitalab, Holliston, the Netherlands) for all measurements. Intra- and inter-assay CV for all biochemical measurements were 4.5% and 6.8%, respectively.

2.6. Assessment of other variables

Blood pressure was measured in seated and relaxed position by using of a standard mercury sphygmomanometer and after subjects rested for 10 min. It was measured three times with a 5 min interval and then, mean of three measurements was recorded as blood pressure. Furthermore, a self-administered questionnaire was used to gather data on age, gender (male/female), marital status (single/married), smoking (non-smoker/former smoker/current smoker), education (under university/university graduated), economic status (weak/good) and intake of nutritional supplements (vitamins, minerals, calcium and iron). Physical activity was assessed using the international physical activity questionnaire (IPAQ. Participants were classified into two categories based on physical activity: inactive and physically active. To determine economic status, we considered income of participants; having ≥2 million toman income per month as good and <2 million toman per month as weak economic status.

2.7. Definition of term

MetS was defined according to National Cholesterol Education Program (NCEP ATPIII) criteria [12]. Presence of three or more of the following criteria was considered as MetS: 1) abdominal obesity [Waist circumference (WC) ≥88 cm for women and ≥102 cm for men]; 2) low HDL concentrations [<50 mg/dl for women and <40 mg/dl for men]; 3) high serum TG [≥150 mg/dl]; 4) abnormal glucose homeostasis [FBS >100 mg/dl]; and 5) elevated blood pressure [systolic blood pressure ≥130 mmHg or diastolic blood pressure ≥85 mmHg].

2.8. Statistical analysis

First, we categorized participants based on tertiles of DASH diet scores. We used one-way ANOVA to assess differences in continues demographic variables and dietary intakes across tertiles of DASH diet scores. To assess distribution of participants in terms of categorical variables across tertiles of DASH diet scores, Chi-square test was used. We used binary logistic regression in crude and adjusted models to determine the association between DASH diet scores and MetS. In the first model, we controlled age, gender and energy intake. Further adjustment was made for marital status (single/married), physical activity (continuous), education (under university/university graduated), smoking (non-smoker/current smoker), economic status (weak/good) and nutritional supplements use (yes/no) in the second model. Furthermore, BMI was additionally controlled in the final model to reach general obesity-independent association between DASH diet scores and MetS. In these analyses, participants in the first tertile of DASH diet scores were considered as the reference group. To obtain the overall trend of odds ratios across increasing tertiles of DASH diet scores, we considered these tertiles as an ordinal variable in the logistic regression models. In addition to MetS, we also performed the same analyses for components of this syndrome in relation to DASH diet scores. All statistical analyses were conducted using the Statistical Package for Social Sciences (version 20; SPSS Inc.). $P < 0.05$ was considered statistically significant.

3. Results

Mean age of study participants was 38.22 ± 9.5 years and 38.1% were female. MetS was prevalent among 48.5% (192) of study participants.

Demographic characteristics, anthropometric measures and biochemical parameters of participants across tertiles of DASH diet scores are shown in Table 1. Compared with participants in the first tertile of DASH diet scores, those in the third tertile were more likely to be male, older and had lower weight and serum levels of TG. In addition, participants' economic status was significantly different across tertiles of DASH diet scores. Subjects in the top tertile of DASH diet scores had higher prevalence of reduced serum HDL-C and lower prevalence of elevated blood pressure and high serum triacylglycerol compared with those in the top tertile. No other significant difference was seen in terms of other demographic variables, anthropometric measures and biochemical parameters across tertiles of DASH diet scores.

Dietary intakes of selected foods and nutrients across tertiles of DASH diet scores are indicated in Table 2. Participants in the highest tertile of DASH diet scores had greater intakes of fiber, calcium, fruits, vegetables, grains, legumes and nuts and lower intakes of total fat, protein, red meat, sugar-sweetened beverages and sweets compared with those in the lowest tertile. In addition, dietary intakes of magnesium, folate, carbohydrate and low-fat dairy products were significantly different across tertiles of DASH diet scores. No other significant difference was observed in this regard.

Multivariate adjusted odds ratios and 95% CIs for MetS and its components across tertiles of DASH diet scores are provided in Table 3. A significant inverse association was observed between adherence to DASH diet and odds of MetS; such that after controlling for energy intake, socio-demographic variables and BMI, participants in the top tertile of DASH diet scores had 72% lower odds of MetS compared with those in the bottom tertile (OR: 0.28, 95% CI: 0.14, 0.54). Moreover, we found that adherence to DASH diet was inversely associated with odds of elevated blood pressure (OR: 0.09, 95% CI: 0.04, 0.17), increased serum TG concentrations (OR: 0.41, 95% CI: 0.24, 0.70) and reduced levels of HDL-C (OR: 0.32, 95% CI: 0.18, 0.57). When potential confounders were taken into account, such association remained significant for elevated blood pressure (OR: 0.12, 95% CI: 0.05, 0.29), however, became marginally significant for increased serum TG concentrations (OR: 0.53, 95% CI: 0.28, 1.00) and reduced levels of HDL-C (OR: 0.51, 95% CI: 0.25, 1.01). No significant association was seen between adherence to DASH diet and abdominal obesity and elevated FBS in fully adjusted model.

4. Discussion

In the present study, we found a significant inverse association between adherence to DASH diet and odds of MetS. Such significant association was also seen even after taking potential confounders into account. In terms of MetS components, adherence to DASH diet was inversely associated with elevated blood pressure, reduced levels of HDL-C and increased levels of TG. However, this association was marginally significant for HDL-C TG in fully adjusted model. No significant association was observed between DASH diet and other MetS components including abdominal obesity and elevated FBS. To the best of our knowledge; this study is among the first studies that examined the association of DASH diet with MetS and its components in the Middle East.

MetS is increasing at an alarming rate in both developed and developing countries [2]. Diet plays an important role in etiology of MetS [7,13–17]. Earlier studies have mainly focused on intake of a single food or nutrient in relation to MetS [18,19]. Assessing dietary pattern can consider interaction of nutrients or dietary components. Several studies have assessed the link between dietary pattern and MetS [20–24]; however, little attention has been paid on DASH diet. In the current study, we observed a significant inverse association between adherence to the DASH diet and odds of MetS. In line with our findings, Saneei et al. reported that adherence to DASH diet was inversely associated with odds of MetS [2]. Findings from a clinical trial revealed that DASH diet could favorably affect components of MetS [21]. Another clinical trial showed a significant reduction in blood pressure following administration of DASH diet during 6 weeks [25]. Protective effects of DASH diet against MetS might be explained by the effect of each component of this diet on this syndrome. Czekajlo et al. showed that fruits and vegetables were negatively associated with risk of MetS [26]. Another cross-sectional study revealed a significant inverse association between nut consumption and odds of MetS in US adolescents [27]. Overall, it seems that beneficial effect of DASH diet on MetS is due to fiber content of this diet. Individuals who adhere to DASH diet receive a high amount of fiber which inhibits the absorption of dietary cholesterol and fatty acids. Moreover, dietary fiber intake increases the production of short-chain fatty acids (SCFA) in the gut. These fatty acids can beneficially affect lipid profile and blood glucose. DASH diet contained high amount of potassium and low amount of sodium which can beneficially affect blood pressure. Of note, the association between DASH diet and MetS might be different across different nations. It might be explained by different processing or cooking methods for preparation of vegetables, whole grains, legume and nuts across different nations.

We found that adherence to DASH diet was inversely associated

Table 1
Baseline characteristics of study participants across tertiles of DASH diet scores.

Variables	Tertiles of the DASH diet score			P-value[a]
	T1 (n = 136)	T2 (n = 131)	T3 (n = 129)	
n	136	131	129	
Age (year)	36.52 ± 7.19	37.06 ± 8.84	41.18 ± 11.68	<0.001
Gender (female) (%)	19.2	33.1	47.7	<0.001
Weight (kg)	84.03 ± 16.20	84.10 ± 19.29	78.18 ± 14.78	0.005
BMI (kg/m^2)	28.69 ± 4.91	29.26 ± 5.79	28.54 ± 4.97	0.50
WC (cm)[3]	98.43 ± 12.60	97.7 ± 13.5	96.47 ± 12.73	0.45
Marital status (married) (%)	34.4	31.9	33.8	0.477
Current Smoker,%	35.3	41.2	23.5	0.156
Education (university graduated),%	30.1	36.4	33.5	0.251
Physical activity	1599.11 ± 2564.98	1254.35 ± 1600.79	1463.95 ± 2862.19	0.52
Economic status (good)	40.8	32.5	26.7	<0.0001
SBP (mmHg)[3]	102.49 ± 35.77	66.80 ± 51.50	68.09 ± 52.12	<0.0001
DBP (mmHg)[3]	53.73 ± 33.14	48.56 ± 34.26	45.77 ± 35.04	0.15
FBS (mg/dL)[3]	102.02 ± 22.82	100.21 ± 22.73	99.84 ± 26.70	0.73
TG (mg/dL) 3	174.13 ± 134.19	148.48 ± 113.35	133.02 ± 89.39	0.01
HDL (mg/dL)[3]	51.71 ± 8.93	50.93 ± 10.07	49.96 ± 10.23	0.34
Components of metabolic syndrome				
Abdominal adiposity	30.6	33.3	36.1	0.258
Elevated blood pressure	47.3	30.6	22.1	<0.0001
High serum triacylglycerol	43.5	33.3	23.2	0.004
Reduced serum HDL-C	27.7	32.1	40.1	<0.0001
Abnormal glucose homeostasis	41	32.9	32.7	0.075

Data are presented as mean (SD) or percent.
Abbreviations: BMI: body mass index; WC: Waist circumference; FBS: Fasting blood glucose; TG: Triglyceride; HDL: high-density lipoprotein; SBP: systolic blood pressure; DBP: diastolic blood pressure.
[a] P-values are obtained from analysis of one-way ANOVA and Chi-square test, where appropriate.

Table 2
Dietary intakes of participants across tertiles of DASH diet scores.

	T1 (n = 136)	T2 (n = 131)	T3 (n = 129)	P-value[a]
Nutrients				
Energy (kcal/d)	2469.4 ± 2122.4	2837.2 ± 1912.2	2432.6 ± 1615.3	0.16
Carbohydrate (g/d)	409.7 ± 6.7	395.5 ± 6.8	423.2 ± 6.9	0.01
Protein (g/d)	187.8 ± 7.95	145.7 ± 8.12	144.1 ± 8.16	<0.001
Total fat (g/d)	179.1 ± 8.3	138.5 ± 8.4	125.4 ± 8.5	<0.001
Fiber (g/d)	59.2 ± 1.8	49.9 ± 1.8	61.5 ± 1.8	<0.001
Magnesium (mg/d)	638 ± 17.1	552.2 ± 17.4	600.8 ± 17.5	0.002
Folate (μg/d)	784.3 ± 15.3	694.8 ± 15.6	712.8 ± 15.7	<0.001
Calcium (mg/d)	1430.1 ± 51.3	1462.9 ± 52.4	1704.2 ± 52.7	<0.001
Food groups (g/d)				
Fruits	259.03 ± 60.13	644.9 ± 61.4	1260.5 ± 61.7	<0.001
Vegetables	151.6 ± 17.3	272.7 ± 17.6	520.3 ± 17.7	<0.001
Legumes and nuts	48.3 ± 4.7	59.3 ± 4.8	75.3 ± 4.8	<0.001
Low-fat dairy products	48.3 ± 4.7	48.3 ± 4.7	48.3 ± 4.7	<0.001
High-fat dairy products	53.2 ± 13.6	99.4 ± 13.9	61 ± 13.9	0.043
Grains	16.7 ± 5.0	44.9 ± 5.1	58.2 ± 5.2	<0.001
SSB and sweets	117.6 ± 22.8	126.9 ± 23.3	35.2 ± 23.5	<0.0001
Red meat	12.6 ± 0.8	6.3 ± 0.9	1.3 ± 0.9	<0.001

All values are presented as mean ± SD.
Abbreviations: SSB: sugar-sweetened beverages.
[a] Obtained from ANOVA.

with reduced levels of HDL-C and increased levels of TG. However, these associations were marginally significant when potential confounders were taken into account. In agreement with our findings, a clinical trial on type 2 diabetic patients revealed a significant increase in HDL-C concentrations and a significant reduction in blood pressure following adherence to DASH diet for 8 weeks [28]. In a prospective study, adherence to DASH diet was inversely associated with serum concentrations of TG [29]. Such inverse association was also reported for HDL-C concentrations in another prospective study [30]. In contrast, findings from a cross-sectional study revealed no significant association between DASH diet and serum TG and HDL-C concentrations [31]. Observed discrepancy across previous studies might be explained by different study design, different sample size, different adjustments and different method used to measure HDL-C, TG and FBS.

Different mechanisms have been proposed on the influence of DASH diet on lipid profile. This diet contained a high amount of calcium which inhibits fat accumulation and decreases the serum levels of free fatty acids. In addition, adherence to DASH diet can significantly decreases insulin resistance which is a contributing factor for elevated serum levels of TG and reduced levels of HDL-C. Moreover, DASH diet is rich in fiber. Greater intake of dietary fiber is inversely associated with dyslipidemia or high levels of TG and low levels of HDL-C.

Some limitations should be considered when interpreting our findings. Present study was cross-sectional which prohibits

Table 3
Odd ratios and 95% CIs for MetS and its components across tertiles of the DASH diet scores.

	T1 (n = 136)	T2 (n = 131)	T3 (n = 129)	*P*-trend[a]
MetS				
Crude	1.00	0.45 (0.27, 0.74)	0.25 (0.15, 0.42)	<0.001
Model 1[¥]	1.00	0.50 (0.29, 0.85)	0.24 (0.13, 0.44)	<0.001
Model 2[€]	1.00	0.54 (0.31, 0.96)	0.26 (0.14, 0.48)	<0.001
Model 3[µ]	1.00	0.49 (0.27, 0.92)	0.28 (0.14, 0.54)	<0.001
Reduced serum HDL				
Crude	1.00	0.48 (0.27, 0.86)	0.32 (0.18, 0.57)	<0.001
Model 1[¥]	1.00	0.63 (0.34, 1.17)	0.52 (0.28, 0.97)	0.045
Model 2[€]	1.00	0.63 (0.33, 1.21)	0.56 (0.29, 1.10)	0.089
Model 3[µ]	1.00	0.65 (0.34, 1.27)	0.51 (0.25, 1.01)	0.053
Abdominal obesity				
Crude	1.00	1.26 (0.77, 2.05)	1.50 (0.92, 2.44)	0.10
Model 1[¥]	1.00	0.98 (0.58, 1.66)	0.80 (0.45, 1.39)	0.443
Model 2[€]	1.00	0.95 (0.54, 1.64)	0.73 (0.40, 1.31)	0.299
Model 3[µ]	1.00	0.87 (0.37, 2.04)	1.16 (0.48, 2.82)	0.773
Elevated FBS				
Crude	1.00	0.62 (0.38, 1.01)	0.60 (0.37, 0.99)	0.044
Model 1[¥]	1.00	0.64 (0.38, 1.07)	0.58 (0.33, 1.00)	0.046
Model 2[€]	1.00	0.68 (0.39, 1.17)	0.60 (0.34, 1.08)	0.086
Model 3[µ]	1.00	0.65 (0.37, 1.14)	0.65 (0.36, 1.17)	0.140
Increased serum TG				
Crude	1.00	0.68 (0.41, 1.12)	0.41 (0.24, 0.70)	0.001
Model 1[¥]	1.00	0.77 (0.46, 1.29)	0.50 (0.28, 0.89)	0.20
Model 2[€]	1.00	0.70 (0.40, 1.21)	0.48 (0.26, 0.89)	0.019
Model 3[µ]	1.00	0.65 (0.36, 1.16)	0.53 (0.28, 1.00)	0.049
Elevated BP				
Crude	1.00	0.17 (0.09, 0.33)	0.09 (0.04, 0.17)	<0.001
Model 1[¥]	1.00	0.16 (0.07, 0.35)	0.08 (0.03, 0.18)	<0.001
Model 2[€]	1.00	0.23 (0.1, 0.53)	0.12 (0.05, 0.29)	<0.001
Model 3[µ]	1.00	0.22 (0.09, 0.51)	0.12 (0.05, 0.29)	<0.001

Data are presented as odds ratio (95% CI).
Abbreviations: WC: Waist circumference; FBS: Fasting blood glucose; TG: Triglyceride; HDL: high-density lipoprotein; SBP: systolic blood pressure; DBP: diastolic blood pressure.
[¥]Model 1: adjusted for age, gender and energy intake.
[€]Model 2: additionally adjusted for marital status, physical activity, educations status, smoking, economic status and supplementation.
[µ]Model 3: further adjustment was made for BMI.
[a] Obtained by binary logistic regression.

inferring a causal link between adherence to the DASH diet and odds of MetS. Therefore, prospective studies are required in this regard. In addition, we used the FFQ for dietary intakes assessment that might lead to misclassification of study participants in terms of adherence to the DASH diet. Despite several adjustments in the current study, further control for confounding variables such as micronutrients deficiencies, menopausal status and psychosocial factors will be needed to reach an independent association between DASH diet and MetS. Unfortunately, we did not collect data on these variables in the present study. Moreover, our study population consists of Tehrani adults. Therefore, the extrapolation of our findings to all Iranian adults must be done cautiously.

In conclusion, we found a significant inverse association between adherence to DASH diet and odds of MetS. Such inverse association was also seen for elevated blood pressure, increased serum levels of TG and reduced levels of HDL-C. Randomized clinical trials are needed to assess the effect of adherence to DASH diet on outcomes of patients with MetS.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.dsx.2019.03.039.

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